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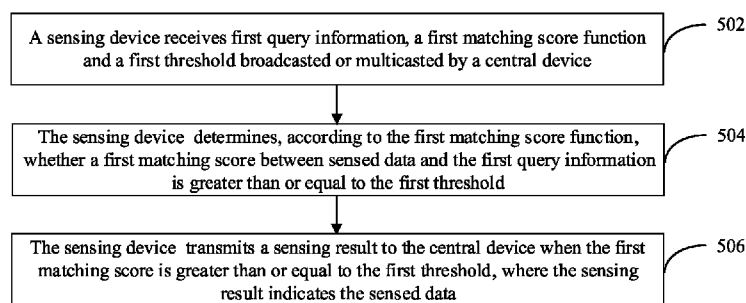


FIG. 5

(57) Abstract: Provided are a method and related products for semantic communications. The method includes: receiving first query information, a first matching score function and a first threshold broadcasted or multicasted by a central device; determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold; and transmitting a sensing result to the central device when the first matching score is greater than or equal to the first threshold, where the sensing result indicates the sensed data. The first query information, the first matching score function and the first threshold are broadcasted or multicasted by the central device, which can ensure that the determination basis for the sensing device is the same as that for other sensing devices, thereby improving the responding accuracy of the sensing device from the horizontal dimension. Further, the transmission of the sensing result has a specific condition, and the sensing result is not transmitted all the time, thus the transmission resources are saved. Besides, the transmitted sensing result meets the requirement of the first query information, that is, irrelevant information is filtered, the transmitted data is what the central device requires, the responding accuracy of the sensing device is thus ensured from the vertical dimension.

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METHOD, APPARATUS AND SYSTEM FOR SEMANTIC COMMUNICATIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to US provisional patent application No. 63/509,420, entitled “METHOD,
5 APPARATUS, AND SYSTEM FOR SEMANTIC/TASK QUERY” and filed on June 21, 2023, which is hereby
incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to the field of communication technologies and, in particular, to
a communication method, a communication apparatus, a communication system and related products.

10

BACKGROUND

[0003] A sensing function will be integrated into a 6th generation (6G) system. A large number of sensing user
equipments (UEs) or sensing devices will be densely deployed in cities, factories, farms and so on. In addition to
mobile phones, sensing devices will become an important type of UEs or devices that claim an arrival of internet of
thing (IoT) time. Like internet searching engines, 6G will come up with the counterpart, an IoT searching engine, in
15 a true physical world. In fact, billions of IoT-based applications such as driverless cars, automation factories, smart
cities, autonomous farms, will heavily depend on an efficient and real-time searching engine in the physical world.

[0004] Recently, artificial intelligence (AI) has conquered various intellectual and cognitive domains. Some AI
is exploring the cutting edge of intellectual knowledge in chemistry, gaming, mathematic, gene engineering; while
some other AI is providing a human-level Q&A platform in the digital world. The domain that AI hasn't conquered
20 is real-time physical world. Physical-world AI, in which AI technologies are to penetrate into all aspects of the
society and life, may be built on omnipresent IoT connections thanks to 6G.

[0005] More challenging than internet searching engines, a real-world searching engine would have to search
the physical world in real time over a large scale of physical area and to deal with a multitude of types of data and

information. Furthermore, green technology, low-energy and low-emission, are also raised as key features of 6G. A sensing device may be battery powered and/or completely powered by solar and wind. In some implementations, a sensing device may be a UE, a mobile phone or a handset, where independence among any two sensing devices are assumed; thereby, a sensing device may be scheduled individually by a wireless system to which the sensing device is associated; and sensed data that the sensing device measures may be application-level payload for the wireless system and protocol. The above scheme of scheduling a sensing device is inefficient in terms of radio bandwidth and energy consumption.

[0006] This background information is provided to reveal information believed by the applicant to be of possible relevance to the present application. No admission is necessarily intended, nor should be construed, that any of the preceding information constitutes prior art against the present application.

SUMMARY

[0007] In a first aspect, a communication method is provided in the present disclosure, and the method includes: receiving first query information, a first matching score function and a first threshold broadcasted or multicasted by a central device;

determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold; and

transmitting a sensing result to the central device when the first matching score is greater than or equal to the first threshold, where the sensing result indicates the sensed data.

[0008] The first query information broadcasted or multicasted by the central device wakes a sensing device to measure sensed data, the sensing device computes the first matching score between the sensed data and the first query information according to the first matching score function broadcasted or multicasted by the central device, in the case that the first matching score is greater than or equal to the first threshold, the sensing device transmits the sensing result to the central device. Firstly, the first query information, the first matching score function and the first threshold are broadcasted or multicasted by the central device, which can ensure that the determination basis for the sensing device is the same as that for other sensing devices, thereby improving the responding accuracy of the sensing device from the horizontal dimension; secondly, the transmission of the sensing result has a specific condition, and the sensing result is not transmitted all the time, thus the transmission resources are saved; thirdly, the transmitted sensing result meets the requirement of the first query information, that is, irrelevant information is filtered, the

transmitted data is what the central device requires, the responding accuracy of the sensing device is thus ensured from the vertical dimension.

[0009] In a possible implementation of the first aspect, the first query information includes query information for one task or query information for one modality.

5 [0010] The sensing device can serve for one task or one modality, i.e., the sensing device is dedicated to one task or one modality, the responding efficiency of the sensing device can thus be improved.

[0011] In a possible implementation of the first aspect, the method further includes: receiving an indication for a task identifier or an indication for a modality identifier from the central device.

[0012] The task identifier or the modality identifier can be explicitly or implicitly indicated.

10 [0013] In a possible implementation of the first aspect, the first query information includes multiple pieces of query information for multiple tasks and multiple task identifiers respectively associated with the multiple pieces of query information.

[0014] The sensing device can simultaneously serve for multiple tasks, resource utilization of the sensing device is thus improved.

15 [0015] In a possible implementation of the first aspect, the first query information includes multiple pieces of query information for multiple modalities and multiple modality identifiers respectively associated with the multiple pieces of query information.

[0016] The sensing device can simultaneously serve for multiple modalities, i.e., the sensing device can sense and feedback more than one modality (i.e., one type of data), which enriching the variety of data with which the
20 sensing device responds.

[0017] In a possible implementation of the first aspect, the first query information includes first multiple pieces of query information for multiple tasks, second multiple pieces of query information for multiple modalities, multiple task identifiers respectively associated with the first multiple pieces of query information, and multiple modality identifiers respectively associated with the second multiple pieces of query information.

25 [0018] The sensing device can simultaneously serve for both multiple tasks and multiple modalities, thereby not only improving the resource utilization of the sensing device, but also enriching the variety of data with which the sensing device responds.

[0019] In a possible implementation of the first aspect, the receiving the first query information, the first matching score function, and the first threshold broadcasted or multicasted by the central device includes:

receiving the first query information, the first matching score function, and the first threshold broadcasted by the central device in a synchronization signal/Physical Broadcast Channel (PBCH) block (SSB).

[0020] In a possible implementation of the first aspect, the first query information is carried in a master information block (MIB) message or a system information block (SIB) message, and the MIB message or the SIB message includes an indication for indicating that whether the first query information is presented in the MIB message or the SIB message.

[0021] Signaling overhead can be saved by virtue of the indication for indicating that whether the first query information is presented, since it is unnecessary to perform subsequent processing if it is indicated that the first query information is not presented.

[0022] In a possible implementation of the first aspect, the MIB message or the SIB message further includes an indication for indicating a period for the first query information.

[0023] The first query information is valid during the period, and may be invalid out of the period, thereby avoiding resource occupancy.

[0024] In a possible implementation of the first aspect, the receiving the first query information, the first matching score function, and the first threshold broadcasted or multicasted by the central device includes:

receiving the first query information, the first matching score function, and the first threshold multicasted by the central device in a multicast message.

[0025] In a possible implementation of the first aspect, the first query information includes at least two query semantics,

the receiving the first query information, the first matching score function, and the first threshold broadcasted or multicasted by the central device includes:

receiving a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic and a format of the first query semantic broadcasted or multicasted by the central device; and receiving a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic broadcasted or multicasted by the central device; or

receiving a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the

first query semantic, a format of the first query semantic, a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic broadcasted or multicasted by the central device in a multiplex way.

5 [0026] In the case that the first query information includes multiple query semantics, the multiple query semantics and information related to the multiple query semantics (i.e., the matching score function, the threshold, the length of the query semantic and the format of the query semantic corresponding to each query semantic) can be received in sequence, or can be simultaneously received in a multiplex way, which provides more flexibility and can thus meet different requirements.

10 [0027] In a possible implementation of the first aspect, the method further includes:
obtaining the sensed data;
translating the sensed data into a common sensing semantic;
the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold includes:

15 determining, according to the second matching score function, whether a second matching score between the common sensing semantic and the first query semantic is greater than or equal to the second threshold; and
determining, according to the third matching score function, whether a third matching score between the common sensing semantic and the second query semantic is greater than or equal to the third threshold.

[0028] In the case that the sensed data is in a form of natural language, while the first query information is in a
20 form of semantics, the sensed data can be translated into a common sensing semantic, for example, a common semantization configuration can be used for generating the common sensing semantic, which may simplify the generation of the sensing semantic. Then the comparison is implemented between the common sensing semantic and each of the query semantics. That is, both the sensed data and the query information are in a common semantic domain on which they can be easily compared to each other and fused. A query semantic may preserve all the key
25 semantic goals conveyed by a query message such that the query semantic can be well translated (de-semantized) back to a query message. Since the form of semantic may provide more accurate true intentions, accuracy of a comparing result is thus improved.

[0029] In a possible implementation of the first aspect, the method further includes:
obtaining the sensed data;

translating the sensed data into a first sensing semantic according to a first semantization configuration, the length of the first query semantic and the format of the first query semantic;

translating the sensed data into a second sensing semantic according to a second semantization configuration, the length of the second query semantic and the format of the second query semantic;

5 the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold includes:

determining, according to the second matching score function, whether a second matching score between the first sensing semantic and the first query semantic is greater than or equal to the second threshold; and

10 determining, according to the third matching score function, whether a third matching score between the second sensing semantic and the second query semantic is greater than or equal to the third threshold.

[0030] In the case that the sensed data is in a form of natural language, while the first query information is in a form of semantics, the sensed data can be translated into a first sensing semantic and a second sensing semantic respectively, respective semantization configurations are used for generating a corresponding sensing semantic, which may ensure the accuracy of the generated sensing semantic. Then the comparison is implemented between the first sensing semantic and the first query semantic, and between the second sensing semantic and the second query semantic. That is, both the sensed data and the query information are in a common semantic domain on which they can be easily compared to each other and fused. A query semantic may preserve all the key semantic goals conveyed by a query message such that the query semantic can be well translated (de-semantized) back to a query message. Since the form of semantic may provide more accurate true intentions, accuracy of a comparing result is thus improved.

20 [0031] In a possible implementation of the first aspect, the method further includes:

obtaining the sensed data;

translating the sensed data into a common sensing semantic;

tokenizing the common sensing semantic into a first sensing token, the first query semantic into a first query token, the common sensing semantic into a second sensing token and the second query semantic into a second query token according to a common tokenization configuration; or, tokenizing the common sensing semantic into a first sensing token and the first query semantic into a first query token according to a first tokenization configuration, and tokenizing the common sensing semantic into a second sensing token and the second query semantic into a second query token according to a second tokenization configuration;

the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold includes:

determining, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold; and

5 determining, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

[0032] In the case that the sensed data is in a form of natural language, while the first query information is in a form of semantics, the sensed data can be processed into a first sensing token and a second sensing token via a common sensing semantic, the first query semantic and the second query semantic can be processed into a first query
10 token and a second query token respectively, then the comparison is implemented between sensing tokens and corresponding query tokens. Since the form of token may provide more accurate true intentions and save signaling overhead, accuracy of a comparing result is thus improved and signaling overhead is saved. Further, the tokenization can be used to prevent a sensing device from recovering a complete query message from a query token. The tokenization may come up with certain privacy protection for query messages.

15 [0033] In a possible implementation of the first aspect, the method further includes:

obtaining the sensed data;

translating the sensed data into a first sensing semantic according to a first semantization configuration, the length of the first query semantic and the format of the first query semantic;

20 translating the sensed data into a second sensing semantic according to a second semantization configuration, the length of the second query semantic and the format of the second query semantic;

tokenizing the first sensing semantic into a first sensing token, the first query semantic into a first query token, the second sensing semantic into a second sensing token and the second query semantic into a second query token according to a common tokenization configuration; or, tokenizing the first sensing semantic into a first sensing token and the first query semantic into a first query token according to a first tokenization configuration, and
25 tokenizing the second sensing semantic into a second sensing token and the second query semantic into a second query token according to a second tokenization configuration;

the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold includes:

determining, according to the second matching score function, whether a second matching score between

the first sensing token and the first query token is greater than or equal to the second threshold; and

determining, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

[0034] In the case that the sensed data is in a form of natural language, while the first query information is in a form of semantics, the sensed data can be processed into a first sensing token and a second sensing token via a first sensing semantic and a second sensing semantic respectively, the first query semantic and the second query semantic can be processed into a first query token and a second query token respectively, then the comparison is implemented between sensing tokens and corresponding query tokens. Since the form of token may provide more accurate true intentions and save signaling overhead, accuracy of a comparing result is thus improved and signaling overhead is saved. Further, the tokenization can be used to prevent a sensing device from recovering a complete query message from a query token. The tokenization may come up with certain privacy protection for query messages.

[0035] In a possible implementation of the first aspect, the first query information includes at least two query tokens,

the receiving the first query information, the first matching score function, and the first threshold broadcasted or multicasted by the central device includes:

receiving a first query token among the at least two query tokens, a second matching score function related to the first query token, a second threshold related to the second matching score function and a length of the first query token broadcasted or multicasted by the central device; and receiving a second query token among the at least two query tokens, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token broadcasted or multicasted by the central device; or

receiving a first query token among the at least two query tokens, a second matching score function related to the first query token, a second threshold related to the second matching score function, a length of the first query token, a second query token among the at least two query tokens, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token broadcasted or multicasted by the central device in a multiplex way.

[0036] In the case that the first query information includes multiple query tokens, the multiple query tokens and information related to the multiple query tokens (i.e., the matching score function, the threshold and the length of the query token corresponding to each query semantic) can be received in sequence, or can be simultaneously

received in a multiplex way, which provides more flexibility and can thus meet different requirements.

[0037] In a possible implementation of the first aspect, the method further includes:

obtaining the sensed data;

translating the sensed data into a common sensing semantic;

5 tokenizing, according to a common tokenization configuration, the common sensing semantic into a first sensing token based on the length of the first query token, and the common sensing semantic into a second sensing token based on the length of the second query token; or, tokenizing, according to a first tokenization configuration, the common sensing semantic into a first sensing token based on the length of the first query token, and tokenizing, according to a second tokenization configuration, the common sensing semantic into a second sensing token based
10 on the length of the second query token;

the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold includes:

determining, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold; and

15 determining, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

[0038] In the case that the sensed data is in a form of natural language, while the first query information is in a form of tokens, the sensed data can be processed into a first sensing token and a second sensing token via a common sensing semantic, then the comparison is implemented between sensing tokens and corresponding query tokens.

20 Since the form of token may provide more accurate true intentions and save signaling overhead, accuracy of a comparing result is thus improved and signaling overhead is saved. Further, the tokenization can be used to prevent a sensing device from recovering a complete query message from a query token. The tokenization may come up with certain privacy protection for query messages.

[0039] In a possible implementation of the first aspect, the method further includes:

25 obtaining the sensed data;

translating the sensed data into a first sensing semantic according to a first semantization configuration;

translating the sensed data into a second sensing semantic according to a second semantization configuration;

tokenizing, according to a common tokenization configuration, the first sensing semantic into a first

sensing token based on the length of the first query token, and the second sensing semantic into a second sensing token based on the length of the second query token; or, tokenizing, according to a first tokenization configuration, the first sensing semantic into a first sensing token based on the length of the first query token, and tokenizing, according to a second tokenization configuration, the second sensing semantic into a second sensing token based on the length of the second query token;

the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold includes:

determining, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold; and

determining, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

[0040] In the case that the sensed data is in a form of natural language, while the first query information is in a form of tokens, the sensed data can be processed into a first sensing token and a second sensing token via a first sensing semantic and a second sensing semantic respectively, then the comparison is implemented between sensing tokens and corresponding query tokens. Since the form of token may provide more accurate true intentions and save signaling overhead, accuracy of a comparing result is thus improved and signaling overhead is saved. Further, the tokenization can be used to prevent a sensing device from recovering a complete query message from a query token. The tokenization may come up with certain privacy protection for query messages.

[0041] In a possible implementation of the first aspect, the first matching score function, the second matching score function or the third matching score function includes an inner product or a euclidean distance.

[0042] In a possible implementation of the first aspect, the sensing result includes one of the following:

raw sensed data;

a sensing semantic obtained from raw sensed data;

half raw sensed data and a sensing semantic obtained from raw sensed data;

raw sensed data and the first matching score;

a sensing semantic obtained from raw sensed data and the first matching score;

half raw sensed data, a sensing semantic obtained from raw sensed data, and the first matching score.

[0043] The sensing result may be in various forms related to the sensed data, which provides more flexibility and can thus meet different requirements.

[0044] In a possible implementation of the first aspect, the transmitting the sensing result to the central device includes:

transmitting a first matched sensing semantic and a fourth matching score related to the first matched sensing semantic to the central device; and transmitting a second matched sensing semantic and a fifth matching score related to the second matched sensing semantic to the central device.

[0045] In response to more than one query, the sensing device can transmit more than one sensing semantic and related matching score to the central device, in the case that a plurality of sensing devices transmit such data to the central device, the central device can perform a fusion operation on the received data from the plurality of sensing devices, so as to improve the accuracy of the fused data.

[0046] In a second aspect, a communication method is provided in the present disclosure, and the method includes:

broadcasting or multicasting first query information, a first matching score function and a first threshold to a plurality of sensing devices; and

receiving a sensing result from at least one sensing device among the plurality of sensing devices, where a first matching score between sensed data and the first query information is greater than or equal to the first threshold, where the first matching score is based on the first matching score function, and the sensing result indicates the sensed data.

[0047] The central device broadcasts or multicasts the first query information, the first matching score function and the first threshold, the transmission efficiency for the central device is thus improved. The central device receives the sensing result in the case that the first matching score between sensed data of a sensing device and the first query information is greater than or equal to the first threshold. The received sensing result meets the requirement of the first query information, that is, irrelevant information is filtered, the received data is what the central device requires, accuracy of data transmission is thus ensured.

[0048] In a possible implementation of the second aspect, the first query information includes query information for one task or query information for one modality.

[0049] In a possible implementation of the second aspect, the method further includes:

transmitting an indication for a task identifier or an indication for a modality identifier.

[0050] In a possible implementation of the second aspect, the first query information includes multiple pieces of query information for multiple tasks and multiple task identifiers respectively associated with the multiple pieces

of query information.

[0051] In a possible implementation of the second aspect, the first query information includes multiple pieces of query information for multiple modalities and multiple modality identifiers respectively associated with the multiple pieces of query information.

5 [0052] In a possible implementation of the second aspect, the first query information includes first multiple pieces of query information for multiple tasks, second multiple pieces of query information for multiple modalities, multiple task identifiers respectively associated with the first multiple pieces of query information, and multiple modality identifiers respectively associated with the second multiple pieces of query information.

[0053] In a possible implementation of the second aspect, the broadcasting or multicasting the first query
10 information, the first matching score function and the first threshold to the plurality of sensing devices includes:

broadcasting the first query information, the first matching score function and the first threshold in a synchronization signal/Physical Broadcast Channel (PBCH) block (SSB), to the plurality of sensing devices.

[0054] In a possible implementation of the second aspect, the first query information is carried in a master information block (MIB) message or a system information block (SIB) message, and the MIB message or the SIB
15 message includes an indication for indicating that whether the first query information is presented in the MIB message or the SIB message.

[0055] In a possible implementation of the second aspect, the MIB message or the SIB message further includes an indication for indicating a period for the first query information.

[0056] In a possible implementation of the second aspect, the broadcasting or multicasting the first query
20 information, the first matching score function and the first threshold to the plurality of sensing devices includes:

multicasting the first query information, the first matching score function and the first threshold in a multicast message, to the plurality of sensing devices.

[0057] In a possible implementation of the second aspect, the method further includes:
receiving second query information from a generative pre-trained transformer (GPT) device;
25 outputting the sensing result to the GPT device.

[0058] The central device receives the second query information from the GPT device, provides the first query information, the first matching score function and the first threshold for a sensing device to make a decision, then receives the sensing result from the sensing device, and outputs the sensing result to the GPT device, the central device serves as a bridge between the sensing device and the GPT device, thereby assisting in smooth communication

between the sensing device and the GPT device.

[0059] In a possible implementation of the second aspect, the receiving the second query information from the GPT device includes:

receiving at least two query semantics from at least two GPT devices;

5 the broadcasting or multicasting the first query information, the first matching score function and the first threshold to the plurality of sensing devices includes:

broadcasting or multicasting a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic and a format of the first query semantic to the plurality of sensing devices; and broadcasting or multicasting a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic to the plurality of sensing devices; or

broadcasting or multicasting a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic, a format of the first query semantic, a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic to the plurality of sensing devices in a multiplex way.

20 [0060] In the case that the second query information includes multiple query semantics, the central device can broadcast or multicast the multiple query semantics and information related to the multiple query semantics (i.e., the matching score function, the threshold, the length of the query semantic and the format of the query semantic corresponding to each query semantic) in sequence, or in a multiplex way, which provides more flexibility and can thus meet different requirements.

25 [0061] In a possible implementation of the second aspect, the receiving the second query information from the GPT device includes:

receiving at least two query semantics from at least two GPT devices;

the method further includes:

tokenizing a first query semantic and a second query semantic among the at least two query semantics

into a first query token and a second query token;

the broadcasting or multicasting the first query information, the first matching score function and the first threshold to the plurality of sensing devices includes:

5 broadcasting or multicasting the first query token, a second matching score function related to the first query token, a second threshold related to the second matching score function and a length of the first query token to the plurality of sensing devices; and broadcasting or multicasting the second query token, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token to the plurality of sensing devices; or

10 broadcasting or multicasting the first query token, a second matching score function related to the first query token, a second threshold related to the second matching score function, a length of the first query token, the second query token, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token to the plurality of sensing devices in a multiplex way.

[0062] In the case that the second query information includes multiple query semantics, the central device can
15 tokenize the query semantics into corresponding query tokens, and then broadcast or multicast multiple query tokens and information related to the multiple query tokens (i.e., the matching score function, the threshold, the length of the query token corresponding to each query token) in sequence, or in a multiplex way, which provides more flexibility and can thus meet different requirements.

[0063] In a possible implementation of the second aspect, the tokenizing the first query semantic and the second
20 query semantic among the at least two query semantics into the first query token and the second query token includes:

tokenizing the first query semantic into the first query token according to a first tokenization configuration; and tokenizing the second query semantic into the second query token according to a second tokenization configuration; or

25 tokenizing the first query semantic into the first query token according to a common tokenization configuration; and tokenizing the second query semantic into the second query token according to the common tokenization configuration.

[0064] The tokenization of different query semantics can be implemented through the same tokenization configuration or different tokenization configurations, which may depend on actual needs.

[0065] In a possible implementation of the second aspect, the first matching score function, the second matching

score function or the third matching score function includes an inner product or a euclidean distance.

[0066] In a possible implementation of the second aspect, the sensing result includes one of the following:

raw sensed data;

a sensing semantic obtained from raw sensed data;

5 half raw sensed data and a sensing semantic obtained from raw sensed data;

raw sensed data and the first matching score;

a sensing semantic obtained from raw sensed data and the first matching score;

half raw sensed data, a sensing semantic obtained from raw sensed data, and the first matching score.

[0067] In a possible implementation of the second aspect, the receiving the sensing result from the at least one

10 sensing device includes:

receiving multiple first matched sensing semantics and multiple fourth matching scores related to the

multiple first matched sensing semantics from the at least one sensing device among the plurality of sensing devices;

and receiving multiple second matched sensing semantics and multiple fifth matching scores related to the multiple

second matched sensing semantics from the at least one sensing device among the plurality of sensing devices;

15 the method further includes:

obtaining a first fused sensing semantic by fusing part or all of the multiple first matched sensing

semantics according to the multiple fourth matching scores; and obtaining a second fused sensing semantic by fusing

part or all of the multiple second matched sensing semantics according to the multiple fifth matching scores.

