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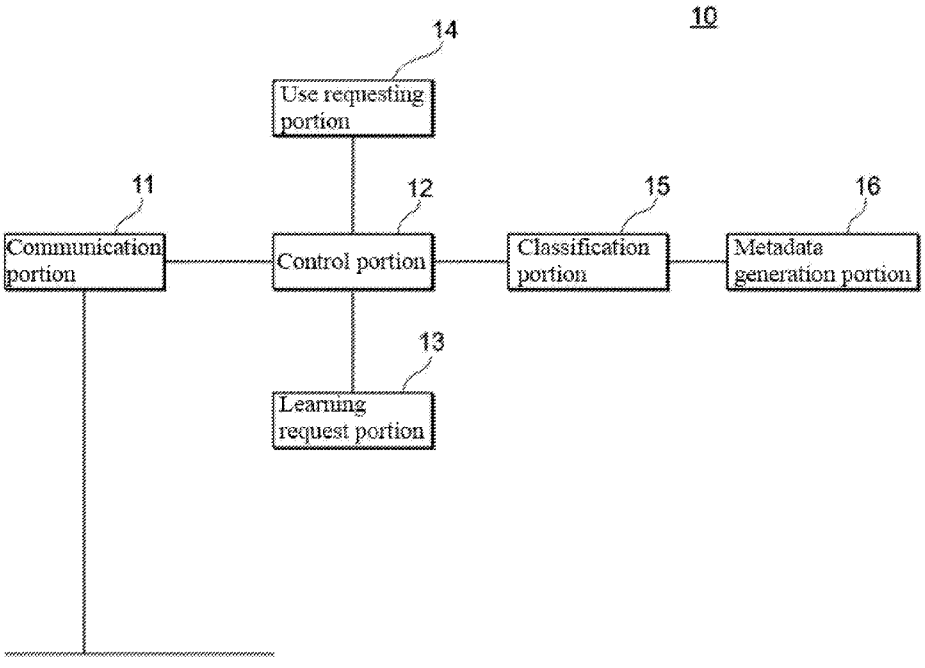
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(54) Title: METADATA GENERATION APPARATUS, METADATA GENERATION METHOD AND METADATA GENERATION PROGRAM

[Fig. 3]



(57) Abstract: A metadata generation apparatus, a metadata generation method and a metadata generation program that can generate metadata of a sensor while reducing the calculation load are provided. The metadata generation apparatus includes a use requesting portion that requests, using input data, a learning result using apparatus to cause output data to be output by a learning module trained so as to classify, into one or more clusters, training data including sensing data output from one or more sensors of a plurality of sensors, with sensing data output from another sensor out of the sensors being used as the input data, a classification portion that classifies the input data such that the input data belongs to one of the clusters, based on the output data, and a metadata generation portion that generates metadata of the other sensor that outputs the sensing data used as the input data, based on attribute information of training data representing the cluster to which the input data belongs.

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Description

Title of Invention: METADATA GENERATION APPARATUS, METADATA GENERATION METHOD AND METADATA GENERATION PROGRAM

Technical Field

[0001] The present invention relates to a metadata generation apparatus, a metadata generation method, and a metadata generation program.

Background Art

[0002] In recent years, a technique called IoT (Internet of Things) has been evolving. IoT is a technique for creating a new value by combining, on a communication network, information regarding various things that exist in the world. In order to create a value through IoT, it is necessary to read a state of a thing using a sensor, and circulate the sensing data.

[0003] Regarding a mechanism for distributing sensing data, Patent Literature 1 describes a data flow control instruction generation apparatus for performing matching of sensor-side metadata that is information regarding a sensor that outputs sensing data and application-side metadata that is information regarding an application that provides a service using the sensing data, and transmitting a data flow control instruction in which the matched sensor and application are specified.

Citation List

Patent Literature

[0004] PTL 1: Japanese Patent No. JP 5445722

Summary of Invention

Technical Problem

[0005] As described in Patent Literature 1, matching of sensors and applications can be performed smoothly by using metadata. Here, there are cases where metadata was individually generated by users.

[0006] However, sensing data is predicted to increase more and more from now on, and when users individually generate metadata, not only does the workload become huge, but also the metadata generation rules vary among users, and the metadata generation rules change even in the case of the same user, making it difficult to secure uniformity of the metadata, and it is envisioned that the calculation load and the communication load required for matching of sensors and applications will increase. In addition, even if metadata is generated by a computer, it is envisioned that the calculation load of the computer will increase according to the diversity of the sensing data.

[0007] In view of this, it is an object of the present invention to provide a metadata generation apparatus, a metadata generation method, and a metadata generation program that can generate metadata of a sensor while decreasing the calculation load.