[0068] In the case that there are multiple sensing results for multiple modalities included in the feedback data

20 of the sensing device, and there are multiple sensing semantics for a single modality, the central device may perform

a fusing operation on the sensing semantics of the same modality respectively, thus, the fused sensing semantic is

comprehensive, thereby improving the accuracy of the fused sensing semantic. During the fusing operation on the

sensing semantics of the same modality, by considering the matching score of each sensing semantic which may

indicate the relevance between the sensing semantic and the first query information, the multiple sensing semantics

25 of the same modality are fused according to their matching scores, for example, in which the sensing semantic with

the higher matching score would be given higher importance in the fusion, thus the impact of some sensing semantics

with lower reliability may be reduced, the accuracy of the fused sensing semantic is thus further improved, and the

reliability of the fused sensing semantic is ensured.

[0069] In a possible implementation of the second aspect, the receiving the sensing result from the at least one

sensing device includes:

receiving multiple sensing semantics, multiple fourth matching scores related to the multiple sensing semantics and multiple fifth matching scores related to the multiple sensing semantics from the at least one sensing device among the plurality of sensing devices;

5 the method further includes:

obtaining a first fused sensing semantic by fusing part or all of the multiple sensing semantics according to the multiple fourth matching scores; and obtaining a second fused sensing semantic by fusing part or all of the multiple second sensing semantics according to the multiple fifth matching scores.

[0070] In the case that there are multiple sensing semantics for one modality but for multiple tasks included in the feedback data of the sensing device, the central device may perform a fusing operation on the sensing semantics of the same task respectively, thus, the fused sensing semantic is comprehensive, thereby improving the accuracy of the fused sensing semantic. During the fusing operation on the sensing semantics of the same task, by considering the matching score of each sensing semantic which may indicate the relevance between the sensing semantic and the first query information, the multiple sensing semantics of the same task are fused according to their matching scores, for example, in which the sensing semantic with the higher matching score would be given higher importance in the fusion, thus the impact of some sensing semantics with lower reliability may be reduced, the accuracy of the fused sensing semantic is thus further improved, and the reliability of the fused sensing semantic is ensured.

[0071] In a possible implementation of the second aspect, the method further includes:
transmitting the first fused sensing semantic to a first GPT device among the at least two GPT devices;
20 and
transmitting the second fused sensing semantic to a second GPT device among the at least two GPT devices.

[0072] The first or second fused sensing semantic can be respectively processed by the first or second GPT device to generate a next query based on the fused input.

25 [0073] In a possible implementation of the second aspect, the method further includes:
determining a sixth matching score for the first fused sensing semantic; and determining a seventh matching score for the second fused sensing semantic.

[0074] The sixth matching score may indicate the relevance between the first fused sensing semantic and the first query information, the seventh matching score may indicate the relevance between the second fused sensing

semantic and the first query information, that is, the sixth matching score and the seventh matching score may be used for evaluating the reliability of corresponding fused sensing semantics.

5 [0075] In a third aspect, a communication apparatus is provided in the present disclosure, the apparatus includes various modules configured to execute the communication method according to the first aspect or any possible implementation of the first aspect.

[0076] In a fourth aspect, a communication apparatus is provided in the present disclosure, the apparatus includes various modules configured to execute the communication method according to the second aspect or any possible implementation of the second aspect.

10 [0077] In a fifth aspect, a sensing device is provided in the present disclosure, the sensing device includes processing circuitry for executing the communication method according to the first aspect or any possible implementation of the first aspect.

[0078] In a sixth aspect, a central device is provided in the present disclosure, the central device includes processing circuitry for executing the communication method according to the second aspect or any possible implementation of the second aspect.

15 [0079] In a seventh aspect, a communication system is provided in the present disclosure, the communication system includes a sensing device according to the fifth aspect and a central device according to the sixth aspect.

[0080] In an eighth aspect, a chip is provided in the present disclosure, the chip includes an input/output (I/O) interface and a processor, where the processor is configured to call and run computer execution instructions stored in a memory, to enable a device installing with the chip to execute the communication method according to the first or second aspect or any possible implementation of the first or second aspect.

20 [0081] In a ninth aspect, a computer-readable medium is provided in the present disclosure, the computer-readable medium stores computer execution instructions which, when executed by a processor, causes the processor to execute the communication method according to the first or second aspect or any possible implementation of the first or second aspect.

25 [0082] In a tenth aspect, a computer program product is provided in the present disclosure, the computer program product includes computer execution instructions which, when executed by a processor, causes the processor to execute the communication method according to the first or second aspect or any possible implementation of the first or second aspect.

[0083] The present disclosure provides a communication method and related products. The central device

broadcasts or multicasts the first query information, the first matching score function and the first threshold to the sensing device. The sensing device determines, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold, and transmits a sensing result to the central device when the first matching score is greater than or equal to the first threshold. The broadcasting or multicasting manner can ensure high transmission efficiency for the central device, and can also ensure that the determination basis for the sensing device is the same as that for other sensing devices, thereby improving the responding accuracy of the sensing device from the horizontal dimension. The transmission of the sensing result for the sensing device has a specific condition, and the sensing result is not transmitted all the time, thus the transmission resources are saved; in addition, the transmitted sensing result meets the requirement of the first query information, that is, irrelevant information is filtered, the transmitted data is what the central device requires, accuracy of data transmission is thus ensured.

BRIEF DESCRIPTION OF DRAWINGS

[0084] The accompanying drawings are used to provide a further understanding of the present disclosure, constitute a part of the specification, and are used to explain the present disclosure together with the following specific example embodiments, but should not be construed as limiting the present disclosure.

[0085] FIG. 1 is a schematic illustration of a communication system according to one or more examples of the present disclosure.

[0086] FIG. 2 is another schematic illustration of a communication system according to one or more examples of the present disclosure.

[0087] FIG. 3 is a schematic illustration of basic component structure of a communication system according to one or more examples of the present disclosure.

[0088] FIG. 4 illustrates a block diagram of a device in a communication system according to one or more examples of the present disclosure.

[0089] FIG. 5 is a schematic flowchart of a communication method according to one or more examples of the present disclosure.

[0090] FIG. 6 is a schematic flowchart of another communication method according to one or more examples of the present disclosure.

[0091] FIG. 7 is a schematic flowchart of still another communication method according to one or more

examples of the present disclosure.

[0092] FIG. 8 is still another schematic illustration of a communication system according to one or more examples of the present disclosure.

5 [0093] FIG. 9 is a schematic illustration of division for sensing devices according to one or more examples of the present disclosure.

[0094] FIG. 10 is a schematic illustration of interaction between devices in a communication system according to one or more examples of the present disclosure.

[0095] FIG. 11 is another schematic illustration of interaction between devices in a communication system according to one or more examples of the present disclosure.

10 [0096] FIG. 12 is a schematic illustration of generating a sequence of query messages in a communication system according to one or more examples of the present disclosure.

[0097] FIG. 13 is a schematic illustration of interaction between a central device and two sensing devices in a communication system according to one or more examples of the present disclosure.

15 [0098] FIG. 14 is another schematic illustration of interaction between a central device and two sensing devices in a communication system according to one or more examples of the present disclosure.

[0099] FIG. 15 is a schematic illustration of generating a query semantic by a GPT device in a communication system according to one or more examples of the present disclosure.

[0100] FIG. 16 is a schematic illustration of recovering a query message from a query semantic in a communication system according to one or more examples of the present disclosure.

20 [0101] FIG. 17 is a schematic illustration of generating a query token by a GPT device in a communication system according to one or more examples of the present disclosure.

[0102] FIG. 18 is a schematic illustration of responding to a query token from a central device by a sensing device according to one or more examples of the present disclosure.

25 [0103] FIG. 19 is a schematic illustration of a scoring operation implemented by a sensing device according to one or more examples of the present disclosure.

[0104] FIG. 20 is a schematic illustration of responding to a query semantic from a central device by a sensing device according to one or more examples of the present disclosure.

[0105] FIG. 21 is another schematic illustration of a scoring operation implemented by a sensing device according to one or more examples of the present disclosure.

[0106] FIG. 22 is another schematic illustration of responding to a query semantic from a central device by a sensing device according to one or more examples of the present disclosure.

[0107] FIG. 23 is still another schematic illustration of a scoring operation implemented by a sensing device according to one or more examples of the present disclosure.

5 [0108] FIG. 24 is a block diagram of a communication apparatus according to one or more examples of the present disclosure.

[0109] FIG. 25 is a block diagram of another communication apparatus according to one or more examples of the present disclosure.

DESCRIPTION OF EMBODIMENTS

10 [0110] In the following description, reference is made to the accompanying figures, which form part of the present disclosure, and which show, by way of illustration, specific aspects of examples of the present disclosure or specific aspects in which examples of the present disclosure may be used. It is understood that examples of the present disclosure may be used in other aspects and include structural or logical changes not depicted in the figures. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present disclosure is defined by the appended claims.

[0111] To assist in understanding the present disclosure, examples of wireless communication systems and devices are described below.

[0112] Example communication systems and devices

[0113] The present disclosure uses the interaction and processing procedures among at least one UE (i.e., the sensing device which is also called a sensing node, which is marked as ED in FIG. 1), at least one BS (i.e., the central device) and at least one GPT device in a wireless system as an illustrative example. The exchanged information and protocol flows can also be used between other network nodes described below, for example, between ED 110 and TRP 170, between ED 110 and core network, between ED 110 and ED 110, between TRP 170 and TRP 170, between TRP 170 and GPT device 180. The UE in the procedure described in the present disclosure may be replaced with a sensing node mentioned below. The BS in the procedure described in the present disclosure may be replaced with a sensing coordinator. The sensing coordinator are nodes in a network that can assist in the sensing operation. These nodes can be stand-alone nodes dedicated to just sensing operations or other nodes (for example TRP 170, ED 110, or core network node shown below) doing the sensing operations in parallel with communication transmissions.

[0114] Referring to FIG. 1, as an illustrative example without limitation, a simplified schematic illustration of a communication system is provided. The communication system 100 (which may be the wireless system in FIG. 1) comprises a radio access network 120. The radio access network 120 may be a next generation (e.g. sixth generation (6G) or later) radio access network, or a legacy (e.g. 5G, 4G, 3G or 2G) radio access network. One or more communication electric device (ED) 110a, 110b, 110c, 110d, 110e, 110f, 110g, 110h, 110i, 110j (generically referred to as 110) may be interconnected to one another or connected to one or more network nodes (170a, 170b, generically referred to as 170) in the radio access network 120. A core network 130 may be a part of the communication system and may be dependent or independent of the radio access technology used in the communication system 100. Also the communication system 100 comprises a public switched telephone network (PSTN) 140, the internet 150, and other networks 160.

[0115] The uplink messages/data transmitted between the central device (e.g., the network node 170) and the sensing device (e.g., ED 180) could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., UCI. Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate message. The downlink messages/data transmitted between the central device and the ED 110 could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., DCI. Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate message.

[0116] In addition, the communication system 100 comprises at least one GPT device 180. The GPT device 180 may be located within the one or more network node 170. The GPT device 180 may be an independent device connected to the network 170, such as an ED 110 which connected to the network node 170 via Uu interface. The GPT device 180 may be a device connected to the network node 170 vial core network 130. When the GPT device 180 is an ED, the uplink messages/data transmitted between the central device (e.g., the network node 170) and the GPT device 180 could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., UCI. Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate

message. The downlink messages/data transmitted between the central device and the GPT device 180 could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., DCI. Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate message.

[0117] FIG. 2 illustrates an example communication system 100. In general, the communication system 100 enables multiple wireless or wired elements to communicate data and other content. The purpose of the communication system 100 may be to provide content, such as voice, data, video, signaling and/or text, via broadcast, multicast and unicast, etc. The communication system 100 may operate by sharing resources, such as carrier spectrum bandwidth, between its constituent elements. The communication system 100 may include a terrestrial communication system and/or a non-terrestrial communication system. The communication system 100 may provide a wide range of communication services and applications (such as earth monitoring, remote sensing, passive sensing and positioning, navigation and tracking, autonomous delivery and mobility, etc.). The communication system 100 may provide a high degree of availability and robustness through a joint operation of a terrestrial communication system and a non-terrestrial communication system. For example, integrating a non-terrestrial communication system (or components thereof) into a terrestrial communication system can result in what may be considered a heterogeneous network comprising multiple layers. Compared to conventional communication networks, the heterogeneous network may achieve better overall performance through efficient multi-link joint operation, more flexible functionality sharing, and faster physical layer link switching between terrestrial networks and non-terrestrial networks.

[0118] The terrestrial communication system and the non-terrestrial communication system could be considered sub-systems of the communication system. In the example shown in FIG. 2, the communication system 100 includes electronic devices (ED) 110a, 110b, 110c, 110d (generically referred to as ED 110), radio access networks (RANs) 120a-120b, a non-terrestrial communication network 120c, a core network 130, a public switched telephone network (PSTN) 140, the Internet 150, and other networks 160. The RANs 120a-120b include respective base stations (BSs) 170a-170b, which may be generically referred to as terrestrial transmit and receive points (T-TRPs) 170a-170b. The non-terrestrial communication network 120c includes an access node 172, which may be generically referred to as a non-terrestrial transmit and receive point (NT-TRP) 172.

[0119] Any ED 110 may be alternatively or additionally configured to interface, access, or communicate with

any T-TRP 170a-170b and NT-TRP 172, the Internet 150, the core network 130, the PSTN 140, the other networks 160, or any combination of the preceding. In some examples, ED 110a may communicate an uplink and/or downlink transmission over a terrestrial air interface 190a with T-TRP 170a. In some examples, the EDs 110a, 110b, 110c and 110d may also communicate directly with one another via one or more sidelink air interfaces 190b. In some examples, ED 110d may communicate an uplink and/or downlink transmission over a non-terrestrial air interface 190c with NT-TRP 172.

[0120] The air interfaces 190a and 190b may use similar communication technology, such as any suitable radio access technology. For example, the communication system 100 may implement one or more channel access methods, such as code division multiple access (CDMA), space division multiple access (SDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal FDMA (OFDMA), Direct Fourier Transform spread OFDMA (DFT-OFDMA) or single-carrier FDMA (SC-FDMA) in the air interfaces 190a and 190b. The air interfaces 190a and 190b may utilize other higher dimension signal spaces, which may involve a combination of orthogonal and/or non-orthogonal dimensions.

[0121] The non-terrestrial air interface 190c can enable communication between the ED 110d and one or multiple NT-TRPs 172 via a wireless link or simply a link. For some examples, the link is a dedicated connection for unicast transmission, a connection for broadcast transmission, or a connection between a group of EDs 110 and one or multiple NT-TRPs 172 for multicast transmission.

[0122] The RANs 120a and 120b are in communication with the core network 130 to provide the EDs 110a 110b, and 110c with various services such as voice, data, and other services. The RANs 120a and 120b and/or the core network 130 may be in direct or indirect communication with one or more other RANs (not shown), which may or may not be directly served by core network 130, and may or may not employ the same radio access technology as RAN 120a, RAN 120b or both. The core network 130 may also serve as a gateway access between (i) the RANs 120a and 120b or EDs 110a 110b, and 110c or both, and (ii) other networks (such as the PSTN 140, the Internet 150, and the other networks 160). In addition, some or all of the EDs 110a 110b, and 110c may include functionality for communicating with different wireless networks over different wireless links using different wireless technologies and/or protocols. Instead of wireless communication (or in addition thereto), the EDs 110a 110b, and 110c may communicate via wired communication channels to a service provider or switch (not shown), and to the Internet 150. PSTN 140 may include circuit switched telephone networks for providing plain old telephone service (POTS). Internet 150 may include a network of computers and subnets (intranets) or both, and incorporate protocols, such as

Internet Protocol (IP), Transmission Control Protocol (TCP), User Datagram Protocol (UDP). EDs 110a 110b, and 110c may be multimode devices capable of operation according to multiple radio access technologies, and incorporate multiple transceivers necessary to support such.

[0123] Basic component structure

5 **[0124]** FIG. 3 illustrates another example of an ED 110 and a base station 170a, 170b and/or 170c. The ED 110 is used to connect persons, objects, machines, etc. The ED 110 may be widely used in various scenarios, for example, cellular communications, device-to-device (D2D), vehicle to everything (V2X), peer-to-peer (P2P), machine-to-machine (M2M), machine-type communications (MTC), Internet of things (IOT), virtual reality (VR), augmented reality (AR), mixed reality (MR), metaverse, digital twin, industrial control, self-driving, remote medical, smart grid, smart furniture, smart office, smart wearable, smart transportation, smart city, drones, robots, remote sensing, passive
10 sensing, positioning, navigation and tracking, autonomous delivery and mobility, etc.

[0125] Each ED 110 represents any suitable end user device for wireless operation and may include such devices (or may be referred to) as a user equipment/device (UE), a wireless transmit/receive unit (WTRU), a mobile station, a fixed or mobile subscriber unit, a cellular telephone, a station (STA), a machine type communication (MTC) device,
15 a personal digital assistant (PDA), a smartphone, a laptop, a computer, a tablet, a wireless sensor, a consumer electronics device, a smart book, a vehicle, a car, a truck, a bus, a train, or an IoT device, wearable devices such as a watch, head mounted equipment, a pair of glasses, an industrial device, or apparatus (e.g. communication module, modem, or chip) in the forgoing devices, among other possibilities. Future generation EDs 110 may be referred to using other terms. Each base station 170a and 170b is a T-TRP and will hereafter be referred to as T-TRP 170. Also
20 shown in FIG.3, a NT-TRP will hereafter be referred to as NT-TRP 172. Each ED 110 connected to T-TRP 170 and/or NT-TRP 172 can be dynamically or semi-statically turned-on (i.e., established, activated, or enabled), turned-off (i.e., released, deactivated, or disabled) and/or configured in response to one of more of: connection availability and connection necessity.

[0126] The ED 110 includes a transmitter 201 and a receiver 203 coupled to one or more antennas 204. Only
25 one antenna 204 is illustrated. One, some, or all of the antennas 204 may alternatively be panels. The transmitter 201 and the receiver 203 may be integrated, e.g. as a transceiver. The transceiver is configured to modulate data or other content for transmission by at least one antenna 204 or network interface controller (NIC). The transceiver is also configured to demodulate data or other content received by the at least one antenna 204. Each transceiver includes any suitable structure for generating signals for wireless or wired transmission and/or processing signals received

wirelessly or by wire. Each antenna 204 includes any suitable structure for transmitting and/or receiving wireless or wired signals.

[0127] The ED 110 includes at least one memory 208. The memory 208 stores instructions and data used, generated, or collected by the ED 110. For example, the memory 208 could store software instructions or modules configured to implement some or all of the functionality and/or embodiments described herein and that are executed by one or more processing unit(s) (e.g., a processor 210). Each memory 208 includes any suitable volatile and/or non-volatile storage and retrieval device(s). Any suitable type of memory may be used, such as random access memory (RAM), read only memory (ROM), hard disk, optical disc, subscriber identity module (SIM) card, memory stick, secure digital (SD) memory card, on-processor cache, and the like.

[0128] The ED 110 may further include one or more input/output devices (not shown) or interfaces (such as a wired interface to the Internet 150 in FIG. 1). The input/output devices permit interaction with a user or other devices in the network. Each input/output device includes any suitable structure for providing information to or receiving information from a user, such as through operation as a speaker, a microphone, a keypad, a keyboard, a display, or a touch screen, including network interface communications.

[0129] The ED 110 includes the processor 210 for performing operations including those operations related to preparing a transmission for uplink transmission to the NT-TRP 172 and/or the T-TRP 170, those operations related to processing downlink transmissions received from the NT-TRP 172 and/or the T-TRP 170, and those operations related to processing sidelink transmission to and from another ED 110. Processing operations related to preparing a transmission for uplink transmission may include operations such as encoding, modulating, transmit beamforming, and generating symbols for transmission. Processing operations related to processing downlink transmissions may include operations such as receive beamforming, demodulating and decoding received symbols. Depending upon the embodiment, a downlink transmission may be received by the receiver 203, possibly using receive beamforming, and the processor 210 may extract signaling from the downlink transmission (e.g. by detecting and/or decoding the signaling). An example of signaling may be a reference signal transmitted by the NT-TRP 172 and/or by the T-TRP 170. In some embodiments, the processor 210 implements the transmit beamforming and/or the receive beamforming based on the indication of beam direction, e.g. beam angle information (BAI), received from the T-TRP 170. In some embodiments, the processor 210 may perform operations relating to network access (e.g. initial access) and/or downlink synchronization, such as operations relating to detecting a synchronization sequence, decoding and obtaining the system information, etc. In some embodiments, the processor 210 may perform channel estimation,

e.g. using a reference signal received from the NT-TRP 172 and/or from the T-TRP 170.

[0130] Although not illustrated, the processor 210 may form part of the transmitter 201 and/or part of the receiver 203. Although not illustrated, the memory 208 may form part of the processor 210.

[0131] The processor 210, the processing components of the transmitter 201 and the processing components of the receiver 203 may each be implemented by the same or different one or more processors that are configured to execute instructions stored in a memory (e.g. in the memory 208). Alternatively, some or all of the processor 210, the processing components of the transmitter 201 and the processing components of the receiver 203 may each be implemented using dedicated circuitry, such as a programmed field-programmable gate array (FPGA), a graphical processing unit (GPU), a Central Processing Unit (CPU) or an application-specific integrated circuit (ASIC).

[0132] In some implementations, the ED 110 may be an apparatus (also called component) for example, communication module, modem, chip, or chipset, it includes at least one processor 210, and an interface or at least one pin. In this scenario, the transmitter 201 and receiver 203 may be replaced by the interface or at least one pin, wherein the interface or at least one pin is to connect the apparatus (e.g., chip) and other apparatus (e.g., chip, memory, or bus). Accordingly, the transmitting information to the NT-TRP 172 and/or the T-TRP 170 and/or another ED 110 may be referred as transmitting information to the interface or at least one pin, or as transmitting information to the NT-TRP 172 and/or the T-TRP 170 and/or another ED 110 via the interface or at least one pin, and receiving information from the NT-TRP 172 and/or the T-TRP 170 and/or another ED 110 may be referred as receiving information from the interface or at least one pin, or as receiving information from the NT-TRP 172 and/or the T-TRP 170 and/or another ED 110 via the interface or at least one pin. The information may include control signaling and/or data.

[0133] The T-TRP 170 may be known by other names in some implementations, such as a base station, a base transceiver station (BTS), a radio base station, a network node, a network device, a device on the network side, a transmit/receive node, a Node B, an evolved NodeB (eNodeB or eNB), a Home eNodeB, a next Generation NodeB (gNB), a transmission point (TP), a site controller, an access point (AP), a wireless router, a relay station, a remote radio head, a terrestrial node, a terrestrial network device, a terrestrial base station, a base band unit (BBU), a remote radio unit (RRU), an active antenna unit (AAU), a remote radio head (RRH), a central unit (CU), a distributed unit (DU), a positioning node, among other possibilities. The T-TRP 170 may be a macro BS, a pico BS, a relay node, a donor node, or the like, or combinations thereof. The T-TRP 170 may refer to the forgoing devices or refer to apparatus (e.g. a communication module, a modem, or a chip) in the forgoing devices.

[0134] In some embodiments, the parts of the T-TRP 170 may be distributed. For example, some of the modules of the T-TRP 170 may be located remote from the equipment that houses the antennas 256 for the T-TRP 170, and may be coupled to the equipment that houses the antennas 256 over a communication link (not shown) sometimes known as front haul, such as common public radio interface (CPRI). Therefore, in some embodiments, the term T-TRP 170 may also refer to modules on the network side that perform processing operations, such as determining the location of the ED 110, resource allocation (scheduling), message generation, and encoding/decoding, and that are not necessarily part of the equipment that houses the antennas 256 of the T-TRP 170. The modules may also be coupled to other T-TRPs. In some embodiments, the T-TRP 170 may actually be a plurality of T-TRPs that are operating together to serve the ED 110, e.g. through the use of coordinated multipoint transmissions.

[0135] The T-TRP 170 includes at least one transmitter 252 and at least one receiver 254 coupled to one or more antennas 256. Only one antenna 256 is illustrated. One, some, or all of the antennas 256 may alternatively be panels. The transmitter 252 and the receiver 254 may be integrated as a transceiver. The T-TRP 170 further includes a processor 260 for performing operations including those related to: preparing a transmission for downlink transmission to the ED 110, processing an uplink transmission received from the ED 110, preparing a transmission for backhaul transmission to the NT-TRP 172, and processing a transmission received over backhaul from the NT-TRP 172. Processing operations related to preparing a transmission for downlink or backhaul transmission may include operations such as encoding, modulating, precoding (e.g. multiple input multiple output (MIMO) precoding), transmit beamforming, and generating symbols for transmission. Processing operations related to processing received transmissions in the uplink or over backhaul may include operations such as receive beamforming, demodulating received symbols and decoding received symbols. The processor 260 may also perform operations relating to network access (e.g. initial access) and/or downlink synchronization, such as generating the content of synchronization signal blocks (SSBs), generating the system information, etc. In some embodiments, the processor 260 also generates an indication of beam direction, e.g. BAI, which may be scheduled for transmission by a scheduler 253. The processor 260 performs other network-side processing operations described herein, such as determining the location of the ED 110, determining where to deploy the NT-TRP 172, etc. In some embodiments, the processor 260 may generate signaling, e.g. to configure one or more parameters of the ED 110 and/or one or more parameters of the NT-TRP 172. Any signaling generated by the processor 260 is sent by the transmitter 252. Note that “signaling”, as used herein, may alternatively be called control signaling. Dynamic signaling may be transmitted in a control channel, e.g. a physical downlink control channel (PDCCH), and static or semi-static higher layer signaling may be

included in a packet transmitted in a data channel, e.g. in a physical downlink shared channel (PDSCH).

[0136] The scheduler 253 may be coupled to the processor 260. The scheduler 253 may be included within or operated separately from the T-TRP 170. The scheduler 253 may schedule uplink, downlink, and/or backhaul transmissions, including issuing scheduling grants and/or configuring scheduling-free (“configured grant”) resources.

5 The T-TRP 170 further includes a memory 258 for storing information and data. The memory 258 stores instructions and data used, generated, or collected by the T-TRP 170. For example, the memory 258 could store software instructions or modules configured to implement some or all of the functionality and/or embodiments described herein and that are executed by the processor 260.

[0137] Although not illustrated, the processor 260 may form part of the transmitter 252 and/or part of the receiver 254. Also, although not illustrated, the processor 260 may implement the scheduler 253. Although not illustrated, the memory 258 may form part of the processor 260.

[0138] The processor 260, the scheduler 253, the processing components of the transmitter 252 and the processing components of the receiver 254 may each be implemented by the same or different one or more processors that are configured to execute instructions stored in a memory, e.g. in the memory 258. Alternatively, some or all of the processor 260, the scheduler 253, the processing components of the transmitter 252 and the processing components of the receiver 254 may be implemented using dedicated circuitry, such as a FPGA, a GPU, a CPU, or an ASIC.

[0139] When the T-TRP 170 is an apparatus (also called as component), for example, communication module, modem, chip, or chipset in a device, it includes at least one processor, and an interface or at least one pin. In this scenario, the transmitter 252 and receiver 254 may be replaced by the interface or at least one pin, wherein the interface or at least one pin is to connect the apparatus (e.g., chip) and other apparatus (e.g., chip, memory, or bus). Accordingly, the transmitting information to the NT-TRP 172 and/or the T-TRP 170 and/or ED 110 may be referred as transmitting information to the interface or at least one pin, and receiving information from the NT-TRP 172 and/or the T-TRP 170 and/or ED 110 may be referred as receiving information from the interface or at least one pin.

25 The information may include control signaling and/or data.

[0140] Although the NT-TRP 172 is illustrated as a drone only as an example, the NT-TRP 172 may be implemented in any suitable non-terrestrial form, such as high altitude platforms, satellite, high altitude platform as international mobile telecommunication base stations and unmanned aerial vehicles, which forms will be discussed hereinafter. Also, the NT-TRP 172 may be known by other names in some implementations, such as a non-terrestrial

node, a non-terrestrial network device, or a non-terrestrial base station. The NT-TRP 172 includes a transmitter 272 and a receiver 274 coupled to one or more antennas 280. Only one antenna 280 is illustrated. One, some, or all of the antennas may alternatively be panels. The transmitter 272 and the receiver 274 may be integrated as a transceiver. The NT-TRP 172 further includes a processor 276 for performing operations including those related to: preparing a transmission for downlink transmission to the ED 110, processing an uplink transmission received from the ED 110, preparing a transmission for backhaul transmission to T-TRP 170, and processing a transmission received over backhaul from the T-TRP 170. Processing operations related to preparing a transmission for downlink or backhaul transmission may include operations such as encoding, modulating, precoding (e.g. MIMO precoding), transmit beamforming, and generating symbols for transmission. Processing operations related to processing received transmissions in the uplink or over backhaul may include operations such as receive beamforming, demodulating received symbols and decoding received symbols. In some embodiments, the processor 276 implements the transmit beamforming and/or receive beamforming based on beam direction information (e.g. BAI) received from the T-TRP 170. In some embodiments, the processor 276 may generate signaling, e.g. to configure one or more parameters of the ED 110. In some embodiments, the NT-TRP 172 implements physical layer processing, but does not implement higher layer functions such as functions at the medium access control (MAC) or radio link control (RLC) layer. As this is only an example, more generally, the NT-TRP 172 may implement higher layer functions in addition to physical layer processing.

[0141] The NT-TRP 172 further includes a memory 278 for storing information and data. Although not illustrated, the processor 276 may form part of the transmitter 272 and/or part of the receiver 274. Although not illustrated, the memory 278 may form part of the processor 276.

[0142] The processor 276, the processing components of the transmitter 272 and the processing components of the receiver 274 may each be implemented by the same or different one or more processors that are configured to execute instructions stored in a memory, e.g. in the memory 278. Alternatively, some or all of the processor 276, the processing components of the transmitter 272 and the processing components of the receiver 274 may be implemented using dedicated circuitry, such as a programmed FPGA, a GPU, a CPU, or an ASIC. In some embodiments, the NT-TRP 172 may actually be a plurality of NT-TRPs that are operating together to serve the ED 110, e.g. through coordinated multipoint transmissions.

[0143] When the NT-TRP 172 is an apparatus (e.g. communication module, modem, chip, or chipset) in a device, it includes at least one processor, and an interface or at least one pin. In this scenario, the transmitter 272 and receiver

257 may be replaced by the interface or at least one pin, wherein the interface or at least one pin is to connect the apparatus (e.g., chip) and other apparatus (e.g., chip, memory, or bus). Accordingly, the transmitting information to the T-TRP 170 and/or another NT-TRP 172 and/or ED 110 may be referred as transmitting information to the interface or at least one pin, and receiving information from the T-TRP 170 and/or another NT-TRP 172 and/or ED 110 may be referred as receiving information from the interface or at least one pin. The information may include control signaling and/or data.

[0144] Note that “TRP”, as used herein, may refer to a T-TRP or a NT-TRP. A T-TRP may alternatively be called a terrestrial network TRP (“TN TRP”) and a NT-TRP may alternatively be called a non-terrestrial network TRP (“NTN TRP”).

[0145] The T-TRP 170, the NT-TRP 172, and/or the ED 110 may include other components, but these have been omitted for the sake of clarity.

[0146] Any or all of the EDs 110 and BS 170 may be sensing nodes in the system 100. Sensing nodes are network entities that perform sensing by transmitting and receiving sensing signals. Some sensing nodes are communication equipment that perform both communications and sensing. However, it is possible that some sensing nodes do not perform communications, and are instead dedicated to sensing. The sensing agent 174 is an example of a sensing node that is dedicated to sensing. Unlike the EDs 110 and BS 170, the sensing agent 174 does not transmit or receive communication signals. However, the sensing agent 174 may communicate configuration information, sensing information, signaling information, or other information within the communication system 100. The sensing agent 174 may be in communication with the core network 130 to communicate information with the rest of the communication system 100. By way of example, the sensing agent 174 may determine the location of the ED 110a, and transmit this information to the base station 170a via the core network 130. Although only one sensing agent 174 is shown in FIG. 2, any number of sensing agents may be implemented in the communication system 100. In some embodiments, one or more sensing agents may be implemented at one or more of the RANs 120.

[0147] A sensing node may combine sensing-based techniques with reference signal-based techniques to enhance UE pose determination. This type of sensing node may also be known as a sensing management function (SMF). In some networks, the SMF may also be known as a location management function (LMF). The SMF may be implemented as a physically independent entity located at the core network 130 with connection to the multiple BSs 170. In other aspects of the present application, the SMF may be implemented as a logical entity co-located inside a BS 170 through logic carried out by the processor 260.

[0148] Although not presented in FIG. 3, a GPT device 180 may be included, which has similar structure to ED 110, e.g., GPT device 180 includes at least one processor, a transmitting and a receiver.

[0149] **Basic module structure**

[0150] One or more steps of the methods provided herein may be performed by corresponding units or modules, according to FIG. 4. FIG. 4 illustrates units or modules in a device, such as in the ED 110, in the T-TRP 170, in the NT-TRP 172, or in the GPT device 180. For example, a signal may be transmitted by a transmitting unit or by a transmitting module. A signal may be received by a receiving unit or by a receiving module. A signal may be processed by a processing unit or a processing module. Other steps may be performed by an artificial intelligence (AI) or machine learning (ML) module. The respective units or modules may be implemented using hardware, one or more components or devices that execute software, or a combination thereof. For instance, one or more of the units or modules may be an integrated circuit, such as a programmed FPGA, a GPU, a CPU, or an ASIC. It will be appreciated that where the modules are implemented using software for execution by a processor for example, the modules may be retrieved by a processor, in whole or part as needed, individually or together for processing, in single or multiple instances, and that the modules themselves may include instructions for further deployment and instantiation. The transmitter mentioned with reference to FIG. 3 may be a detailed implementation for the transmitting module. The receiver mentioned with reference to FIG. 3 may be a detailed implementation for the receiving module. The processor mentioned with reference to FIG. 3 may be a detailed implementation for the processing module.

[0151] Additional details regarding the EDs 110, the T-TRP 170, the NT-TRP 172 and the GPT device 180 are known to those of skill in the art. As such, these details are omitted here.

[0152] **Example concepts of some terms**

[0153] Message: a payload in a natural language, e.g., English, French, Chinese, etc.

Query message: a query sentence in a natural language.

Sensing message: a description about an observation or sensed data in a natural language.

Semantic: a vector, a matrix, a tensor of scalars to embed a message.

Query semantic: a semantic that embeds a query message.

Sensing semantic: a semantic that embeds a sensing message.

Token: a vector of scalars encoded from a semantic.

Query token: a token that is encoded from a query semantic.

Sensing token: a token that is encoded from a sensing semantic.

GPT device: a device that runs over generative AI model or models to generate a query message or messages given a sensing message or messages.

5 Central device: a device as BS that connects a plurality of terminal devices via radio access in DL and UL, and connects with the core network via backbone network.

Sensing device: a device as terminal that connects to a BS or BSs and that is equipped with the sensing gadget to measure data of interest near it.

[0154] The above describes possible scenarios or generalized description of the examples of the present disclosure, the motivation and technical concepts of the present disclosure are illustrated in the following.

10 [0155] A sensing function will be integrated into the 6th generation (6G) system. A large number of the sensing user equipments (UEs) or sensing devices will be densely deployed in cities, factories, farms and so on. In addition to mobile phones, sensing devices will become an important type of UEs or devices that claim an arrival of IoT time.

[0156] Like internet searching engines, 6G will come up with the counterpart, an internet of thing (IoT) searching engine, in a true physical world. In fact, billions of IoT-based applications such as driverless cars,
15 automation factories, smart cities, autonomous farms, will heavily depend on an efficient and real-time searching engine in our physical world.

[0157] Recently, artificial intelligence (AI) has conquered various intellectual and cognitive domains. some AI is exploring the cutting edge of our intellectual knowledge in chemistry, gaming, mathematic, gene engineering; some other AI is providing a human-level Q&A platform in the digital world; the domain that AI hasn't conquered
20 is real-time physical world. Physical-world AI, in which AI technologies are to penetrate into all the aspects of our society and life, may be built on omnipresent IoT connections thanks to 6G.

[0158] More challenging than internet searching engine, real-world searching engine would have to search the physical world in real time over a large scale of physical area and to deal with a multitude of types of data and information (some may be novel and some may haven't been invented yet). Furthermore, green technology, low-
25 energy and low-emission, are also raised as key feature of 6G. A sensing device may be battery powered and/or completely powered by solar and wind. It would be costly and impracticable to ask all the sensing devices in a large scale to feedback what they are sensing at the same time. On one hand, the frequent sensing and transmission consumes a sensing device much energy and reduce their battery life time; on other hand, such a high density of the IoT deployment may block the uplink channels, especially the uplink (UL) bandwidth is more expensive than the

downlink (DL) one.

[0159] In some implementations, a sensing device may be a UE, a mobile phone or a handset, where independence among any two sensing devices are assumed; thereby, a sensing device may be scheduled individually by the wireless system to which the sensing device is associated; and the sensed data that the sensing device measures
5 may be application-level payload for the wireless system and protocol.

[0160] The above scheme of scheduling a sensing device is inefficient in terms of radio bandwidth and energy consumption. For instance, a sensing device blindly keeps transmitting its sensed data to the central device, regardless of whether the sensed data is required or not.

[0161] From a higher level perspective, it is better to wake a plurality of sensing devices to measure and transmit
10 only when their sensed data would serve a goal or goals; for example, when a generative pre-trained transformer (GPT) device such as a driverless car, may request the information about the moving obstacles near itself, it is useless to keep transmitting irrelevant information to the driverless car, or to transmit all the moving obstacles nearby to the car when the car is parking on the roadside.

[0162] To avoid any missing probability of the information, resources in the wireless system in above
15 implementations may be over-scheduled.

[0163] The basic concepts of the present disclosure may be as follows. When receiving query information (or referred to as first query information, a query, a query message, a first query message, etc.), not all the sensing devices feedback what they are sensing, only the sensing devices whose sensed data has sufficient relevance with the query information (i.e., a matching score between the sensed data and the query information is greater than or
20 equal to a threshold) would response and transmit their sensed data. For example, the central device (or referred to as BS) may broadcast semantic queries, only sensing devices (or referred to as UEs) with corresponding results will feedback semantic results, so as to greatly reduce the UL transmission overhead. The scheme provided by the present disclosure can be applied to object detection, sensing tracking, V2X communication, etc.

[0164] The above briefly describes technical concepts of the present disclosure, and then specific examples of
25 the present disclosure will be elaborated in the following description.

[0165] The present disclosure provides a communication method, as shown in FIG. 5, the communication method may be implemented by a sensing device, and may include the following steps.

[0166] Step 502, a sensing device receives first query information, a first matching score function and a first threshold broadcasted or multicasted by a central device.

[0167] The first query information is used for retrieving related data from the sensing device. Specifically, the first query information may be a question in natural language or in machine-readable language, which is not limited herein. For example, the first query information may be in a form of a query message, a query semantic, a query token, etc. Details about the first query information will be described later.

5 [0168] The first matching score function can be used for computing a first matching score between sensed data of the sensing device and the first query information. The sensing device decides whether or not to transmit a sensing result according to a comparing result between the first matching score and the first threshold. It should be noted that a threshold in the present disclosure may be predefined or determined according to actual needs.

[0169] Step 504, the sensing device determines, according to the first matching score function, whether a first
10 matching score between sensed data and the first query information is greater than or equal to the first threshold.

[0170] The sensing device is responsible for measuring and/or collecting local physical-world data. It may be sensing UE, sensing equipment, IoT equipment, UE, mobile phones, handset, or other equipment. The sensing device may be equipped with a sensing gadget or component to measure local physical-world data or information which may be referred to as sensed data. Further, the sensing device may encode and transmit the sensed data to a central
15 device.

[0171] Step 506, the sensing device transmits a sensing result to the central device when the first matching score is greater than or equal to the first threshold, where the sensing result indicates the sensed data.

[0172] The central device may be a base station (BS), e.g. gNB, or eNB etc., or the central device may be an access point (AP). The sensing result is related to the sensed data obtained by the sensing device. If the first matching
20 score is greater than or equal to the first threshold, the sensing device will respond with the sensing result. If the first matching score is less than the first threshold, the sensing device will not respond. Details about the specific contents of the sensing result will be described later.

[0173] It should be noted that in some circumstances, some sensing devices may actively transmit their sensing result without receiving any query information from the central device. The sensing devices that actively transmit
25 the sensing result may respond to some urgency queries such as fire alarming or car accidents. In some sense, some query messages have been pre-defined and configured into the system by default.

[0174] The first query information broadcasted or multicasted by the central device wakes a sensing device to measure sensed data, the sensing device computes the first matching score between the sensed data and the first query information according to the first matching score function broadcasted or multicasted by the central device, in

the case that the first matching score is greater than or equal to the first threshold, the sensing device transmits the sensing result to the central device. Firstly, the first query information, the first matching score function and the first threshold are broadcasted or multicasted by the central device, which can ensure that the determination basis for the sensing device is the same as that for other sensing devices, thereby improving the responding accuracy of the sensing device from the horizontal dimension; secondly, the transmission of the sensing result has a specific condition, and the sensing result is not transmitted all the time, thus the transmission resources are saved; thirdly, the transmitted sensing result meets the requirement of the first query information, that is, irrelevant information is filtered, the transmitted data is what the central device requires, the responding accuracy of the sensing device is thus ensured from the vertical dimension.

[0175] The first query information is goal-oriented or task-oriented, and may trigger a sensing device to complete one or more tasks, collect and transmit data of one or more modalities. It should be noted that a task and a modality may be independent, or may be related to each other. For example, the central device (or referred to as BS) may broadcast or multicast a query for a single task, a single modality, multiple modalities, multiple tasks. In this case, the sensing device may feedback data of one or more modalities in response to one task, and sensed data of one modality may be the requested data corresponding to one or more tasks. Some implementations are illustrated in the following.

[0176] In a possible implementation, the first query information includes query information for one task or query information for one modality. The query information can also be referred to as a query, and may be in a form of a query message, a query semantic, a query token. Specifically, the sensing device may receive an indication for a task identifier or an indication for a modality identifier from the central device. The indication for a task identifier and the indication for a modality identifier may be certain field(s), which is not limited here. The task identifier is used for distinguishing a certain task, and the modality identifier is used for distinguishing a certain modality. The query for a single task or a single modality may be indicated by a single task/modality message format. For example, the single task/modality message format may be: $\{q_1, q_2, \dots, q_n\}$ for n queries, where $n \geq 1$; each q_i is represented by a length N_j vector, or $N_j \times M_j$ matrix. The identifier for the task/modality can be explicitly/implicitly indicated. The sensing device can serve for one task or one modality, i.e., the sensing device is dedicated to one task or one modality, the responding efficiency of the sensing device can thus be improved.

[0177] In a possible implementation, the first query information includes multiple pieces of query information for multiple tasks and multiple task identifiers respectively associated with the multiple pieces of query information.

The queries for multiple tasks may be indicated by a multi task message format, where each with a task identifier. For example, the multi task message format may be: $\{\{t_1, \{q_{1,1}, \dots, q_{1,n_1}\}\}, \dots, \{t_m, \{q_{m,1}, \dots, q_{m,n_m}\}\}\}$ for m tasks, each task t_i has n_i queries, $m \geq 1$, $n_i \geq 1$; t_i is the identifier for the i -th task; each $q_{i,j}$ is represented by a length $N_{i,j}$ vector, or $N_j \times M_j$ matrix. The sensing device can simultaneously serve for multiple tasks, resource utilization of the sensing device is thus improved.

[0178] In a possible implementation, the first query information includes multiple pieces of query information for multiple modalities and multiple modality identifiers respectively associated with the multiple pieces of query information. The queries for multiple modalities may be indicated by a multi modality message format, where each with a modality identifier. For example, the multi modality message format may be: $\{\{y_1, \{q_{1,1}, \dots, q_{1,n_1}\}\}, \dots, \{y_m, \{q_{m,1}, \dots, q_{m,n_m}\}\}\}$ for m modalities, each modality y_i has n_i queries, $m \geq 1$, $n_i \geq 1$. y_i is the identifier for the i -th modality; each $q_{i,j}$ is represented by a length $N_{i,j}$ vector, or $N_j \times M_j$ matrix. The sensing device can simultaneously serve for multiple modalities, i.e., the sensing device can sense and feedback more than one modality (i.e., one type of data), which enriching the variety of data with which the sensing device responds.

[0179] In a possible implementation, the first query information includes first multiple pieces of query information for multiple tasks, second multiple pieces of query information for multiple modalities, multiple task identifiers respectively associated with the first multiple pieces of query information, and multiple modality identifiers respectively associated with the second multiple pieces of query information. The queries for multiple tasks and multiple modalities may be indicated by a multi modality and multi task message format, where each task has multiple modalities or each modality has multiple tasks. The description of the query information for multiple tasks and for multiple modalities is similar to the foregoing description, which is not repeated here. The sensing device can simultaneously serve for both multiple tasks and multiple modalities, thereby not only improving the resource utilization of the sensing device, but also enriching the variety of data with which the sensing device responds.

[0180] The above describes information related to the task and/or the modality which may be included in the first query information, and the transmission manner of the first query information will be described in the following.

[0181] The first query information can be transmitted to the sensing device from the central device in a broadcasting or multicasting way. In an example, the sensing device may receive the first query information, the first matching score function and the first threshold broadcasted by the central device in a synchronization signal/Physical Broadcast Channel (PBCH) block (SSB). The first query information is carried in a master information block (MIB)

message or a system information block (SIB) message, and the MIB message or the SIB message includes an indication for indicating that whether the first query information is presented in the MIB message or the SIB message. Signaling overhead can be saved by virtue of the indication for indicating that whether the first query information is presented, since it is unnecessary to perform subsequent processing if it is indicated that the first query information is not presented. In a possible implementation, the MIB message or the SIB message further includes an indication for indicating a period for the first query information. The first query information is valid during the period, and may be invalid out of the period, thereby avoiding resource occupancy. It should be noted that, the indication for indicating that whether the first query information is presented and the indication for indicating a period may be certain field(s), which is not limited here. For example, there may be a flag indicating whether such a query message in SIBx is presented, and also indicating the period. In another example, the sensing device may receive the first query information, the first matching score function and the first threshold multicasted by the central device in a multicast message.

[0182] As mentioned before, the first query information may be in a form of a query message, a query semantic or a query token. In addition to a single task, the sensing device may serve two or more tasks, i.e., there may be one or more query messages/semantics/tokens included in the first query information. The following gives some implementations in the case that the first query information includes at least two query semantics or at least two query tokens. It should be noted that, there may be other implementations under other cases, for example, in the case that the first query information includes at least two query messages, or a single query message/semantic/token, which is not limited herein.

[0183] In a possible implementation, the first query information includes at least two query semantics, the sensing device may receive a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic and a format of the first query semantic broadcasted or multicasted by the central device; and receive a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic broadcasted or multicasted by the central device. Or, the sensing device may receive a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic, a format of the first query semantic, a second query semantic among the at least two

query semantics, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic broadcasted or multicasted by the central device in a multiplex way. In the case that the first query information includes multiple query semantics, the multiple query semantics and information related to the multiple query semantics (i.e., the matching score function, the threshold, the length of the query semantic and the format of the query semantic corresponding to each query semantic) can be received in sequence, or can be simultaneously received in a multiplex way, which provides more flexibility and can thus meet different requirements.

[0184] Regarding determination of the matching score under the above situation, there may be multiple manners. The following implementations are only illustrative and not restrictive. In an implementation, the sensing device may obtain the sensed data, translate the sensed data into a common sensing semantic; then, determine, according to the second matching score function, whether a second matching score between the common sensing semantic and the first query semantic is greater than or equal to the second threshold, and determine, according to the third matching score function, whether a third matching score between the common sensing semantic and the second query semantic is greater than or equal to the third threshold. In the case that the sensed data is in a form of natural language, while the first query information is in a form of semantics, the sensed data can be translated into a common sensing semantic, for example, a common semantization configuration can be used for generating the common sensing semantic, which may simplify the generation of the sensing semantic. Then the comparison is implemented between the common sensing semantic and each of the query semantics. That is, both the sensed data and the query information are in a common semantic domain on which they can be easily compared to each other and fused. A query semantic may preserve all the key semantic goals conveyed by the query message such that the query semantic can be well translated (de-semantized) back to a query message. Since the form of semantic may provide more accurate true intentions, accuracy of a comparing result is thus improved.

[0185] In another implementation, the sensing device may obtain the sensed data, translate the sensed data into a first sensing semantic according to a first semantization configuration, the length of the first query semantic and the format of the first query semantic, translate the sensed data into a second sensing semantic according to a second semantization configuration, the length of the second query semantic and the format of the second query semantic; then, determine, according to the second matching score function, whether a second matching score between the first sensing semantic and the first query semantic is greater than or equal to the second threshold, and determine, according to the third matching score function, whether a third matching score between the second sensing semantic

and the second query semantic is greater than or equal to the third threshold. In the case that the sensed data is in a form of natural language, while the first query information is in a form of semantics, the sensed data can be translated into a first sensing semantic and a second sensing semantic respectively, respective semantization configurations are used for generating a corresponding sensing semantic, which may ensure the accuracy of the generated sensing semantic. Then the comparison is implemented between the first sensing semantic and the first query semantic, and between the second sensing semantic and the second query semantic. That is, both the sensed data and the query information are in a common semantic domain on which they can be easily compared to each other and fused. A query semantic may preserve all the key semantic goals conveyed by a query message such that the query semantic can be well translated (de-semantized) back to a query message. Since the form of semantic may provide more accurate true intentions, accuracy of a comparing result is thus improved.

[0186] In still another implementation, the sensing device may obtain the sensed data, translate the sensed data into a common sensing semantic, tokenize the common sensing semantic into a first sensing token, the first query semantic into a first query token, the common sensing semantic into a second sensing token and the second query semantic into a second query token according to a common tokenization configuration; or, tokenize the common sensing semantic into a first sensing token and the first query semantic into a first query token according to a first tokenization configuration, and tokenize the common sensing semantic into a second sensing token and the second query semantic into a second query token according to a second tokenization configuration; then, determine, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold, and determine, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold. In the case that the sensed data is in a form of natural language, while the first query information is in a form of semantics, the sensed data can be processed into a first sensing token and a second sensing token via a common sensing semantic, the first query semantic and the second query semantic can be processed into a first query token and a second query token respectively, then the comparison is implemented between sensing tokens and corresponding query tokens. Since the form of token may provide more accurate true intentions and save signaling overhead, accuracy of a comparing result is thus improved and signaling overhead is saved. Further, the tokenization can be used to prevent a sensing device from recovering a complete query message from a query token. The tokenization may come up with certain privacy protection for query messages.

[0187] In yet another implementation, the sensing device may obtain the sensed data, translate the sensed data

into a first sensing semantic according to a first semantization configuration, the length of the first query semantic and the format of the first query semantic, translate the sensed data into a second sensing semantic according to a second semantization configuration, the length of the second query semantic and the format of the second query semantic; then, tokenize the first sensing semantic into a first sensing token, the first query semantic into a first query token, the second sensing semantic into a second sensing token and the second query semantic into a second query token according to a common tokenization configuration; or, tokenize the first sensing semantic into a first sensing token and the first query semantic into a first query token according to a first tokenization configuration, and tokenize the second sensing semantic into a second sensing token and the second query semantic into a second query token according to a second tokenization configuration; next, determine, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold, and determine, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold. In the case that the sensed data is in a form of natural language, while the first query information is in a form of semantics, the sensed data can be processed into a first sensing token and a second sensing token via a first sensing semantic and a second sensing semantic respectively, the first query semantic and the second query semantic can be processed into a first query token and a second query token respectively, then the comparison is implemented between sensing tokens and corresponding query tokens. Since the form of token may provide more accurate true intentions and save signaling overhead, accuracy of a comparing result is thus improved and signaling overhead is saved. Further, the tokenization can be used to prevent a sensing device from recovering a complete query message from a query token.

The tokenization may come up with certain privacy protection for query messages.

[0188] In a possible implementation, the first query information includes at least two query tokens, the sensing device may receive first query token among the at least two query tokens, a second matching score function related to the first query token, a second threshold related to the second matching score function and a length of the first query token broadcasted or multicasted by the central device; and receive a second query token among the at least two query tokens, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token broadcasted or multicasted by the central device. Or, the sensing device may receive a first query token among the at least two query tokens, a second matching score function related to the first query token, a second threshold related to the second matching score function, a length of the first query token, a second query token among the at least two query tokens, a third matching score function

related to the second query token, a third threshold related to the third matching score function and a length of the second query token broadcasted or multicasted by the central device in a multiplex way. In the case that the first query information includes multiple query tokens, the multiple query tokens and information related to the multiple query tokens (i.e., the matching score function, the threshold and the length of the query token corresponding to each query semantic) can be received in sequence, or can be simultaneously received in a multiplex way, which provides more flexibility and can thus meet different requirements.

[0189] Regarding determination of the matching score under the above situation, multiple manners can be provided. The following implementations are only illustrative and not restrictive. In an implementation, the sensing device may obtain the sensed data, translate the sensed data into a common sensing semantic, then tokenize, according to a common tokenization configuration, the common sensing semantic into a first sensing token based on the length of the first query token, and the common sensing semantic into a second sensing token based on the length of the second query token; or, tokenize, according to a first tokenization configuration, the common sensing semantic into a first sensing token based on the length of the first query token, and tokenize, according to a second tokenization configuration, the common sensing semantic into a second sensing token based on the length of the second query token; next, determine, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold, and determine, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold. In the case that the sensed data is in a form of natural language, while the first query information is in a form of tokens, the sensed data can be processed into a first sensing token and a second sensing token via a common sensing semantic, then the comparison is implemented between sensing tokens and corresponding query tokens. Since the form of token may provide more accurate true intentions and save signaling overhead, accuracy of a comparing result is thus improved and signaling overhead is saved. Further, the tokenization can be used to prevent a sensing device from recovering a complete query message from a query token. The tokenization may come up with certain privacy protection for query messages.

[0190] In another implementation, the sensing device may obtain the sensed data, translate the sensed data into a first sensing semantic according to a first semantization configuration, translate the sensed data into a second sensing semantic according to a second semantization configuration; then, tokenize, according to a common tokenization configuration, the first sensing semantic into a first sensing token based on the length of the first query token, and the second sensing semantic into a second sensing token based on the length of the second query token;

or, tokenize, according to a first tokenization configuration, the first sensing semantic into a first sensing token based on the length of the first query token, and tokenize, according to a second tokenization configuration, the second sensing semantic into a second sensing token based on the length of the second query token; next, determine, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold, and determine, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold. In the case that the sensed data is in a form of natural language, while the first query information is in a form of tokens, the sensed data can be processed into a first sensing token and a second sensing token via a first sensing semantic and a second sensing semantic respectively, then the comparison is implemented between sensing tokens and corresponding query tokens. Since the form of token may provide more accurate true intentions and save signaling overhead, accuracy of a comparing result is thus improved and signaling overhead is saved. Further, the tokenization can be used to prevent a sensing device from recovering a complete query message from a query token. The tokenization may come up with certain privacy protection for query messages.

[0191] In the above implementations, the first matching score function, the second matching score function or the third matching score function can be implemented through an inner product or a euclidean distance. There may be other manners to implement a scoring function (i.e. the first/second/third matching score function) as long as the score of relevance between the sensed data and the first query information or the similarity between the sensed data and the first query information can be obtained.

[0192] It should be noted that a translating operation in the present disclosure refers to the semantization processing, and the translating operation can be replaced with an embedding operation, a converting operation, a transforming operation, etc. For example, the translating the sensed data into the sensing semantic can be replaced with embedding the sensed data into the sensing semantic, converting the sensed data into the sensing semantic, transforming the sensed data into the sensing semantic, etc. The specific means of the translating operation, the embedding operation, the converting operation, the transforming operation are not limited here. For example, the transforming operation can be implemented by using an existing manner.

[0193] The semantization of sensed data can be implemented through the same semantization configuration or different semantization configurations, the tokenization of different query semantics or different sensing semantics can be implemented through the same tokenization configuration or different tokenization configurations, which

may depend on actual needs. The tokenization configuration includes one of the following: a tokenization model, a tokenization function, a projection matrix, a graph-based or topology-based pruning, a compression approach. There are a plurality of tokenization configurations to be chose, which provides more flexibility and can thus meet different requirements. The above lists some implementations for the tokenization, the specific means of the tokenization
5 implementations are not limited here. For example, the tokenization model can be implemented by using an existing manner.

[0194] In a possible implementation, the sensing result includes one of the following: raw sensed data; a sensing semantic obtained from raw sensed data; half raw sensed data and a sensing semantic obtained from raw sensed data; raw sensed data and the first matching score; a sensing semantic obtained from raw sensed data and the first matching
10 score; half raw sensed data, a sensing semantic obtained from raw sensed data, and the first matching score. The sensing result may be in various forms related to the sensed data, which provides more flexibility and can thus meet different requirements.

[0195] In a possible implementation, the sensing device may transmit a first matched sensing semantic and a fourth matching score related to the first matched sensing semantic to the central device; and transmit a second
15 matched sensing semantic and a fifth matching score related to the second matched sensing semantic to the central device. As mentioned before, a single sensing device can handle two or more queries simultaneously, thus, the responsive sensing device may transmit more than one sensing result to the central device, e.g., may transmit two sensing semantics to the central device. The transmitted sensing semantic may be referred to as a matched sensing semantic since the sensing device has already determined that a matching score between the sensed data and the
20 corresponding query is greater than or equal to a threshold. For example, a sensing device receives two queries: Q1 and Q2. The sensing device collects and measures its sensed data, computes a matching score between the sensed data and Q1, a matching score between the sensed data and Q2. In the case that the computed matching scores are greater than or equal to the threshold, the sensing device may transmit Q1 (i.e., the foregoing first matched sensing semantic), a matching score between the sensed data and Q1 (i.e., the foregoing fourth matching score), Q2 (i.e., the
25 foregoing second matched sensing semantic), a matching score between the sensed data and Q2 (i.e., the foregoing fifth matching score), to the central device. In response to more than one query, the sensing device can transmit more than one sensing semantic and related matching score to the central device, in the case that a plurality of sensing devices transmit such data to the central device, the central device can perform a fusion operation on the received data from the plurality of sensing devices, so as to improve the accuracy of the fused data. The fusion operation will

be introduced at the central device side.

[0196] In the above, the communication method of the present disclosure is described from the perspective of the sensing device in combination with FIG. 5. In the following, a communication method of the present disclosure will be described from the perspective of a central device, and as illustrated in FIG. 6, the method can include the following:

step 602, a central device broadcasts or multicasts first query information, a first matching score function and a first threshold to a plurality of sensing devices; and

step 604, the central device receives a sensing result from at least one sensing device among the plurality of sensing devices, where a first matching score between sensed data and the first query information is greater than or equal to the first threshold, where the first matching score is based on the first matching score function, and the sensing result indicates the sensed data.

[0197] Regarding the description for step 602 and step 606, reference may be made to the description for step 502 and step 506, which will not be repeated here. The central device broadcasts or multicasts the first query information, the first matching score function and the first threshold, the transmission efficiency for the central device is thus improved. The central device receives the sensing result in the case that the first matching score between sensed data of a sensing device and the first query information is greater than or equal to the first threshold. The received sensing result meets the requirement of the first query information, that is, irrelevant information is filtered, the received data is what the central device requires, accuracy of data transmission is thus ensured.

[0198] Next, the information related to the task and/or the modality which may be included in the first query information, and the transmission manner of the first query information will be described briefly, for detailed description, reference may be made to the relevant description at the sensing device side, which will not be repeated here.

[0199] In a possible implementation, the first query information includes query information for one task or query information for one modality.

[0200] In a possible implementation, the central device may transmit an indication for a task identifier or an indication for a modality identifier.

[0201] In a possible implementation, the first query information includes multiple pieces of query information for multiple tasks and multiple task identifiers respectively associated with the multiple pieces of query information.

[0202] In a possible implementation, the first query information includes multiple pieces of query information

for multiple modalities and multiple modality identifiers respectively associated with the multiple pieces of query information.

[0203] In a possible implementation, the first query information includes first multiple pieces of query information for multiple tasks, second multiple pieces of query information for multiple modalities, multiple task
5 identifiers respectively associated with the first multiple pieces of query information, and multiple modality identifiers respectively associated with the second multiple pieces of query information.

[0204] In a possible implementation, the central device may broadcast the first query information, the first matching score function and the first threshold in a synchronization signal/Physical Broadcast Channel (PBCH) block (SSB), to the plurality of sensing devices.

10 [0205] In a possible implementation, the first query information is carried in a master information block (MIB) message or a system information block (SIB) message, and the MIB message or the SIB message includes an indication for indicating that whether the first query information is presented in the MIB message or the SIB message. Signaling overhead can be saved by virtue of the indication for indicating that whether the first query information is presented, since it is unnecessary to perform subsequent processing if it is indicated that the first query information
15 is not presented.

[0206] In a possible implementation, the MIB message or the SIB message further includes an indication for indicating a period for the first query information. The first query information is valid during the period, and may be invalid out of the period, thereby avoiding resource occupancy.

20 [0207] In a possible implementation, the central device may multicast the first query information, the first matching score function and the first threshold in a multicast message, to the plurality of sensing devices.

[0208] In a possible implementation, as shown in FIG. 7, the communication method includes:

step 702, a central device receives second query information from a generative pre-trained transformer (GPT) device;

25 step 704, the central device broadcasts or multicasts first query information, a first matching score function and a first threshold to a plurality of sensing devices;

step 706, the central device receives a sensing result from at least one sensing device among the plurality of sensing devices, where a first matching score between sensed data and the first query information is greater than or equal to the first threshold, where the first matching score is based on the first matching score function, and the sensing result indicates the sensed data;

step 708, the central device outputs the sensing result to the GPT device.

[0209] Regarding the description for step 704 and step 706, reference may be made to the description for step 502 and step 506, which will not be repeated here. The second query information is used for the central device to generate the first query information. The central device may directly forward query information received from the GPT device to the sensing devices, or, may perform processing (e.g., semantization processing, tokenization processing, etc.) on the received query information from the GPT device, and then transmit the processed query information to the sensing devices. The central device receives the second query information from the GPT device, provides the first query information, the first matching score function and the first threshold for the sensing device to make a decision, then receives the sensing result from the sensing device, and outputs the sensing result to the GPT device, the central device serves as a bridge between the sensing device and the GPT device, thereby assisting in smooth communication between the sensing device and the GPT device.

[0210] The second query information may be in a form of a query message, a query semantic or a query token. In addition to a single task, the GPT device may transmit two or more tasks to the central device, i.e., there may be one or more query messages/semantics/tokens included in the second query information. The following gives some implementations in the case that the first query information includes at least two query semantics or at least two query tokens. It should be noted that, there may be other implementations under other cases, for example, in the case that the first query information includes at least two query messages, or a single query message/semantic/token, which is not limited herein.

[0211] In a possible implementation, the central device may receive at least two query semantics from at least two GPT devices; broadcast or multicast a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic and a format of the first query semantic to the plurality of sensing devices, and broadcast or multicast a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic to the plurality of sensing devices. Or, the central device may broadcast or multicast a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic, a format of the first query semantic, a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third

threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic to the plurality of sensing devices in a multiplex way. In the case that the second query information includes multiple query semantics, the central device can broadcast or multicast the multiple query semantics and information related to the multiple query semantics (i.e., the matching score function, the threshold, the length of the query semantic and the format of the query semantic corresponding to each query semantic) in sequence, or in a multiplex way, which provides more flexibility and can thus meet different requirements.

[0212] In a possible implementation, the central device may receive at least two query semantics from at least two GPT devices, and tokenize a first query semantic and a second query semantic among the at least two query semantics into a first query token and a second query token. Then, the central device may broadcast or multicast the first query token, a second matching score function related to the first query token, a second threshold related to the second matching score function and a length of the first query token to the plurality of sensing devices; broadcast or multicast the second query token, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token to the plurality of sensing devices. Or, the central device may broadcast or multicast the first query token, a second matching score function related to the first query token, a second threshold related to the second matching score function, a length of the first query token, the second query token, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token to the plurality of sensing devices in a multiplex way. In the case that the second query information includes multiple query semantics, the central device can tokenize the query semantics into corresponding query tokens, and then broadcast or multicast multiple query tokens and information related to the multiple query tokens (i.e., the matching score function, the threshold, the length of the query token corresponding to each query token) in sequence, or in a multiplex way, which provides more flexibility and can thus meet different requirements.

[0213] In a possible implementation, the central device may tokenize the first query semantic into the first query token according to a first tokenization configuration; and tokenize the second query semantic into the second query token according to a second tokenization configuration. Or, the central device may tokenize the first query semantic into the first query token according to a common tokenization configuration; and tokenize the second query semantic into the second query token according to the common tokenization configuration. The tokenization of different query semantics can be implemented through the same tokenization configuration or different tokenization configurations, which may depend on actual needs. The tokenization configuration includes one of the following: a tokenization

model, a tokenization function, a projection matrix, a graph-based or topology-based pruning, a compression approach. There are a plurality of tokenization configurations to be chose, which provides more flexibility and can thus meet different requirements. The above lists some implementations for the tokenization, the specific means of the tokenization implementations are not limited here. For example, the tokenization model can be implemented by
5 using an existing manner.

[0214] In a possible implementation, the first matching score function, the second matching score function or the third matching score function can be implemented through an inner product or a euclidean distance. It should be noted that there may be other manners to implement a scoring function as long as the score of relevance between the sensed data and the first query information or the similarity between the sensed data and the first query information
10 can be obtained.

[0215] In a possible implementation, the sensing result includes one of the following: raw sensed data; a sensing semantic obtained from raw sensed data; half raw sensed data and a sensing semantic obtained from raw sensed data; raw sensed data and the first matching score; a sensing semantic obtained from raw sensed data and the first matching score; half raw sensed data, a sensing semantic obtained from raw sensed data, and the first matching score. The
15 sensing result may be in various forms related to the sensed data, which provides more flexibility and can thus meet different requirements.

[0216] In a possible implementation, the central device may receive multiple first matched sensing semantics and multiple fourth matching scores related to the multiple first matched sensing semantics from the at least one sensing device among the plurality of sensing devices; and receive multiple second matched sensing semantics and
20 multiple fifth matching scores related to the multiple second matched sensing semantics from the at least one sensing device among the plurality of sensing devices; then, obtain a first fused sensing semantic by fusing part or all of the multiple first matched sensing semantics according to the multiple fourth matching scores; and obtain a second fused sensing semantic by fusing part or all of the multiple second matched sensing semantics according to the multiple fifth matching scores. In the case that there are multiple sensing results for multiple modalities included in the
25 feedback data of the sensing device, and there are multiple sensing semantics for a single modality, the central device may perform a fusing operation on the sensing semantics of the same modality respectively, thus, the fused sensing semantic is comprehensive, thereby improving the accuracy of the fused sensing semantic. For example, the matching score of each sensing semantic may be regarded as a weight of each sensing semantic when fusing the plurality of sensing semantics. For another example, the matching score of each sensing semantic may be regarded

as a criterion for selecting the sensing semantics to fuse. It should be noted that, there may be other examples for use of the matching score, which is not limited here. During the fusing operation on the sensing semantics of the same modality, by considering the matching score of each sensing semantic which may indicate the relevance between the sensing semantic and the first query information, the multiple sensing semantics of the same modality are fused according to their matching scores, for example, in which the sensing semantic with the higher matching score would be given higher importance in the fusion, thus the impact of some sensing semantics with lower reliability may be reduced, the accuracy of the fused sensing semantic is thus further improved, and the reliability of the fused sensing semantic is ensured.

[0217] In a possible implementation, the central device may receive multiple sensing semantics, multiple fourth matching scores related to the multiple sensing semantics and multiple fifth matching scores related to the multiple sensing semantics from the at least one sensing device among the plurality of sensing devices; then, obtain a first fused sensing semantic by fusing part or all of the multiple sensing semantics according to the multiple fourth matching scores; and obtain a second fused sensing semantic by fusing part or all of the multiple second sensing semantics according to the multiple fifth matching scores. In the case that there are multiple sensing semantics for one modality but for multiple tasks included in the feedback data of the sensing device, the central device may perform a fusing operation on the sensing semantics of the same task respectively, thus, the fused sensing semantic is comprehensive, thereby improving the accuracy of the fused sensing semantic. During the fusing operation on the sensing semantics of the same task, by considering the matching score of each sensing semantic which may indicate the relevance between the sensing semantic and the first query information, the multiple sensing semantics of the same task are fused according to their matching scores, for example, in which the sensing semantic with the higher matching score would be given higher importance in the fusion, thus the impact of some sensing semantics with lower reliability may be reduced, the accuracy of the fused sensing semantic is thus further improved, and the reliability of the fused sensing semantic is ensured.

[0218] In a possible implementation, after obtaining the first and second fused sensing semantics, the central device may transmit the first fused sensing semantic to a first GPT device among the at least two GPT devices, and transmit the second fused sensing semantic to a second GPT device among the at least two GPT devices. The first or second fused sensing semantic can be respectively processed by the first or second GPT device to generate a next query based on the fused input. In other words, a GPT device may generate a sequence of queries (e.g., query semantics, query tokens, or other forms) by interacting with a sequence of fused sensing semantics (or fused sensing

messages, or other forms) into which the central device fuses the sensed data.

[0219] In a possible implementation, the central device may determine a sixth matching score for the first fused sensing semantic; and determine a seventh matching score for the second fused sensing semantic. The sixth matching score may indicate the relevance between the first fused sensing semantic and the first query information, the seventh matching score may indicate the relevance between the second fused sensing semantic and the first query information, that is, the sixth matching score and the seventh matching score may be used for evaluating the reliability of corresponding fused sensing semantics.

[0220] In order to elaborate the communication methods of the present disclosure more clearly, in the following, taking the communication system including at least a central device, a plurality of distributed sensing devices and at least a GPT device as an example, the method will be described in more details with the following example embodiments.

[0221] **Embodiment 1**

[0222] In the present disclosure, the wireless system is also called a communication system, or a wireless communication system. Herein the wireless system comprises a plurality of devices, for example, the plurality of devices comprise at least a central device, a plurality of distributed sensing devices and at least a GPT device (in FIG. 8).

[0223] The GPT device is responsible for encoding or decoding query messages and sensed data. In details, it generates a query message that contains one goal or more goals in natural language for the central device; the central device semantizes the query message into a semantic vector (i.e., the foregoing mentioned query semantic), tokenizes the semantic vector into a goal semantic token (or vector) (i.e., the foregoing mentioned query token), and then broadcasts the goal semantic token to the sensing devices. A sensing device, triggered by receiving the goal semantic token, measures its sensed data and converts the sensed data into a sensed semantic token (i.e., the foregoing mentioned sensing token).. The sensing device compares and scores the relevance between the goal semantic token and the sensed semantic token, and transmits the sensed data in semantic vector only if the score of relevance is higher than a threshold. The central device fuses the sensed data in semantic vectors, and outputs the fused one to the GPT device that will generate the next query message based on the fused input.

[0224] A central device may be a BS, e.g. gNB, or eNB etc., or the central device may be an access point (AP).

[0225] A sensing device is responsible for measuring and/or collecting local physical-world data. It may be sensing UE, sensing equipment, IoT equipment, UE, mobile phones, handset, or other equipment. The sensing device

may be equipped with a sensing gadget or component to measure local physical-world data near it into sensed data; the sensing device encodes and transmits them to the central device.

[0226] A GPT device may generate a sequence of the query messages and receive a fused sensing message from the central device. In the present disclosure, the GPT device could be also called an AI agent device, a robot device, or a smart controlling device.

[0227] In details, a plurality of the sensing devices herein may be grouped or classified in terms of types of sensed data. The first group of the sensing devices may measure the first type of sensed data (e.g. red, green, blue (RGB) images or video), whereas the second group of sensing devices may measure the second type of sensed data (e.g. Radio RF point-cloud or Lidar Point cloud) as illustrated in FIG. 9. It should be noted that, some sensing devices can be grouped into more than one group, i.e., some sensing devices can measure more than one type of sensed data.

[0228] The central device actively requests or triggers the sensing devices to transmit their most recent sensed data (in FIG. 10). Accordingly, the sensing devices will transmit their sensed data.

[0229] The central device may transmit the first query message or messages to one or some sensing devices in DL broadcast, multicast, or unicast channel or channels, which may be in physical broadcast channel(s), shared channel, or dedicated channel(s).

[0230] After a sensing device receives the first query message, the sensing device decides whether or not to transmit its sensed data. In details, the sensing device decodes the first query message, measures its data, and decides whether or not to transmit its sensed data, which is called as responding to the first query message. If the sensing device decides to respond to the first query message, the sensing device would encode/encapsulate the sensed data into a payload and then transmit it to the central device in UL channel or channel(s), which may be physical UL shared channel or dedicated UL channel.

[0231] After the central device of the wireless system receives all the payloads (i.e., the foregoing mentioned sensing results) from the sensing devices that responded to the first query message, the central device may fuse all or some payloads into a fused payload. Optionally, the central device may input the fused payload into the GPT device that may process them and then generate the second query message.

[0232] The central device may transmit the second query message or messages to one or some sensing devices in DL broadcast, multicast, or unicast channel or channel(s).

[0233] The GPT device transmits the query message(s) to the central device to inform and configure the central device to schedule when, how, what, and which sensing devices to sense and transmit their sensed data to the central

device. The GPT device may be implemented/located together with the central device for shorter latency, or the GPT device may be implemented in a remote data center, to which the central device may access via core network, or the GPT device may be on another connected device in the same wireless system of the central device. Please note that, in the present disclosure, the query message from the central device to the sensing device (downlink message) could be carried in higher layer signaling, such as radio resource control (RRC) signaling, or medium access control (MAC) layer signaling. Or, the query message could be carried in physical layer signaling, e.g., downlink control information (DCI). Or the query message is carried in the combination of the higher layer signaling and the physical signaling. It is similar for other downlink messages/data transmitted from the central device to the sensing device. Similarly, in the present disclosure, for uplink messages/data, they could be carried in higher layer signaling, such as RRC signaling, or MAC layer signaling. Or, they could be carried in physical layer signaling, e.g., uplink control information (UCI). Or they could be carried in the combination of the higher layer signaling and the physical signaling. It could be noted that the message in the present disclosure could be replaced with information, which may be carried in one single message, or be carried in more than one separate message.

[0234] In the above, the GPT device may generate a query message, and transmit the query message to the central device. In response to the query message from the GPT device, the central device may transmit the query message to a sensing device. In response to the query message from the central device, the sensing device may collect sensed data, and transmit the sensed data to the central device when determining that the sensed data and the query message are matched. It should be noted that, the query message transmitted from the GPT device to the central device is a specific form of the foregoing mentioned second query information, and the query message transmitted from the central device to the sensing device is a specific form of the foregoing mentioned first query information. Further, the first query information and the second query information may include a single query message, or more than one query message. Similarly, the fused sensing message is a specific form of the foregoing mentioned fused sensing result, and the fused sensing result may include a single fused sensing message, or more than one fused sensing message.

[0235] The wireless system comprising a central device, sensing devices, and a GPT device may form a series of interactions, in which the GPT device generates a sequence of the query messages for the sensing devices, the sensing devices collect and feedback the sensed data, and the central device fuses them and input them to the GPT device as illustrated in FIG. 11.

[0236] In some circumstances, some sensing devices may actively transmit their sensed data without receiving

any query message from the central device. The sensing devices that transmit the sensed data may respond to some urgency queries such as fire alarming or car accidents. In some sense, some query messages have been pre-defined and configured into the system by default.

[0237] Embodiment 2

5 **[0238]** A GPT device in Embodiment 1 may generate a sequence of the query messages based on the previous sensing messages, wherein the previous sensing messages are received and/or fused by the central device. The GPT device may inference one or several generative AI models. The generative AI model or model inferences deep neural network or networks to output a query message or messages. The GPT device generates a sequence of the query messages, called as “a chain of the thoughts” by interacting with a sequence of the fused sensing messages into
10 which the central device fuses the sensed data transmitted by the responsive sensing devices; as illustrated in FIG. 12.

15 **[0239]** A query message that the GPT device generates may convey semantic goals, tasks, or objectives. For example, a query message of “localize an incoming pedestrian” explicitly establishes a semantic goal for the sensing devices to focus on its nearby pedestrian and to prevent the sensing devices from being distracted. Since a query message conveys a semantic goal or goals, the query message that the central device transmits to the sensing devices may trigger a goal-oriented sensing task at each responsive sensing device that receives and responds to the very query message. Please note that a message may convey several goals. For example, a message of “find a moving pedestrian with a white coat” conveys two semantic goals or tasks: a moving pedestrian and a pedestrian with a white coat.

20 **[0240]** In an implementation, the central device may broadcast a sequence of the query messages, because it may be too costly or even forbidden to schedule a sensing device individually in a wireless system comprising such a high density of sensing devices. Therefore, once a sensing device receives a query message, the sensing device may become waken but with little idea whether or not its sensed data is sufficiently relevant to the goal conveyed by the query message. Thereby the sensing device may enable its sensing gadget to sense its nearby environment into
25 sensed data and compare the sensed data with the query message. If the sensing device tells that the sensed data is sufficiently relevant with the query message, the sensing device encodes and transmits the sensed data to the central device (Sensing Device #1 in FIG. 13). Otherwise, the sensing may not respond to the query message at all (Sensing Device #2 in FIG. 13). In this sense, the wireless system doesn’t schedule an individual sensing device but schedule a common task across a collectivity of sensing devices;

[0241] The central device may receive a plurality of sensed data from some or all the sensing devices that respond to the query message at the end of a pre-defined responding timing interval. The central device may fuse all the sensed data into one sensing message and input the sensing message to the GPT device that would generate the next query message based on the sensing message, as shown in FIG. 14.

5 [0242] Because only those sensing devices that respond to the query message would transmit the sensed data, lots of radio resource would be saved in comparison with one-to-one scheduling algorithm.

[0243] **Embodiment 3**

[0244] A sequence of the query messages in Embodiment 2 that the GPT device generates and the central device broadcasts is in a natural language, that is, human-readable. The GPT device may employ an LLM (large-language-model) to inference over a fused sensing message (in a natural language too) input to generate a new query message.
10 The LLM model may be a “standard” foundation model like a transformer, or a “custom” model that is built for a narrower vocabulary and specific scenario. For example, a customized LLM for dealing with industry 4.0 or a customized LLM for dealing with wireless communication signaling and protocols. The GPT device may change, update, downsize, upsize, replace its LLM or LLMs anytime as it wishes. Please note that broadcast, multicast or
15 unicast is allowed.

[0245] A query message in Embodiment 2 that the GPT device generates is in a natural language. Because of randomness in generating, two different query messages may convey very similar semantic goal or goals. For example, “find a pedestrian” and “localize a walking man” may have the same semantic goal. Therefore, the GPT device may semantize a query message into a query semantic, which is called as “embedding”, “semantization”,
20 “encoding”, “natural-language to machine translation” and so on. The GPT device may translate a query message into a query semantic that may comprise a vector, a matrix, or a tensor of scalars. The translation may be realized by the deep-neural network or other classic functions. A query semantic may preserve all the key semantic goals conveyed by the query message such that the query semantic can be well translated (de-semantized) back to a query message. Optionally, the GPT device may transmit a query semantic instead of a query message to the central device,
25 as illustrated in FIG. 15. As illustrated in FIG. 16, the query semantic is reversible, which means that the query message can be recovered from the query semantic. Please note that if all the LLMs output a common natural language (e.g. English), these LLMs are said to be aligned by the natural language; then whatever LLMs are used, everyone can be smoothly hooked into the GPT device and work well within the wireless system.

[0246] In an implementation, the central device may further tokenize a query semantic into a query token. A

query token is a fixed-length semantic but comprising a vector of scalars, simpler for transmission and comparison purposes. The wireless system may pre-specify a plurality of lengths for query tokens. Thus, the central device may choose a right token length when tokenizing a query semantic according to the size range of the query semantic. The tokenization can be such a harsh function to prevent a sensing device from recovering a complete query message from a query token. The tokenization may come up with certain privacy protection for query messages. The tokenization may be realized by the deep-neural network or other classic functions; as shown in FIG. 17.

[0247] Optionally, the central device receives a query semantic from the GPT device, and then the central device converts the query semantic into a query token with a fixed length; the central device may broadcast the query token with the length to all the sensing devices; the central device may keep the query semantic in its memory or storage to check the feedback sensed data.

[0248] As in Embodiment 2, a sensing device may compare its sensed data with the query message; after the sensing device receives a query token (with its length or indicator of its length), the sensing device is waked up to enable its sensing gadget to measure its nearby physical-world environment into sensed data; the sensing device may be equipped with one LLM or more LLMs as a semantization model and input the sensed data into the semantization model to output a sensing semantic; optionally, the sensing device may choose a right length and format of the sensing semantic; and the sensing device may continue to tokenize the sensing semantic into a sensing token with the same length as the query token that the sensing device has received; the sensing device compares or scores the relevance between the query message and sensed data, which is based on what the sensing device has received:

[0249] Alternative #1 (FIG. 18 and FIG. 19): the sensing device receives a query token and scoring function; it compares and scores the relevance between the query token and the sensing token; if the score of relevance was greater than or equal to a pre-defined threshold, the sensing device would tell that the sensed data is sufficiently relevant with the query message from the central device.

[0250] Alternative #2 (FIG. 20 and FIG. 21): the sensing device receives a query semantic and scoring function; it compares and scores the relevance between the query semantic with the sensing semantic, if both semantics are in a similar size and format; if the score of relevance was greater than or equal to a pre-defined threshold, the sensing device would tell that the sensed data is sufficiently relevant with the query message from the central device.

[0251] Alternative #3 (FIG. 22 and FIG. 23): the sensing device receives a query semantic and scoring function; it firstly converts the query semantic into a query token by the local tokenization model; and it compares and scores the relevance between the query token and sensing token; if the score of relevance was greater than or equal to a pre-

defined threshold, the sensing device would tell that the sensed data is sufficiently relevant with the query message from the central device.

[0252] Therefore, the central device may send the information of scoring function or functions and threshold or thresholds related to the query semantics (or messages or tokens) to the sensing device(s). In an implementation, the scoring function can be a “standard” one such as a simple inner product, so that only the threshold related to a query token is transmitted with the query token to the sensing devices.

[0253] **Embodiment 4**

[0254] The transmission of a query token (or semantic) in Embodiment 3 can be integrated into the physical layer of a wireless communication system for the purpose of the short latency, i.e. a fast physical-world search. For example, the query token (or semantic) may be carried in the physical layer signaling.

[0255] A query token, as mentioned in Embodiment 3, may be a fixed length of a vector of scalars, while a sensing device may generate a sensing token with the same length as its query token; a query token can be encoded in the following possible ways.

[0256] Alternative #1: a query token can be encoded into a sequence of a pre-defined length; in the wireless system a sequence of a pre-defined length can be applied (transmitted) in various forms, such as ambles (pre, post, or mid), mask codes (over ambles, over pilots, over spreading codes), interleaving sequence, or others.

[0257] Alternative #2: a query token can be encoded as a special payload with fixed MCS schemes; for example, the lengths of a token can be power-of-two, so that a polar code with puncturing can be directly employed to encode a query token.

[0258] Alternative #3: if an inner product was used as a scoring function, a long query token can be divided into several sub-blocks for incremental transmissions; if the inner product on the first sub-block has already given a strong correlation, the following sub-block could be saved.

[0259] Next, example embodiments of products related to the communication methods will be described.

[0260] FIG. 24 illustrates a block diagram of a communication apparatus 2400. As shown in FIG. 24, the apparatus 2400 includes:

a first receiving module 2402, configured to receive first query information, a first matching score function and a first threshold broadcasted or multicasted by a central device;

a determining module 2404, configured to determine, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first

threshold; and

a transmitting module 2406, configured to transmit a sensing result to the central device when the first matching score is greater than or equal to the first threshold, where the sensing result indicates the sensed data.

[0261] In a possible implementation, the first query information includes query information for one task or query information for one modality.

[0262] In a possible implementation, the method further includes: a second receiving module, configured to receive an indication for a task identifier or an indication for a modality identifier from the central device.

[0263] In a possible implementation, the first query information includes multiple pieces of query information for multiple tasks and multiple task identifiers respectively associated with the multiple pieces of query information.

[0264] In a possible implementation, the first query information includes multiple pieces of query information for multiple modalities and multiple modality identifiers respectively associated with the multiple pieces of query information.

[0265] In a possible implementation, the first query information includes first multiple pieces of query information for multiple tasks, second multiple pieces of query information for multiple modalities, multiple task identifiers respectively associated with the first multiple pieces of query information, and multiple modality identifiers respectively associated with the second multiple pieces of query information.

[0266] In a possible implementation, the first receiving module is specifically configured to: receive the first query information, the first matching score function and the first threshold broadcasted by the central device in a synchronization signal/Physical Broadcast Channel (PBCH) block (SSB).

[0267] In a possible implementation, the first query information is carried in a master information block (MIB) message or a system information block (SIB) message, and the MIB message or the SIB message includes an indication for indicating that whether the first query information is presented in the MIB message or the SIB message.

[0268] In a possible implementation, the MIB message or the SIB message further includes an indication for indicating a period for the first query information.

[0269] In a possible implementation, the first receiving module is specifically configured to: receive the first query information, the first matching score function and the first threshold multicasted by the central device in a multicast message.

[0270] In a possible implementation, the first query information includes at least two query semantics, the first receiving module is specifically configured to:

receive a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic and a format of the first query semantic broadcasted or multicasted by the central device; and receive a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic broadcasted or multicasted by the central device; or

receive a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic, a format of the first query semantic, a second query semantic among the at least two query semantics, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic broadcasted or multicasted by the central device in a multiplex way.

[0271] In a possible implementation, the apparatus further includes:

an obtaining module, configured to obtain the sensed data;

a translating module, configured to translate the sensed data into a common sensing semantic;

the determining module is specifically configured to:

determine, according to the second matching score function, whether a second matching score between the common sensing semantic and the first query semantic is greater than or equal to the second threshold; and

determine, according to the third matching score function, whether a third matching score between the common sensing semantic and the second query semantic is greater than or equal to the third threshold.

[0272] In a possible implementation, the apparatus further includes:

an obtaining module, configured to obtain the sensed data;

a first translating module, configured to translate the sensed data into a first sensing semantic according to a first semantization configuration, the length of the first query semantic and the format of the first query semantic;

a second translating module, configured to translate the sensed data into a second sensing semantic according to a second semantization configuration, the length of the second query semantic and the format of the second query semantic;

the determining module is specifically configured to:

determine, according to the second matching score function, whether a second matching score between the first sensing semantic and the first query semantic is greater than or equal to the second threshold; and

determine, according to the third matching score function, whether a third matching score between the second sensing semantic and the second query semantic is greater than or equal to the third threshold.

[0273] In a possible implementation, the method further includes:

an obtaining module, configured to obtain the sensed data;

5 a translating module, configured to translate the sensed data into a common sensing semantic;

a tokenizing module, configured to tokenize the common sensing semantic into a first sensing token, the first query semantic into a first query token, the common sensing semantic into a second sensing token and the second query semantic into a second query token according to a common tokenization configuration; or, tokenize the common sensing semantic into a first sensing token and the first query semantic into a first query token according to a first tokenization configuration, and tokenize the common sensing semantic into a second sensing token and the second query semantic into a second query token according to a second tokenization configuration;

the determining module is specifically configured to:

determine, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold; and

15 determine, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

[0274] In a possible implementation, the apparatus further includes:

an obtaining module, configured to obtain the sensed data;

20 a first translating module, configured to translate the sensed data into a first sensing semantic according to a first semantization configuration, the length of the first query semantic and the format of the first query semantic;

a second translating module, configured to translate the sensed data into a second sensing semantic according to a second semantization configuration, the length of the second query semantic and the format of the second query semantic;

25 a tokenizing module, configured to tokenize the first sensing semantic into a first sensing token, the first query semantic into a first query token, the second sensing semantic into a second sensing token and the second query semantic into a second query token according to a common tokenization configuration; or, tokenize the first sensing semantic into a first sensing token and the first query semantic into a first query token according to a first tokenization configuration, and tokenize the second sensing semantic into a second sensing token and the second query semantic into a second query token according to a second tokenization configuration;

the determining module is specifically configured to:

determine, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold; and

5 determine, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

[0275] In a possible implementation, the first query information includes at least two query tokens,

the first receiving module is specifically configured to:

10 receive a first query token among the at least two query tokens, a second matching score function related to the first query token, a second threshold related to the second matching score function and a length of the first query token broadcasted or multicasted by the central device; and receive a second query token among the at least two query tokens, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token broadcasted or multicasted by the central device;
or

15 receive a first query token among the at least two query tokens, a second matching score function related to the first query token, a second threshold related to the second matching score function, a length of the first query token, a second query token among the at least two query tokens, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token broadcasted or multicasted by the central device in a multiplex way.

[0276] In a possible implementation, the apparatus further includes:

20 an obtaining module, configured to obtain the sensed data;

a translating module, configured to translate the sensed data into a common sensing semantic;

25 a tokenizing module, configured to tokenize, according to a common tokenization configuration, the common sensing semantic into a first sensing token based on the length of the first query token, and the common sensing semantic into a second sensing token based on the length of the second query token; or, tokenize, according to a first tokenization configuration, the common sensing semantic into a first sensing token based on the length of the first query token, and tokenize, according to a second tokenization configuration, the common sensing semantic into a second sensing token based on the length of the second query token;

the determining module is specifically configured to:

determine, according to the second matching score function, whether a second matching score between

the first sensing token and the first query token is greater than or equal to the second threshold; and

determine, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

[0277] In a possible implementation, the apparatus further includes:

5 an obtaining module, configured to obtain the sensed data;

a first translating module, configured to translate the sensed data into a first sensing semantic according to a first semantization configuration;

a second translating module, configured to translate the sensed data into a second sensing semantic according to a second semantization configuration;

10 a tokenizing module, configured to tokenize, according to a common tokenization configuration, the first sensing semantic into a first sensing token based on the length of the first query token, and the second sensing semantic into a second sensing token based on the length of the second query token; or, tokenize, according to a first tokenization configuration, the first sensing semantic into a first sensing token based on the length of the first query token, and tokenize, according to a second tokenization configuration, the second sensing semantic into a second sensing token based on the length of the second query token;

15 the determining module is specifically configured to:

determine, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold; and

20 determine, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

[0278] In a possible implementation, the first matching score function, the second matching score function or the third matching score function includes an inner product or a euclidean distance.

[0279] In a possible implementation, the sensing result includes one of the following: raw sensed data; a sensing semantic obtained from raw sensed data; half raw sensed data and a sensing semantic obtained from raw sensed data; raw sensed data and the first matching score; a sensing semantic obtained from raw sensed data and the first matching score; half raw sensed data, a sensing semantic obtained from raw sensed data, and the first matching score.

25 [0280] In a possible implementation, the transmitting module is specifically configured to: transmit a first matched sensing semantic and a fourth matching score related to the first matched sensing semantic to the central device; and transmit a second matched sensing semantic and a fifth matching score related to the second matched

sensing semantic to the central device.

[0281] The communication apparatus may be applied to the sensing device as described in the above method examples or may be the sensing device as described in the above method examples. It should be understood by a person skilled in the art that, the relevant description of the modules in the examples of the present disclosure may be understood with reference to the relevant description of the communication method in the examples of the present disclosure.

[0282] As illustrated in FIG. 25, the present disclosure provides a communication apparatus 2500 including:
a first transmitting module 2502, configured to broadcast or multicast first query information, a first matching score function and a first threshold to a plurality of sensing devices; and

a first receiving module 2504, configured to receive a sensing result from at least one sensing device among the plurality of sensing devices, where a first matching score between sensed data and the first query information is greater than or equal to the first threshold, where the first matching score is based on the first matching score function, and the sensing result indicates the sensed data.

[0283] In a possible implementation, the first query information includes query information for one task or query information for one modality.

[0284] In a possible implementation, the apparatus further includes: a second transmitting module, configured to transmit an indication for a task identifier or an indication for a modality identifier.

[0285] In a possible implementation, the first query information includes multiple pieces of query information for multiple tasks and multiple task identifiers respectively associated with the multiple pieces of query information.

[0286] In a possible implementation, the first query information includes multiple pieces of query information for multiple modalities and multiple modality identifiers respectively associated with the multiple pieces of query information.

[0287] In a possible implementation, the first query information includes first multiple pieces of query information for multiple tasks, second multiple pieces of query information for multiple modalities, multiple task identifiers respectively associated with the first multiple pieces of query information, and multiple modality identifiers respectively associated with the second multiple pieces of query information.

[0288] In a possible implementation, the first transmitting module is specifically configured to: broadcast the first query information, the first matching score function and the first threshold in a synchronization signal/Physical Broadcast Channel (PBCH) block (SSB), to the plurality of sensing devices.

[0289] In a possible implementation, the first query information is carried in a master information block (MIB) message or a system information block (SIB) message, and the MIB message or the SIB message includes an indication for indicating that whether the first query information is presented in the MIB message or the SIB message.

5 [0290] In a possible implementation, the MIB message or the SIB message further includes an indication for indicating a period for the first query information.

[0291] In a possible implementation, the first transmitting module is specifically configured to: multicast the first query information, the first matching score function and the first threshold in a multicast message, to the plurality of sensing devices.

10 [0292] In a possible implementation, the apparatus further includes a second receiving module and an outputting module, where the second receiving module is configured to receive second query information from a generative pre-trained transformer (GPT) device; the outputting module is configured to output the sensing result to the GPT device.

[0293] In a possible implementation, the second receiving module is specifically configured to: receive at least two query semantics from at least two GPT devices;

15 the first transmitting module is specifically configured to:

broadcast or multicast a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic and a format of the first query semantic to the plurality of sensing devices; and broadcast or multicast a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic to the plurality of sensing devices; or

20 broadcast or multicast a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic, a format of the first query semantic, a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic to the plurality of sensing devices in a multiplex way.

25 [0294] In a possible implementation, the second receiving module is specifically configured to: receive at least two query semantics from at least two GPT devices;

the apparatus further includes a tokenizing module, configured to tokenize a first query semantic and a second query semantic among the at least two query semantics into a first query token and a second query token;

the first transmitting module is specifically configured to:

5 broadcast or multicast the first query token, a second matching score function related to the first query token, a second threshold related to the second matching score function and a length of the first query token to the plurality of sensing devices; and broadcast or multicast the second query token, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token to the plurality of sensing devices; or

10 broadcast or multicast the first query token, a second matching score function related to the first query token, a second threshold related to the second matching score function, a length of the first query token, the second query token, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token to the plurality of sensing devices in a multiplex way.

[0295] In a possible implementation, the tokenizing module is specifically configured to:

15 tokenize the first query semantic into the first query token according to a first tokenization configuration; and tokenize the second query semantic into the second query token according to a second tokenization configuration; or

20 tokenize the first query semantic into the first query token according to a common tokenization configuration; and tokenize the second query semantic into the second query token according to the common tokenization configuration.

[0296] In a possible implementation, the first matching score function, the second matching score function or the third matching score function includes an inner product or a euclidean distance.

[0297] In a possible implementation, the sensing result includes one of the following: raw sensed data; a sensing semantic obtained from raw sensed data; half raw sensed data and a sensing semantic obtained from raw sensed data; 25 raw sensed data and the first matching score; a sensing semantic obtained from raw sensed data and the first matching score; half raw sensed data, a sensing semantic obtained from raw sensed data, and the first matching score.

[0298] In a possible implementation, the first receiving module is specifically configured to: receive multiple first matched sensing semantics and multiple fourth matching scores related to the multiple first matched sensing semantics from the at least one sensing device among the plurality of sensing devices; and receive multiple second

matched sensing semantics and multiple fifth matching scores related to the multiple second matched sensing semantics from the at least one sensing device among the plurality of sensing devices;

the apparatus further includes an obtaining module, configured to obtain a first fused sensing semantic by fusing part or all of the multiple first matched sensing semantics according to the multiple fourth matching scores; and obtain a second fused sensing semantic by fusing part or all of the multiple second matched sensing semantics according to the multiple fifth matching scores.

[0299] In a possible implementation, the first receiving module is specifically configured to: receive multiple sensing semantics, multiple fourth matching scores related to the multiple sensing semantics and multiple fifth matching scores related to the multiple sensing semantics from the at least one sensing device among the plurality of sensing devices;

the apparatus further includes an obtaining module, configured to obtain a first fused sensing semantic by fusing part or all of the multiple sensing semantics according to the multiple fourth matching scores; and obtain a second fused sensing semantic by fusing part or all of the multiple second sensing semantics according to the multiple fifth matching scores.

[0300] In a possible implementation, the apparatus further includes a third transmitting module, configured to: transmit the first fused sensing semantic to a first GPT device among the at least two GPT devices, and transmit the second fused sensing semantic to a second GPT device among the at least two GPT devices.

[0301] In a possible implementation, the apparatus further includes: a determining module, configured to determine a sixth matching score for the first fused sensing semantic; and determine a seventh matching score for the second fused sensing semantic.

[0302] The communication apparatus may be applied to the central device as described in the above method examples or may be the central device as described in the above method examples. It should be understood by a person skilled in the art that, the relevant description of the modules in the examples of the present disclosure may be understood with reference to the relevant description of the communication method in the examples of the present disclosure.

[0303] The present disclosure provides a sensing device including processing circuitry for executing any of the above communication method. It should be understood that the sensing device can execute the steps performed by the sensing device in the method examples, which will not be repeated here.

[0304] The present disclosure provides a central device including processing circuitry for executing any of the

above communication method. It should be understood that the central device can execute the steps performed by the central device in the method examples, which will not be repeated here.

5 [0305] The present disclosure provides a communication system, including a central device and a sensing device. The sensing device is configured to execute the steps executed by the sensing device in any of the communication method, and the central device is configured to execute the steps executed by the central device in any of the communication method.

10 [0306] The present disclosure provides a communication system, including a sensing device and at least one of a central device and a GPT device. The sensing device is configured to execute the steps executed by the sensing device in any of the communication method, and the central device/the GPT device is configured to execute the steps executed by the central device in any of the communication method.

[0307] The present disclosure provides a chip, including an input/output (I/O) interface and a processor, where the processor is configured to call and run computer execution instructions stored in a memory, to enable a device installing with the chip to execute any of the above communication methods.

15 [0308] The present disclosure provides a computer-readable medium storing computer execution instructions which, when executed by a processor, causes the processor to execute any of the above communication methods.

[0309] The present disclosure provides a computer program product including computer execution instructions which, when executed by a processor, causes the processor to execute any of the above communication methods.

[0310] The present disclosure provides a computer program including computer execution instructions which, when executed by a processor, causes the processor to execute any of the above communication methods.

20 [0311] Some aspects of the present disclosure relate to a scheme of a semantic-based communication to manage and schedule a large number of sensing devices, in which the sensing devices may belong to different types. The query semantics are goal-oriented and only the sensing device whose sensed data has sufficient relevance with the semantic message(s) would response and transmit their sensed data that are preferably in semantic form too.

25 [0312] Some aspects of the present disclosure relate to a scheme of a collective semantic token-based scheduling over a large number of sensing devices rather than one-to-one individual scheduling.

[0313] Some aspects of the present disclosure relate to a scheme of using the large-Language-model (LLM) to turn query and sensed data into a common semantic domain on which they can be easily compared to each other and fused.

[0314] The above one or more aspects of the present disclosure may have at least one of the following benefits:

Scheduling may be task-oriented or goal-oriented; only the sensing devices that has contributions to a scheduled task or goal will response and transmit their sensed data;

Privacy may be protected: both the task, goal, or query and sensed data are well protected; no raw data or minimum raw data or message is transmitted over the air;

5 Forward compatible: semantic-based sensing system in this disclosure may be forward compatible in a sense that any new sensing mechanism can be supported.

[0315] In some aspects of the present disclosure, there is provided a computer program comprising instructions. The instructions, when executed by a processor, may cause the processor to implement the method of the present disclosure.

10 [0316] In some aspects of the present disclosure, there is provided a non-transitory computer-readable medium storing instructions, the instructions, when executed by a processor, may cause the processor to implement the method of the present disclosure.

[0317] In some aspects of the present disclosure, there is provided an apparatus/chipset system comprising means to implement the method implemented by the sensing device of the present disclosure.

15 [0318] In some aspects of the present disclosure, there is provided an apparatus/chipset system comprising means to implement the method implemented by the central device of the present disclosure.

[0319] In some aspects of the present disclosure, there is provided an apparatus/chipset system comprising means to implement the method implemented by the GPT device of the present disclosure.

20 [0320] In some aspects of the present disclosure, there is provided a system comprising at least two of an apparatus in the sensing device of the present disclosure, an apparatus in the central device of the present disclosure and an apparatus in the GPT device of the present disclosure.

[0321] In some aspects of the present disclosure, there is provided an apparatus/chipset system comprising at least one processor executing instructions stored in a computer-readable medium to implement the method implemented by the sensing device of the present disclosure.

25 [0322] In some aspects of the present disclosure, there is provided an apparatus/chipset system comprising at least one processor executing instructions stored in a computer-readable medium to implement the method implemented by the central device of the present disclosure.

[0323] In some aspects of the present disclosure, there is provided an apparatus/chipset system comprising at least one processor executing instructions stored in a computer-readable medium to implement the method

implemented by the GPT device of the present disclosure.

[0324] Please note that the different examples may be implemented separately or combined. Although a combination of features is shown in the illustrated embodiments, not all of them need to be combined to realize the benefits of various examples of the present disclosure. In other words, a system or method designed in the present disclosure will not necessarily include all of the features shown in any one of the figures or all of the portions schematically shown in the figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

[0325] Although this disclosure has been described with reference to illustrative embodiments, the description is not intended to be construed in a limiting sense. Various modifications and combinations of the illustrative embodiments, as well as other examples of the disclosure, will be apparent to persons skilled in the art upon reference to the description. It is therefore intended that the appended claims encompass any such modifications or examples.

[0326] Although the present disclosure describes methods and processes with steps in a certain order, one or more steps of the methods and processes may be omitted or altered as appropriate. One or more steps may take place in an order other than that in which they are described, as appropriate.

[0327] Note that the expression “at least one of A or B”, as used herein, is interchangeable with the expression “A and/or B”. It refers to a list in which you may select A or B or both A and B. Similarly, “at least one of A, B, or C”, as used herein, is interchangeable with “A and/or B and/or C” or “A, B, and/or C”. It refers to a list in which you may select: A or B or C, or both A and B, or both A and C, or both B and C, or all of A, B and C. The same principle applies for longer lists having a same format.

[0328] Although the present disclosure is described, at least in part, in terms of methods, a person of ordinary skill in the art will understand that the present disclosure is also directed to the various components for performing at least some of the aspects and features of the described methods, be it by way of hardware components, software or any combination of the two. Accordingly, the technical solution of the present disclosure may be embodied in the form of a software product. A suitable software product may be stored in a pre-recorded storage device or other similar non-volatile or non-transitory computer readable medium, including DVDs, CD-ROMs, USB flash disk, a removable hard disk, or other storage media, for example. The software product includes instructions tangibly stored thereon that enable a processing device (e.g., a personal computer, a server, or a network device) to execute examples of the methods disclosed herein. The machine-executable instructions may be in the form of code sequences, configuration information, or other data, which, when executed, cause a machine (e.g., a processor or other

processing device) to perform steps in a method according to examples of the present disclosure.

[0329] The present disclosure may be embodied in other specific forms without departing from the subject matter of the claims. The described examples are to be considered in all respects as being only illustrative and not restrictive. Selected features from one or more of the above-described examples may be combined to create
5 alternative examples not explicitly described, features suitable for such combinations being understood within the scope of this disclosure.

[0330] All values and sub-ranges within disclosed ranges are also disclosed. Also, although the systems, devices and processes disclosed and shown herein may include a specific number of elements/components, the systems, devices and assemblies could be modified to include additional or fewer of such elements/components. For example,
10 although any of the elements/components disclosed may be referenced as being singular, the examples disclosed herein could be modified to include a plurality of such elements/components. The subject matter described herein intends to cover and embrace all suitable changes in technology.

[0331] Although examples have been described above with reference to the accompanying drawings, those of skill in the art will appreciate that variations and modifications may be made without departing from the scope
15 thereof as defined by the appended claims.

CLAIMS

1. A communication method, comprising:

receiving first query information, a first matching score function, and a first threshold broadcasted or multicasted by a central device;

5 determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold; and

transmitting a sensing result to the central device when the first matching score is greater than or equal to the first threshold, wherein the sensing result indicates the sensed data.

2. The method according to claim 1, wherein the first query information comprises query information for one
10 task or query information for one modality.

3. The method according to claim 2, wherein the method further comprises:

receiving an indication for a task identifier or an indication for a modality identifier from the central device.

4. The method according to claim 1, wherein the first query information comprises multiple pieces of query
15 information for multiple tasks and multiple task identifiers respectively associated with the multiple pieces of query information.

5. The method according to claim 1, wherein the first query information comprises multiple pieces of query information for multiple modalities and multiple modality identifiers respectively associated with the multiple pieces of query information.

6. The method according to claim 1, wherein the first query information comprises first multiple pieces of query
20 information for multiple tasks, second multiple pieces of query information for multiple modalities, multiple task identifiers respectively associated with the first multiple pieces of query information, and multiple modality identifiers respectively associated with the second multiple pieces of query information.

7. The method according to any one of claims 1-6, wherein the receiving the first query information, the first matching score function, and the first threshold broadcasted or multicasted by the central device comprises:

25 receiving the first query information, the first matching score function, and the first threshold broadcasted by the central device in a synchronization signal/Physical Broadcast Channel (PBCH) block (SSB).

8. The method according to claim 7, wherein the first query information is carried in a master information block (MIB) message or a system information block (SIB) message, and the MIB message or the SIB message comprises

an indication for indicating that whether the first query information is presented in the MIB message or the SIB message.

9. The method according to claim 8, wherein the MIB message or the SIB message further comprises an indication for indicating a period for the first query information.

5 10. The method according to any one of claims 1-6, wherein the receiving the first query information, the first matching score function, and the first threshold broadcasted or multicasted by the central device comprises:

receiving the first query information, the first matching score function, and the first threshold multicasted by the central device in a multicast message.

10 11. The method according to any one of claims 1-10, wherein the first query information comprises at least two query semantics,

the receiving the first query information, the first matching score function, and the first threshold broadcasted or multicasted by the central device comprises:

15 receiving a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic and a format of the first query semantic broadcasted or multicasted by the central device; and receiving a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic broadcasted or multicasted by the central device; or

20 receiving a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic, a format of the first query semantic, a second query semantic among the at least two query semantics, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic broadcasted or multicasted by the central device in a multiplex way.

25 12. The method according to claim 11, wherein the method further comprises:

obtaining the sensed data;

translating the sensed data into a common sensing semantic;

the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold comprises:

determining, according to the second matching score function, whether a second matching score between the

common sensing semantic and the first query semantic is greater than or equal to the second threshold; and

determining, according to the third matching score function, whether a third matching score between the common sensing semantic and the second query semantic is greater than or equal to the third threshold.

13. The method according to claim 11, wherein the method further comprises:

5 obtaining the sensed data;

translating the sensed data into a first sensing semantic according to a first semantization configuration, the length of the first query semantic and the format of the first query semantic;

translating the sensed data into a second sensing semantic according to a second semantization configuration, the length of the second query semantic and the format of the second query semantic;

10 the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold comprises:

determining, according to the second matching score function, whether a second matching score between the first sensing semantic and the first query semantic is greater than or equal to the second threshold; and

15 determining, according to the third matching score function, whether a third matching score between the second sensing semantic and the second query semantic is greater than or equal to the third threshold.

14. The method according to claim 11, wherein the method further comprises:

obtaining the sensed data;

translating the sensed data into a common sensing semantic;

20 tokenizing the common sensing semantic into a first sensing token, the first query semantic into a first query token, the common sensing semantic into a second sensing token and the second query semantic into a second query token according to a common tokenization configuration; or, tokenizing the common sensing semantic into a first sensing token and the first query semantic into a first query token according to a first tokenization configuration, and tokenizing the common sensing semantic into a second sensing token and the second query semantic into a second query token according to a second tokenization configuration;

25 the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold comprises:

determining, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold; and

determining, according to the third matching score function, whether a third matching score between the second

sensing token and the second query token is greater than or equal to the third threshold.

15. The method according to claim 11, wherein the method further comprises:

obtaining the sensed data;

translating the sensed data into a first sensing semantic according to a first semantization configuration, the

5 length of the first query semantic and the format of the first query semantic;

translating the sensed data into a second sensing semantic according to a second semantization configuration,
the length of the second query semantic and the format of the second query semantic;

tokenizing the first sensing semantic into a first sensing token, the first query semantic into a first query token,
the second sensing semantic into a second sensing token and the second query semantic into a second query token
10 according to a common tokenization configuration; or, tokenizing the first sensing semantic into a first sensing token
and the first query semantic into a first query token according to a first tokenization configuration, and tokenizing
the second sensing semantic into a second sensing token and the second query semantic into a second query token
according to a second tokenization configuration;

the determining, according to the first matching score function, whether a first matching score between sensed
15 data and the first query information is greater than or equal to the first threshold comprises:

determining, according to the second matching score function, whether a second matching score between the
first sensing token and the first query token is greater than or equal to the second threshold; and

determining, according to the third matching score function, whether a third matching score between the second
sensing token and the second query token is greater than or equal to the third threshold.

20 16. The method according to any one of claims 1-10, wherein the first query information comprises at least two
query tokens,

the receiving the first query information, the first matching score function, and the first threshold broadcasted
or multicasted by the central device comprises:

receiving a first query token among the at least two query tokens, a second matching score function related to
25 the first query token, a second threshold related to the second matching score function and a length of the first query
token broadcasted or multicasted by the central device; and receiving a second query token among the at least two
query tokens, a third matching score function related to the second query token, a third threshold related to the third
matching score function and a length of the second query token broadcasted or multicasted by the central device; or
receiving a first query token among the at least two query tokens, a second matching score function related to

the first query token, a second threshold related to the second matching score function, a length of the first query token, a second query token among the at least two query tokens, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token broadcasted or multicasted by the central device in a multiplex way.

5 17. The method according to claim 16, wherein the method further comprises:

obtaining the sensed data;

translating the sensed data into a common sensing semantic;

tokenizing, according to a common tokenization configuration, the common sensing semantic into a first sensing token based on the length of the first query token, and the common sensing semantic into a second sensing token based on the length of the second query token; or, tokenizing, according to a first tokenization configuration, the common sensing semantic into a first sensing token based on the length of the first query token, and tokenizing, according to a second tokenization configuration, the common sensing semantic into a second sensing token based on the length of the second query token;

10 the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold comprises:

determining, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold; and

determining, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

15 18. The method according to claim 16, wherein the method further comprises:

obtaining the sensed data;

translating the sensed data into a first sensing semantic according to a first semantization configuration;

translating the sensed data into a second sensing semantic according to a second semantization configuration;

20 tokenizing, according to a common tokenization configuration, the first sensing semantic into a first sensing token based on the length of the first query token, and the second sensing semantic into a second sensing token based on the length of the second query token; or, tokenizing, according to a first tokenization configuration, the first sensing semantic into a first sensing token based on the length of the first query token, and tokenizing, according to a second tokenization configuration, the second sensing semantic into a second sensing token based on the length of the second query token;

the determining, according to the first matching score function, whether a first matching score between sensed data and the first query information is greater than or equal to the first threshold comprises:

determining, according to the second matching score function, whether a second matching score between the first sensing token and the first query token is greater than or equal to the second threshold; and

5 determining, according to the third matching score function, whether a third matching score between the second sensing token and the second query token is greater than or equal to the third threshold.

19. The method according to any one of claims 11-18, wherein the first matching score function, the second matching score function or the third matching score function comprises an inner product or a euclidean distance.

20. The method according to any one of claims 1-19, wherein the sensing result comprises one of the following:

10 raw sensed data;

a sensing semantic obtained from raw sensed data;

half raw sensed data and a sensing semantic obtained from raw sensed data;

raw sensed data and the first matching score;

a sensing semantic obtained from raw sensed data and the first matching score;

15 half raw sensed data, a sensing semantic obtained from raw sensed data, and the first matching score.

21. The method according to any one of claims 11-20, wherein the transmitting the sensing result to the central device comprises:

transmitting a first matched sensing semantic and a fourth matching score related to the first matched sensing semantic to the central device; and transmitting a second matched sensing semantic and a fifth matching score related to the second matched sensing semantic to the central device.

20

22. A communication method, comprising:

broadcasting or multicasting first query information, a first matching score function and a first threshold to a plurality of sensing devices; and

receiving a sensing result from at least one sensing device among the plurality of sensing devices, wherein a first matching score between sensed data and the first query information is greater than or equal to the first threshold, wherein the first matching score is based on the first matching score function, and the sensing result indicates the sensed data.

25

23. The method according to claim 22, wherein the first query information comprises query information for one task or query information for one modality.

24. The method according to claim 23, wherein the method further comprises:

transmitting an indication for a task identifier or an indication for a modality identifier.

25. The method according to claim 22, wherein the first query information comprises multiple pieces of query information for multiple tasks and multiple task identifiers respectively associated with the multiple pieces of query information.

26. The method according to claim 22, wherein the first query information comprises multiple pieces of query information for multiple modalities and multiple modality identifiers respectively associated with the multiple pieces of query information.

27. The method according to claim 22, wherein the first query information comprises first multiple pieces of query information for multiple tasks, second multiple pieces of query information for multiple modalities, multiple task identifiers respectively associated with the first multiple pieces of query information, and multiple modality identifiers respectively associated with the second multiple pieces of query information.

28. The method according to any one of claims 22-27, wherein the broadcasting or multicasting the first query information, the first matching score function and the first threshold to the plurality of sensing devices comprises: broadcasting the first query information, the first matching score function and the first threshold in a synchronization signal/Physical Broadcast Channel (PBCH) block (SSB), to the plurality of sensing devices.

29. The method according to claim 28, wherein the first query information is carried in a master information block (MIB) message or a system information block (SIB) message, and the MIB message or the SIB message comprises an indication for indicating that whether the first query information is presented in the MIB message or the SIB message.

30. The method according to claim 29, wherein the MIB message or the SIB message further comprises an indication for indicating a period for the first query information.

31. The method according to any one of claims 22-27, wherein the broadcasting or multicasting the first query information, the first matching score function and the first threshold to the plurality of sensing devices comprises: multicasting the first query information, the first matching score function and the first threshold in a multicast message, to the plurality of sensing devices.

32. The method according to any one of claims 22-31, wherein the method further comprises: receiving second query information from a generative pre-trained transformer (GPT) device; outputting the sensing result to the GPT device.

33. The method according to claim 32, wherein the receiving the second query information from the GPT device comprises:

receiving at least two query semantics from at least two GPT devices;

the broadcasting or multicasting the first query information, the first matching score function and the first threshold to the plurality of sensing devices comprises:

5 broadcasting or multicasting a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic and a format of the first query semantic to the plurality of sensing devices; and broadcasting or multicasting a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic to the plurality of sensing devices; or

10 broadcasting or multicasting a first query semantic among the at least two query semantics, a second matching score function related to the first query semantic, a second threshold related to the second matching score function, a length of the first query semantic, a format of the first query semantic, a second query semantic among the at least two query semantics, a third matching score function related to the second query semantic, a third threshold related to the third matching score function, a length of the second query semantic and a format of the second query semantic to the plurality of sensing devices in a multiplex way.

34. The method according to claim 32, wherein the receiving the second query information from the GPT device comprises:

20 receiving at least two query semantics from at least two GPT devices;

the method further comprises:

tokenizing a first query semantic and a second query semantic among the at least two query semantics into a first query token and a second query token;

the broadcasting or multicasting the first query information, the first matching score function and the first threshold to the plurality of sensing devices comprises:

25 broadcasting or multicasting the first query token, a second matching score function related to the first query token, a second threshold related to the second matching score function and a length of the first query token to the plurality of sensing devices; and broadcasting or multicasting the second query token, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the

second query token to the plurality of sensing devices; or

broadcasting or multicasting the first query token, a second matching score function related to the first query token, a second threshold related to the second matching score function, a length of the first query token, the second query token, a third matching score function related to the second query token, a third threshold related to the third matching score function and a length of the second query token to the plurality of sensing devices in a multiplex way.

35. The method according to claim 34, wherein the tokenizing the first query semantic and the second query semantic among the at least two query semantics into the first query token and the second query token comprises:

tokenizing the first query semantic into the first query token according to a first tokenization configuration; and tokenizing the second query semantic into the second query token according to a second tokenization configuration; or

tokenizing the first query semantic into the first query token according to a common tokenization configuration; and tokenizing the second query semantic into the second query token according to the common tokenization configuration.

36. The method according to any one of claims 33-35, wherein the first matching score function, the second matching score function or the third matching score function comprises an inner product or a euclidean distance.

37. The method according to any one of claims 22-36, wherein the sensing result comprises one of the following:

raw sensed data;

a sensing semantic obtained from raw sensed data;

half raw sensed data and a sensing semantic obtained from raw sensed data;

raw sensed data and the first matching score;

a sensing semantic obtained from raw sensed data and the first matching score;

half raw sensed data, a sensing semantic obtained from raw sensed data, and the first matching score.

38. The method according to any one of claims 22-37, wherein the receiving the sensing result from the at least one sensing device comprises:

receiving multiple first matched sensing semantics and multiple fourth matching scores related to the multiple first matched sensing semantics from the at least one sensing device among the plurality of sensing devices; and receiving multiple second matched sensing semantics and multiple fifth matching scores related to the multiple second matched sensing semantics from the at least one sensing device among the plurality of sensing devices;

the method further comprises:

obtaining a first fused sensing semantic by fusing part or all of the multiple first matched sensing semantics according to the multiple fourth matching scores; and obtaining a second fused sensing semantic by fusing part or all of the multiple second matched sensing semantics according to the multiple fifth matching scores.

5 39. The method according to any one of claims 22-37, wherein the receiving the sensing result from the at least one sensing device comprises:

receiving multiple sensing semantics, multiple fourth matching scores related to the multiple sensing semantics and multiple fifth matching scores related to the multiple sensing semantics from the at least one sensing device among the plurality of sensing devices;

10 the method further comprises:

obtaining a first fused sensing semantic by fusing part or all of the multiple sensing semantics according to the multiple fourth matching scores; and obtaining a second fused sensing semantic by fusing part or all of the multiple second sensing semantics according to the multiple fifth matching scores.

40. The method according to claim 38 or 39, further comprising:

15 transmitting the first fused sensing semantic to a first GPT device among the at least two GPT devices; and transmitting the second fused sensing semantic to a second GPT device among the at least two GPT devices.

41. The method according to any one of claims 38-40, further comprising:

determining a sixth matching score for the first fused sensing semantic; and determining a seventh matching score for the second fused sensing semantic.

20 42. A communication apparatus, comprising modules for performing the method according to any one of claims 1-21, or modules for carrying out the method according to any one of claims 22-41.

43. An electronic device comprising processing circuitry for performing the method according to any one of claims 1-21, or processing circuitry for carrying out the method according to any one of claims 22-41.

25 44. A chip, comprising an input/output (I/O) interface and a processor, wherein the processor is configured to call and run a computer program stored in a memory, to enable a device installing with the chip to perform the method according to any one of claims 1-21, or carry out the method according to any one of claims 22-41.

45. A sensing device, comprising:

one or more processors; and

a non-transitory computer-readable storage medium coupled to the one or more processors and storing

programming for execution by the processors, wherein the programming, when executed by the processors, configures the sensing device to perform the method according to any one of claims 1-21.

46. A central device, comprising:

one or more processors; and

5 a non-transitory computer-readable storage medium coupled to the processors and storing programming for execution by the processors, wherein the programming, when executed by the processors, configures the central device to perform the method according to any one of claims 22-41.

47. A communication system, comprising: the sensing device according to claim 45 and the central device according to claim 46.

10 48. A non-transitory computer-readable medium carrying a program code which, when executed by a computer device, causes the computer device to perform the method according to any one of claims 1-21 or the method according to any one of claims 22-41.

49. A computer program product comprising program code for performing the method according to any one of claims 1-21 or the method according to any one of claims 22-41 when executed on a computer or a processor.

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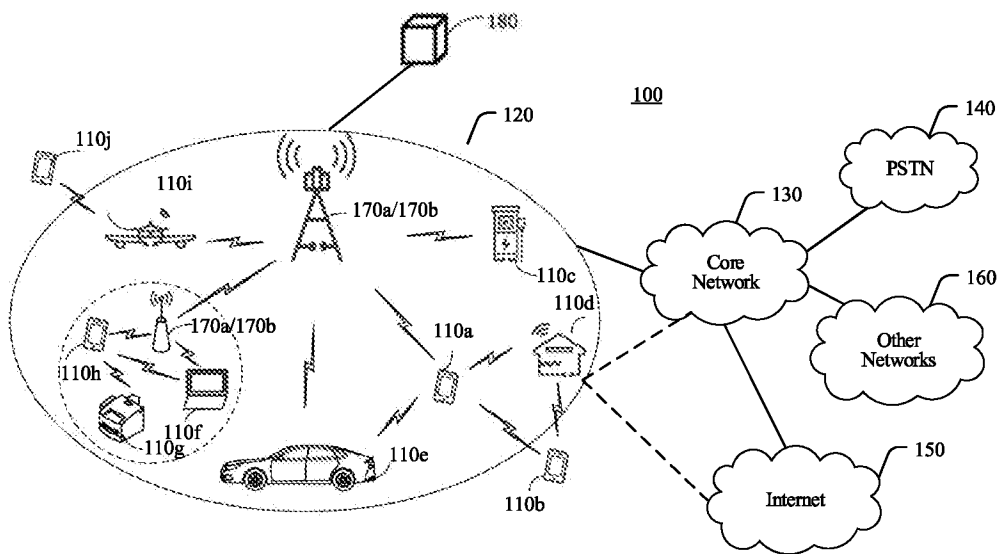


FIG. 1

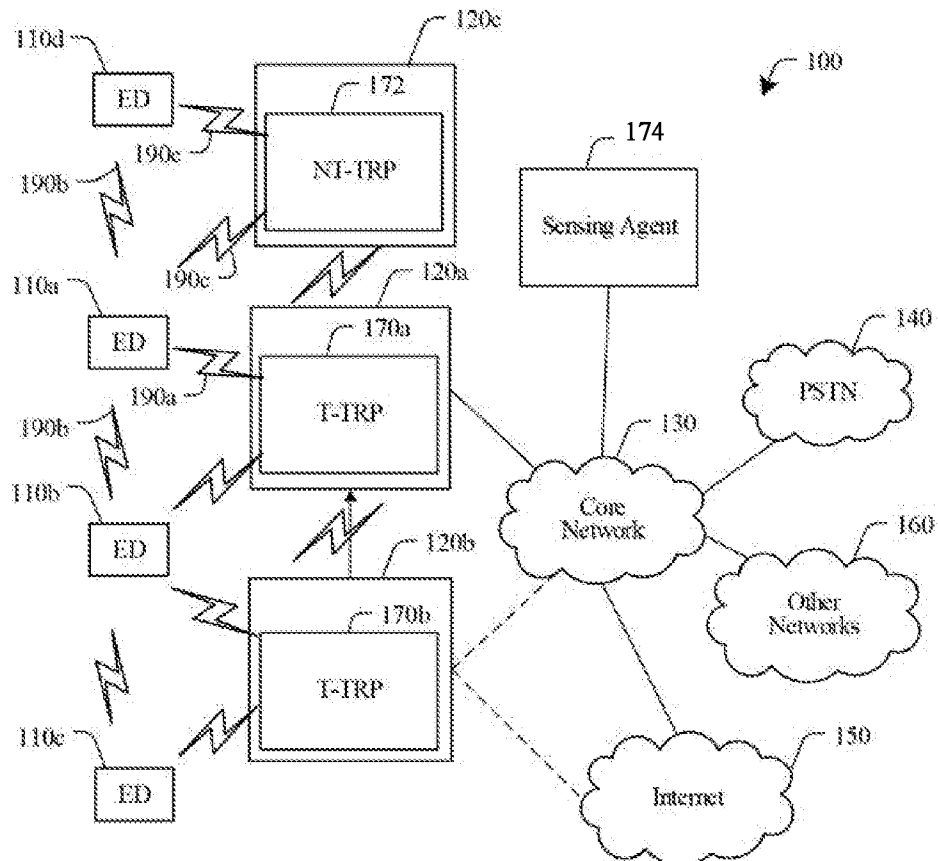


FIG. 2

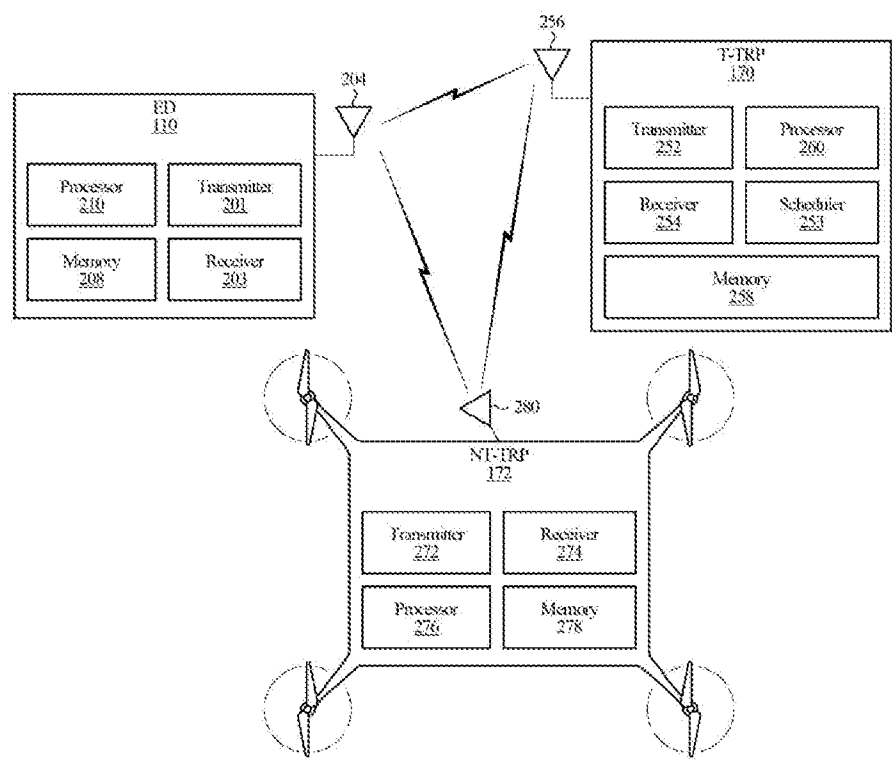


FIG. 3

110, 170, 172 or 180

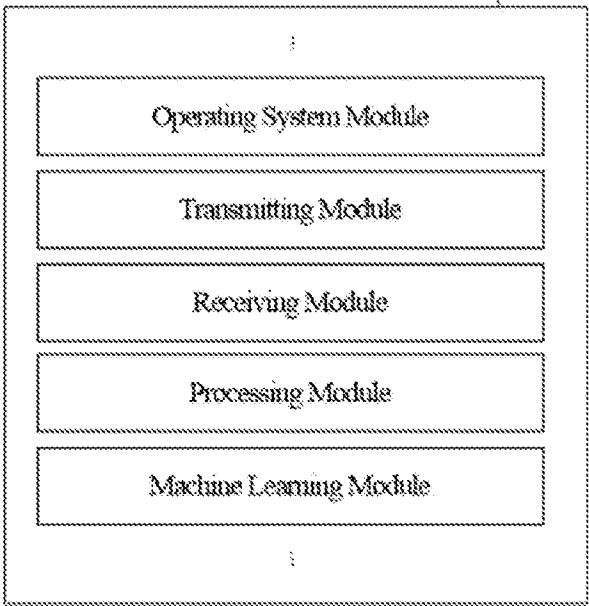


FIG. 4

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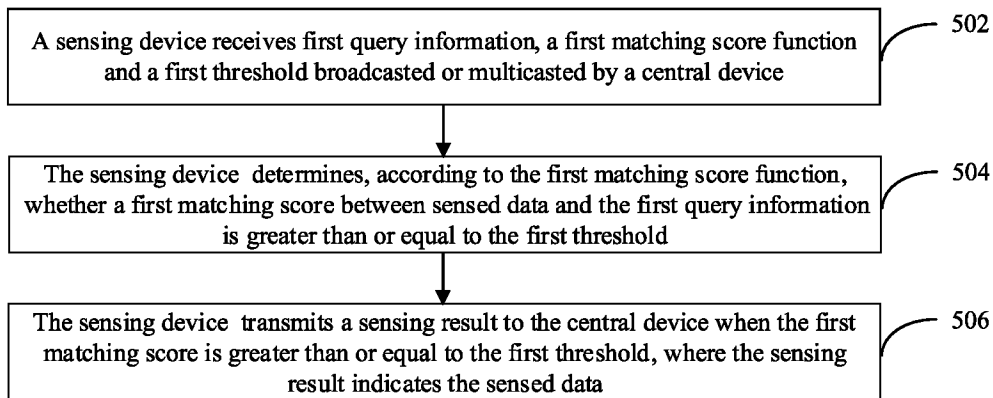


FIG. 5

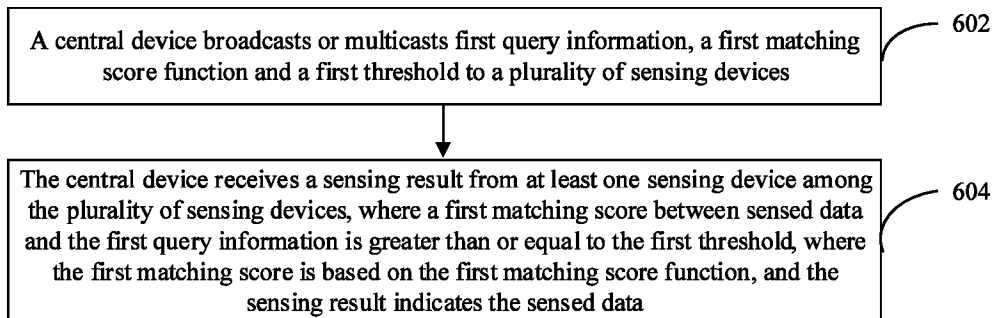


FIG. 6

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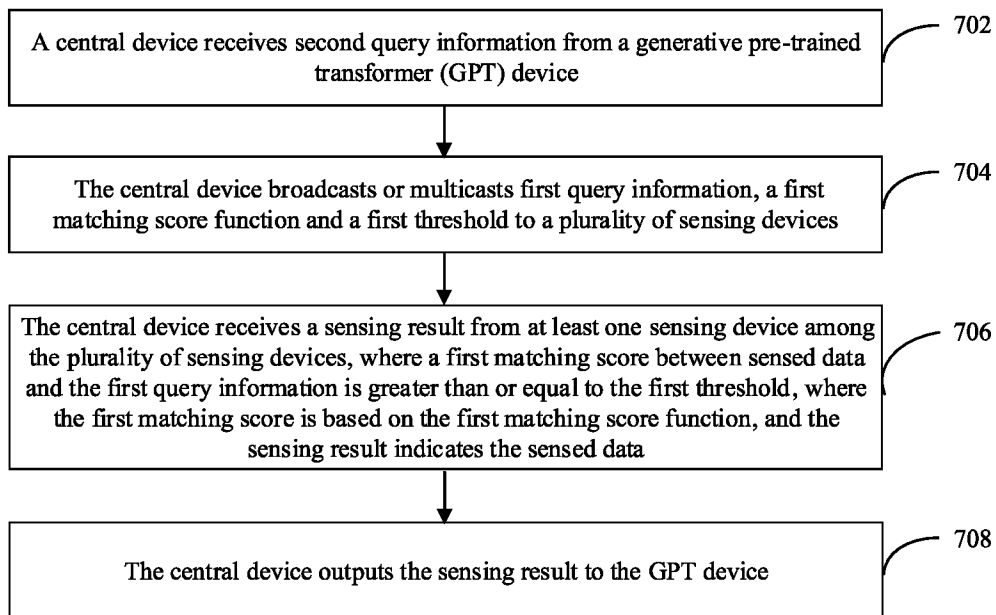


FIG. 7

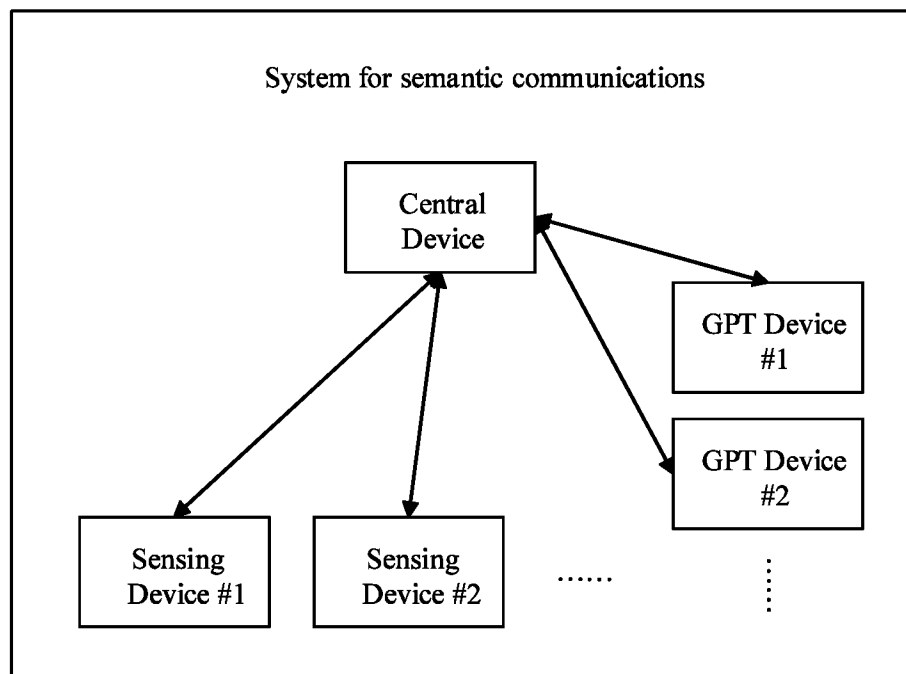


FIG. 8

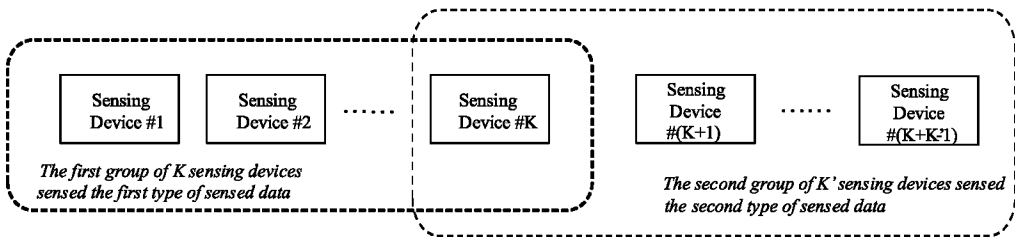


FIG. 9

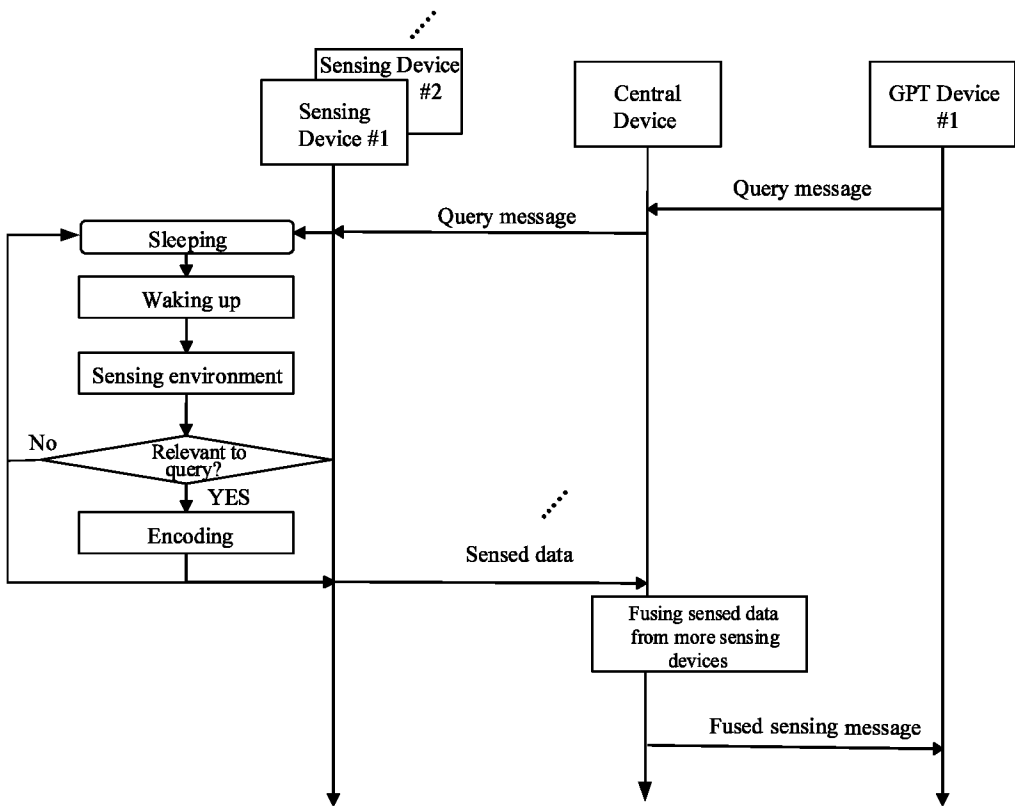


FIG. 10

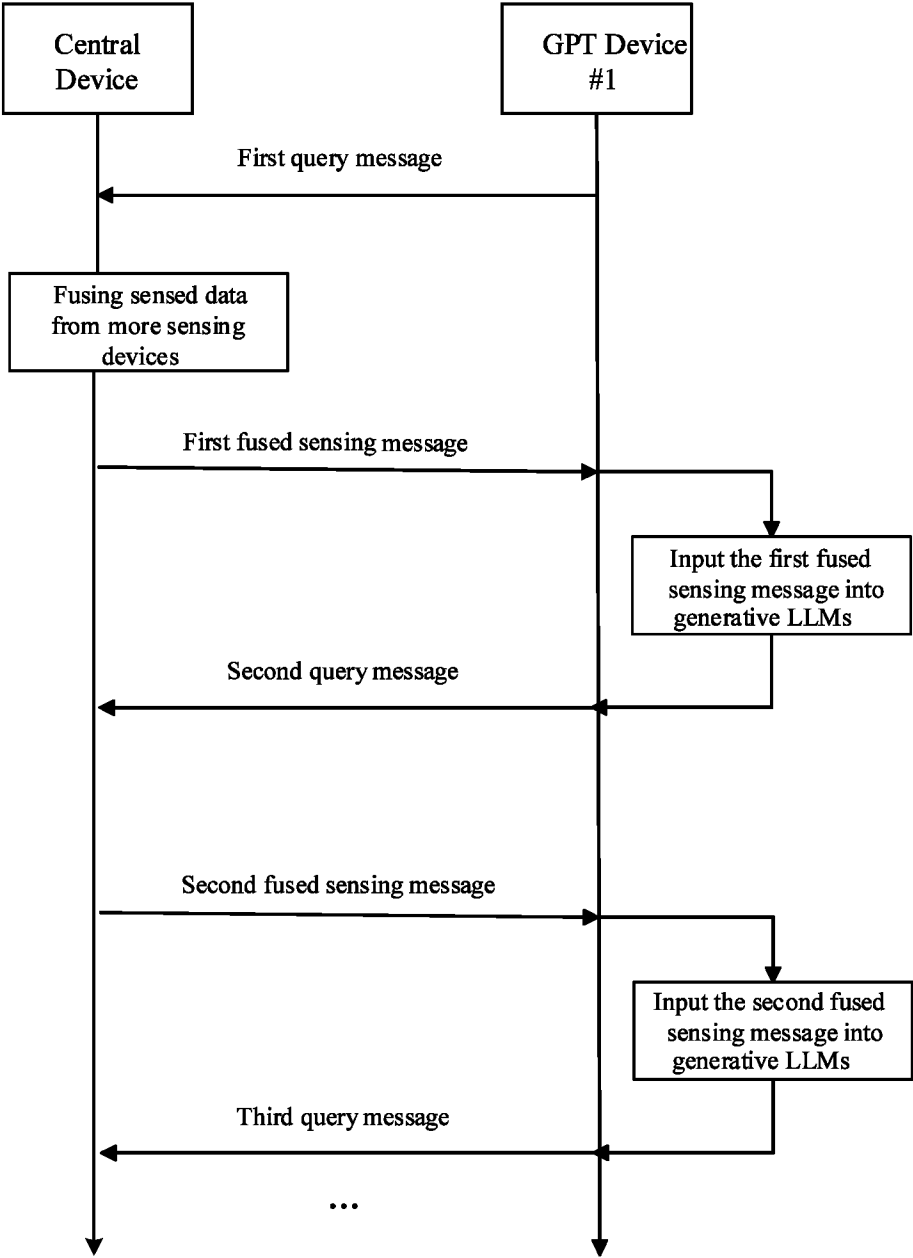


FIG. 11

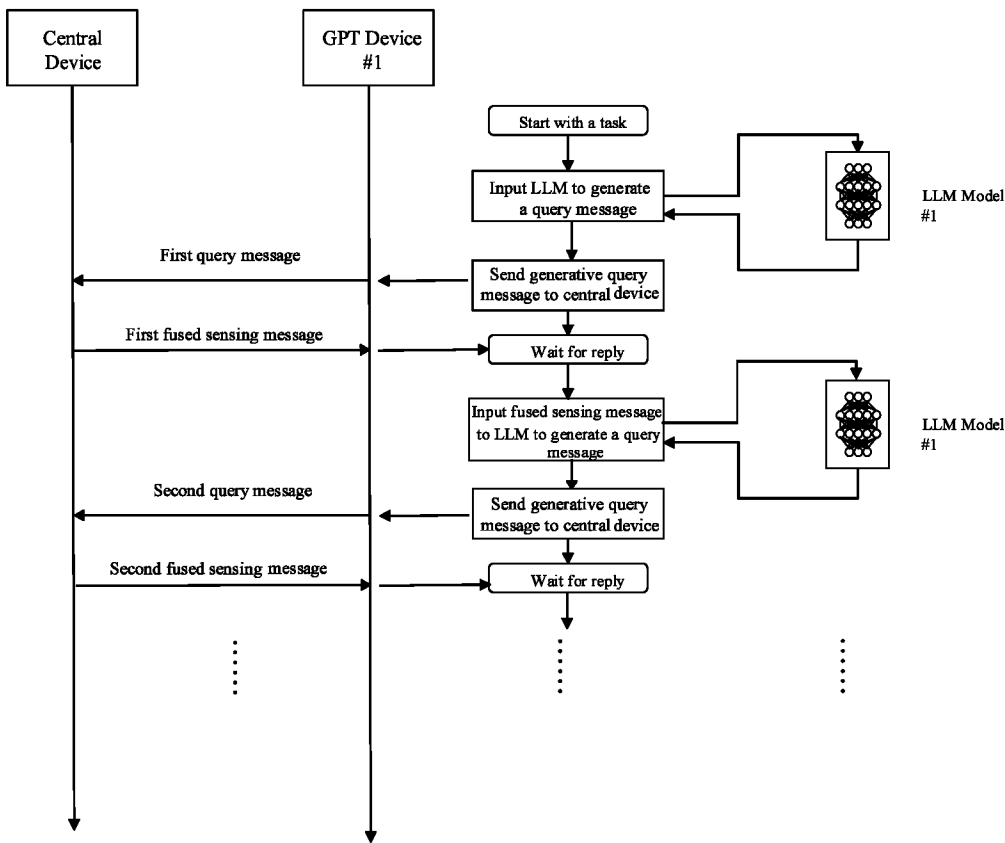


FIG. 12

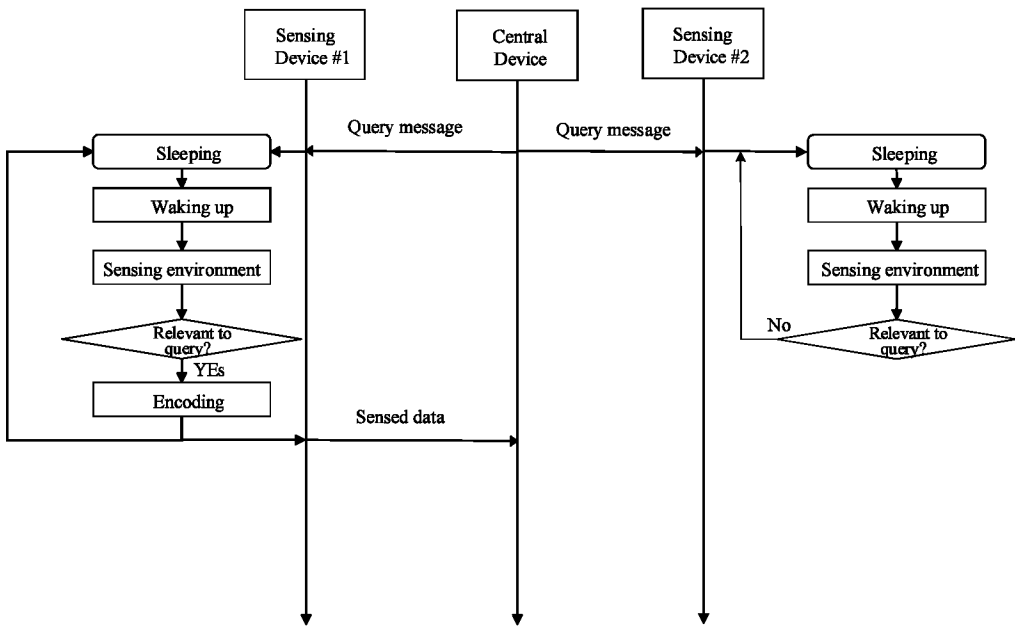


FIG. 13

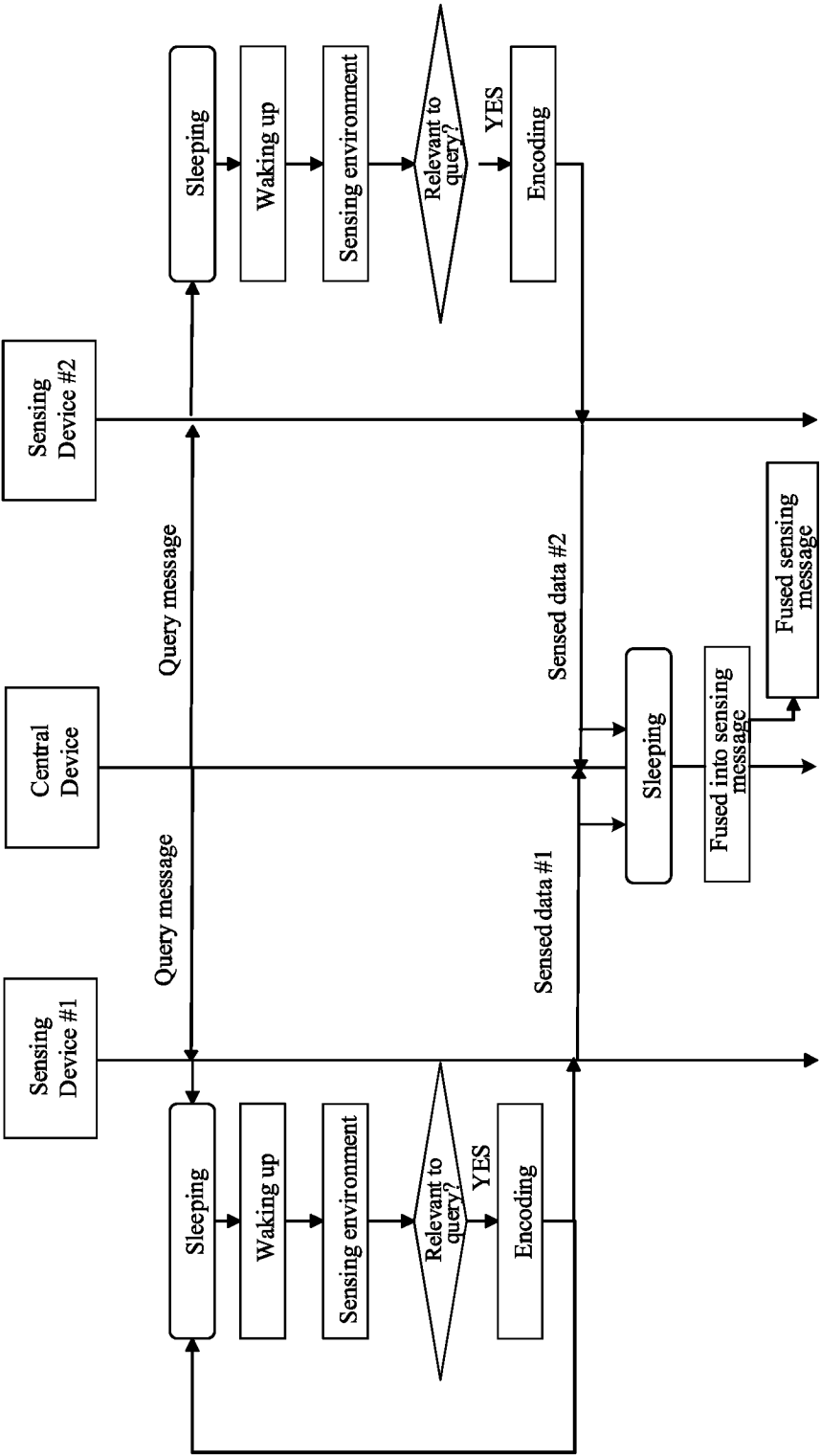


FIG. 14

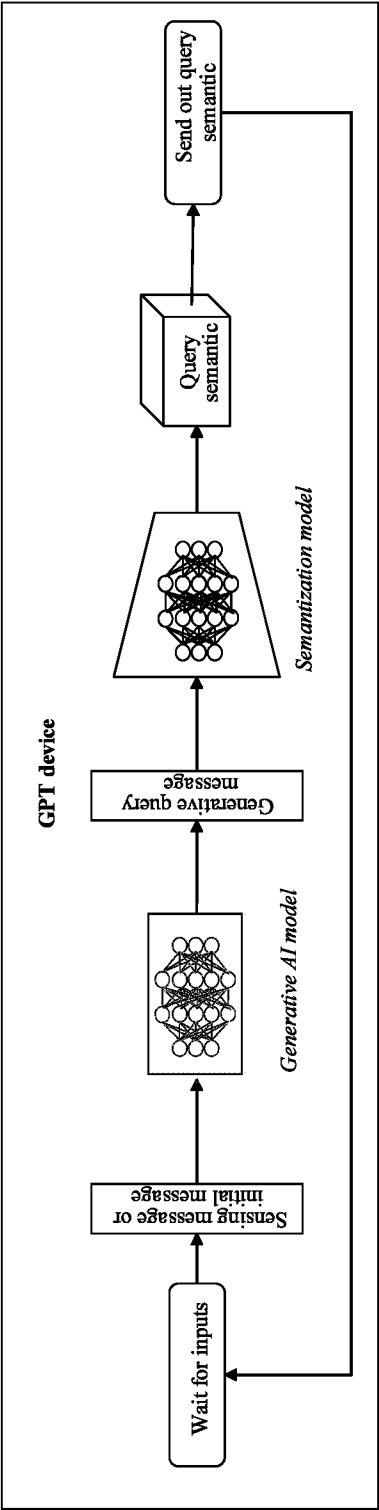


FIG. 15

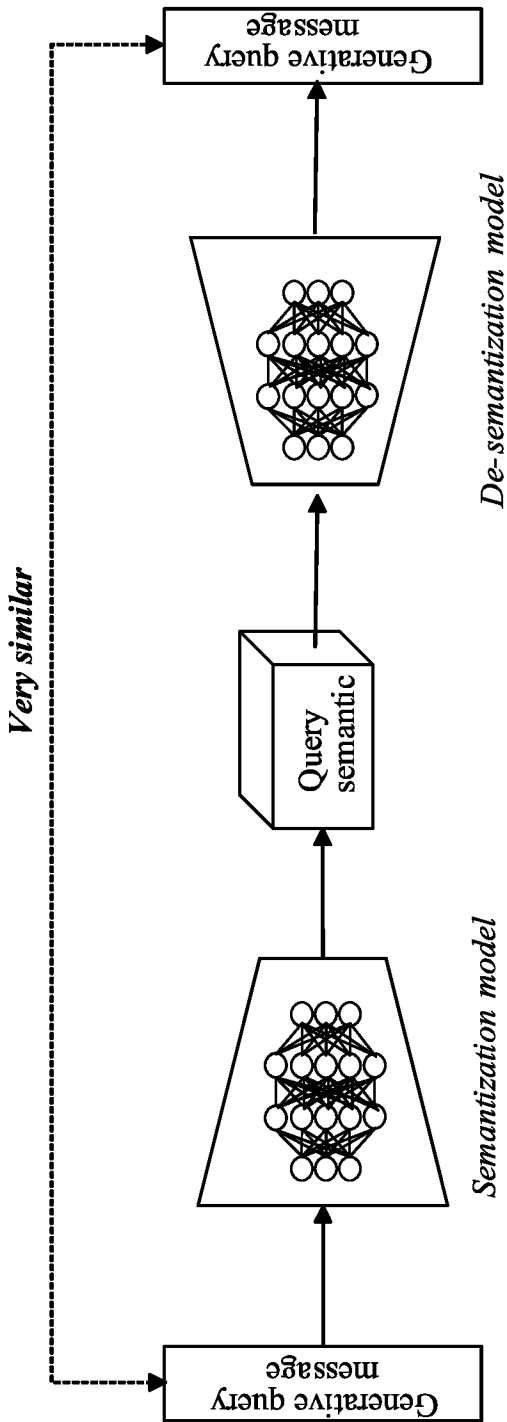


FIG. 16

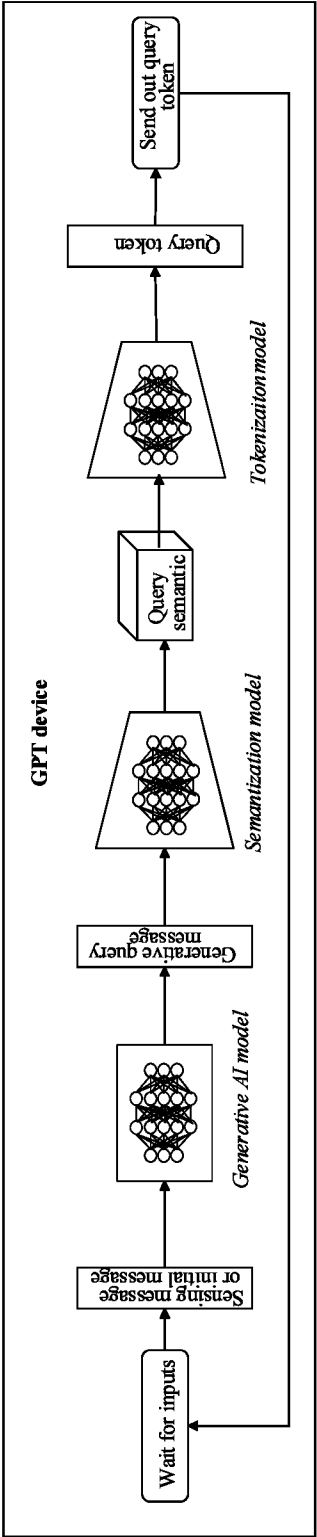


FIG. 17

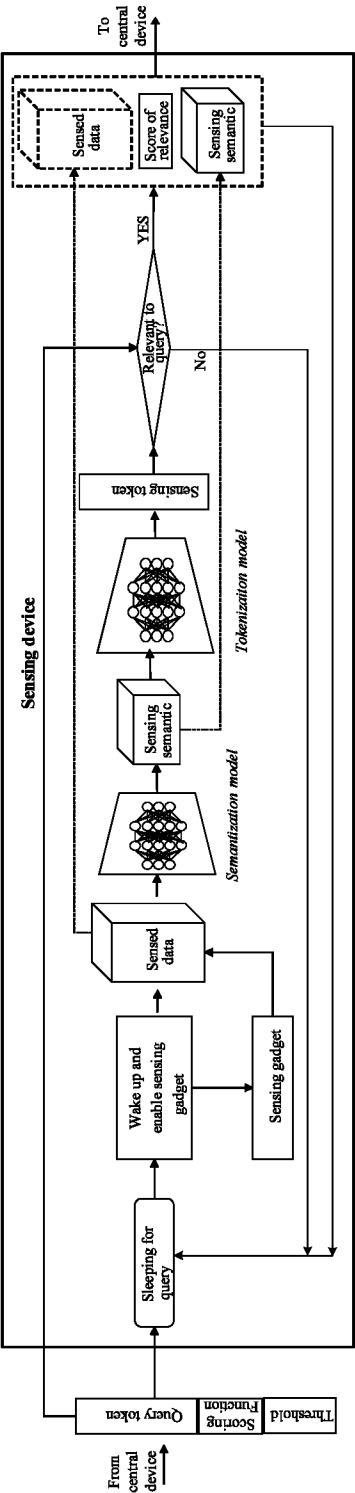


FIG. 18

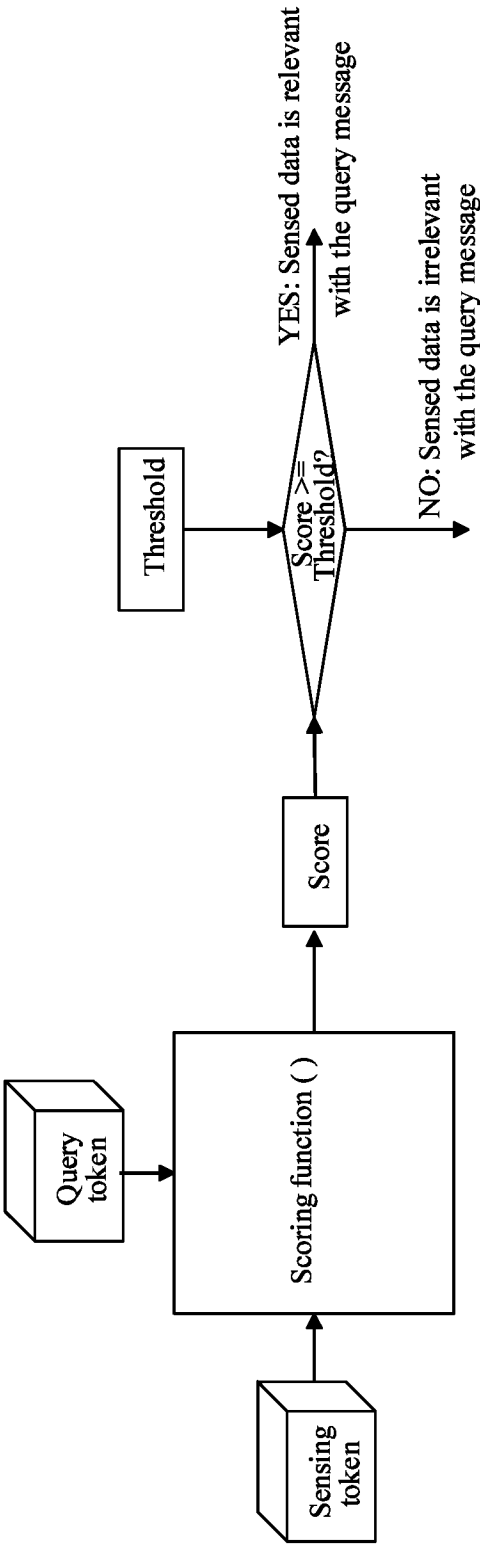


FIG. 19

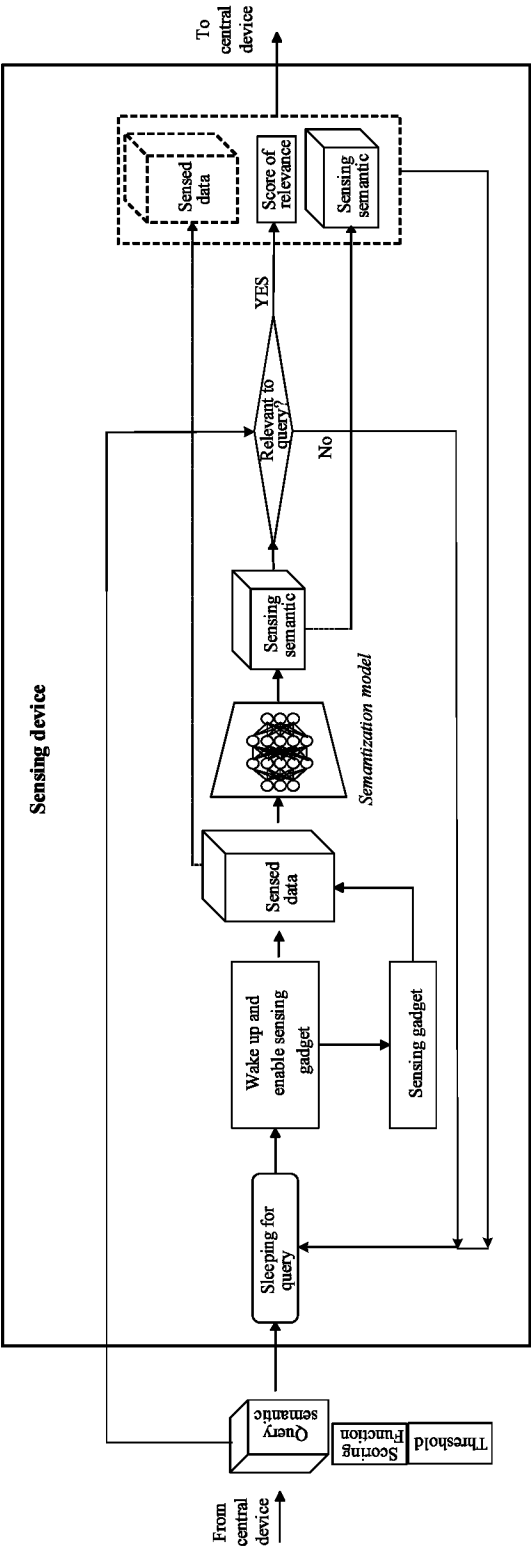


FIG. 20

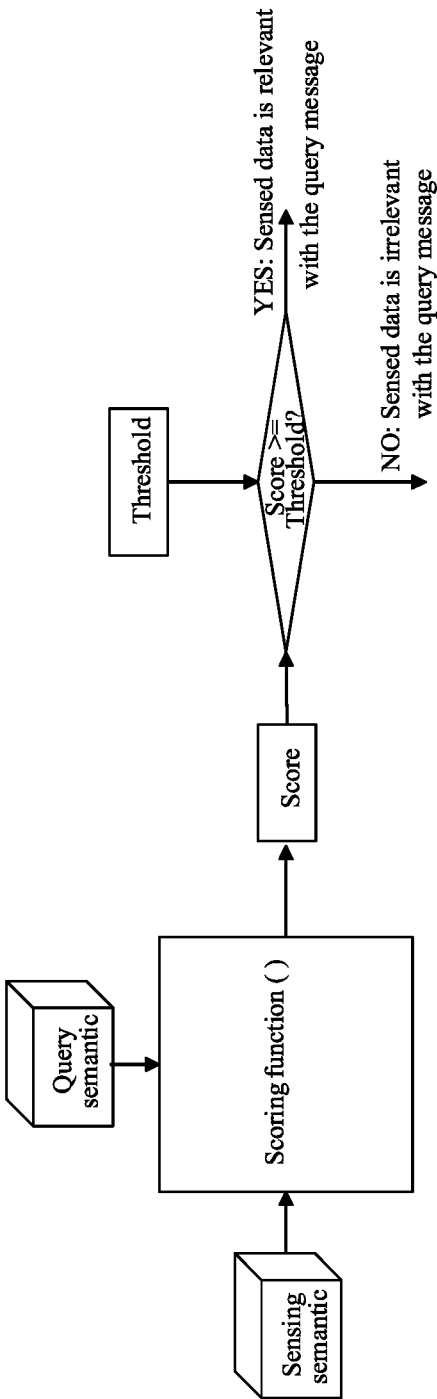


FIG. 21

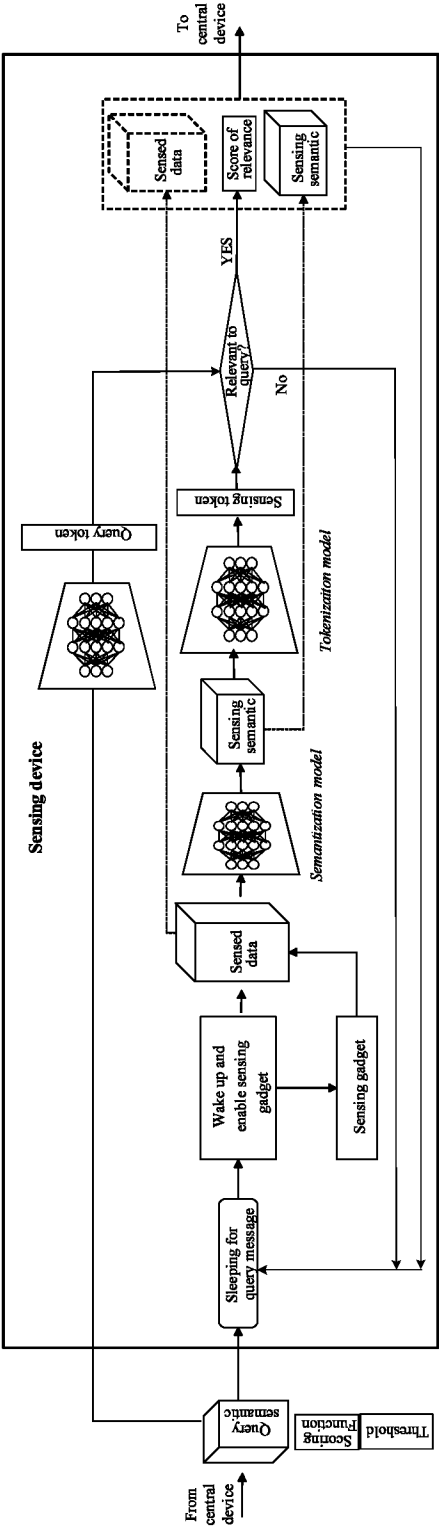


FIG. 22

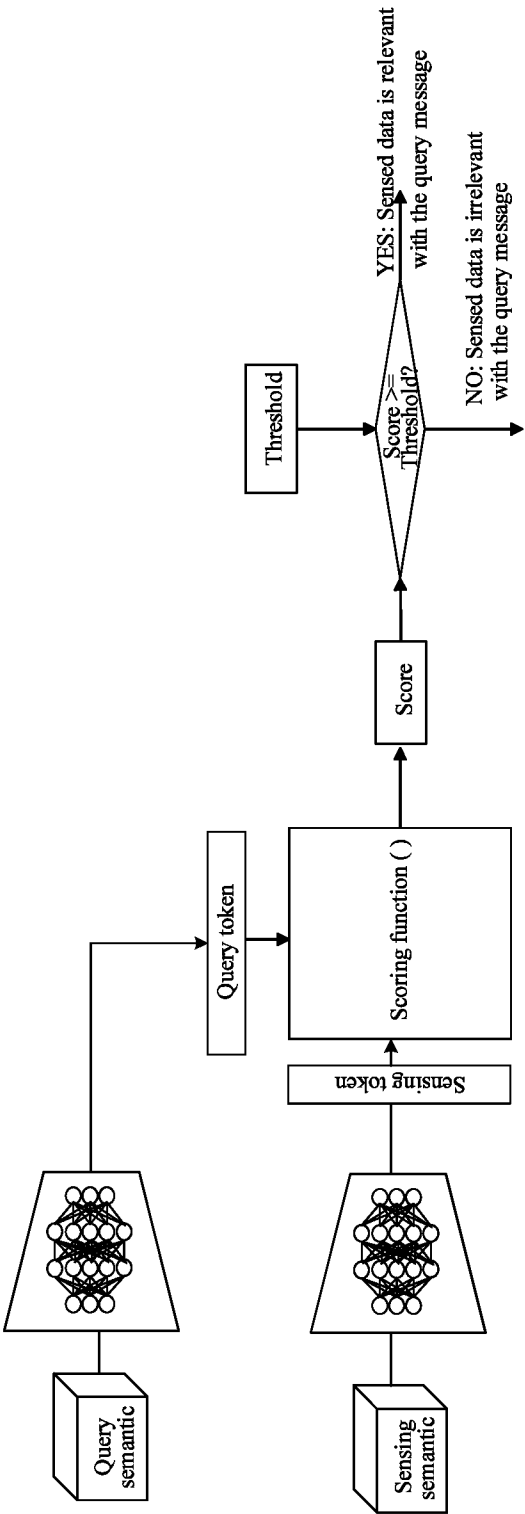


FIG. 23

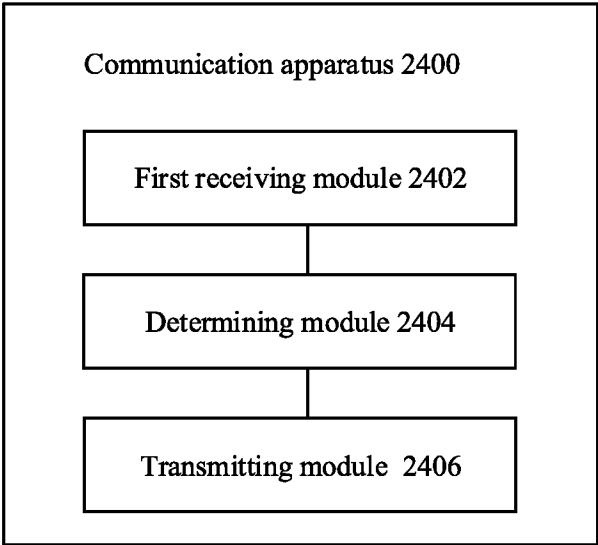


FIG. 24

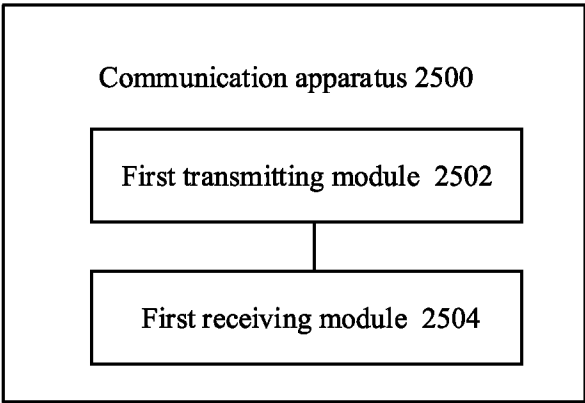


FIG. 25

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/128910

A. CLASSIFICATION OF SUBJECT MATTER

H04W 28/06(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W, H04L, G06F, G06N, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, CNABS, ENTXT, ENTXTC, DWPI, VEN, CNKI, IEEE: search, query, match+, score, threshold, sensor, PBCH, SSB, MIB, PDCCH, token, semantic, broadcast, multicast, relevancy, correlation, base station, BS, gNB, eNB, AP, IoT, 6G, UE, GPT, LLM?

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 112311097 A (STATE GRID INTELLIGENT TECHNOLOGY CO LTD) 02 February 2021 (2021-02-02) Paragraphs [0098]-[0286] in the description	1-10,20,22-32,37,42-49
Y	CN 104537041 A (BEIJING QIHOO SCI & TECHNOLOGY CO LTD, et al.) 22 April 2015 (2015-04-22) Paragraphs [0032]-[0074] in the description	1-10,20,22-32,37,42-49
A	CN 112311097 A (STATE GRID INTELLIGENT TECHNOLOGY CO LTD) 02 February 2021 (2021-02-02) See the whole document	11-19,21,33-36,38-41
A	CN 104537041 A (BEIJING QIHOO SCI & TECHNOLOGY CO LTD, et al.) 22 April 2015 (2015-04-22) See the whole document	11-19,21,33-36,38-41
A	CN 103874091 A (UNIV CHINA RENMIN) 18 June 2014 (2014-06-18) See the whole document	1-49

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

27 February 2024

Date of mailing of the international search report

18 March 2024

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/128910

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 101494919 A (SHENZHEN ADVANCED TECHNOLOGY RES INST) 29 July 2009 (2009-07-29) See the whole document	1-49
A	US 2021022024 A1 (INTEL CORP) 21 January 2021 (2021-01-21) See the whole document	1-49

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/128910

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	112311097	A	02 February 2021	CN	112311097	B	26 January 2024
CN	104537041	A	22 April 2015	CN	104537041	B	04 May 2018
CN	103874091	A	18 June 2014	CN	103874091	B	30 October 2018
CN	101494919	A	29 July 2009	CN	101494919	B	22 June 2011
US	2021022024	A1	21 January 2021	None			