Solution to Problem

[0008] A metadata generation apparatus according to one aspect of the present invention includes a use requesting portion that requests, using input data, a learning result using apparatus to cause output data to be output by a learning module trained so as to classify, into one or more clusters, training data including sensing data output from one or more sensors of a plurality of sensors, with sensing data output from another sensor out of the plurality of sensors being used as the input data, a classification portion that classifies the input data such that the input data belongs to at least one of the one or more clusters, based on the output data, and a metadata generation portion that generates metadata of the other sensor that outputs the sensing data that is used as the input data, based on attribute information of training data representing the cluster to which the input data belongs.

[0009] According to this aspect, by generating metadata of the sensors based on the attribute information of the training data representing the cluster to which the input data belongs out of the clusters of the training data, the calculation load required for generating metadata is suppressed to a low level even in a case where new sensing data is used as input data. In addition, uniformity of the metadata is secured, and thus the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0010] In the above aspect, at least one of the plurality of sensors may be constituted by a plurality of sub sensors.

[0011] According to this aspect, in a case where a plurality of sub sensors are grouped together and function as a single sensor, metadata can be uniformly generated for the single sensor. Therefore, it is not necessary to perform sensor-application matching for each of the plurality of sub sensors, and the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0012] In the above aspect, a learning request portion that requests a learning apparatus to train a learning module based on the training data so as to classify the training data into one or more clusters may be further included, and the metadata generation portion may select training data representing one of the one or more clusters, and may generate metadata of the one or more sensors that output the sensing data that is used as the training data based on attribute information of the selected training data.

[0013] According to this aspect, by classifying the training data into clusters, and generating metadata of the sensors based on the attribute information of the training data rep-

resenting the cluster, metadata can be uniformly generated for a large amount of sensing data. Due to uniformity of the metadata being secured, the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0014] In the above aspect, the learning request portion may request the learning apparatus to train the learning module by unsupervised learning based on the training data so as to classify the training data into one or more clusters.

[0015] According to this aspect, the training data can be autonomously classified using the learning module, and metadata can be generated based on more objective classification. In addition, it is not necessary to prepare supervisor data, and thus there is no processing load or communication load for generating or collecting supervisor data, and it is not necessary to secure a storage capacity for storing supervisor data.

[0016] In the above aspect, the learning request portion may request the learning apparatus to train the learning module by supervised learning in which supervisor data including the attribute information of the training data is used, based on the training data, so as to classify the training data into one or more clusters.

[0017] According to this aspect, the training data can be classified in consideration of existing attribute information, and metadata can be generated while making wide use of existing information. In addition, it is not necessary to assign meaning to the output data from the learning module, and thus calculation or communication does not need to be performed in order to interpret the output data, and the processing load and the communication load are suppressed.

[0018] In the above aspect, the plurality of sensors may be sensors installed at specific locations, and the attribute information of the training data may include information regarding the specific locations.

[0019] According to this aspect, metadata can be uniformly generated for the sensors installed at various locations from the viewpoint of attributes of installation locations, and the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0020] In the above aspect, the sensing data may be data regarding a volume of vehicle traffic at a specific location.

[0021] According to this aspect, metadata can be uniformly generated for the traffic volume sensors installed at various locations from the viewpoint of a feature of the volume of vehicle traffic, and the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0022] A metadata generation method according to one aspect of the present invention includes requesting, using input data, a learning result using apparatus to cause output data to be output by a learning module trained so as to classify, into one or more

clusters, training data including sensing data output from one or more sensors of a plurality of sensors, with sensing data output from one or more other sensors out of the plurality of sensors being used as the input data, classifying the input data such that the input data belongs to at least one of the one or more clusters, based on the output data, and generating metadata of the other sensor that outputs the sensing data that is used as the input data, based on attribute information of training data representing the cluster to which the input data belongs.

[0023] According to this aspect, by generating metadata of the sensor based on the attribute information of the training data representing the cluster to which the input data belongs out of the clusters of the training data, the calculation load required for generating the metadata is suppressed to a low level even in the case where new sensing data is used as input data. In addition, uniformity of the metadata is secured, and thus the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0024] A metadata generation program according to one aspect of the present invention causes a computer to function as a use requesting portion that requests, using input data, a learning result using apparatus to cause output data to be output by a learning module trained so as to classify, into one or more clusters, training data including sensing data output from one or more sensors of a plurality of sensors, with sensing data output from another sensor out of the plurality of sensors being used as the input data, a classification portion that classifies the input data such that the input data belongs to at least one of the one or more clusters, based on the output data, and a metadata generation portion that generates metadata of the other sensor that outputs the sensing data that is used as the input data, based on attribute information of training data representing the cluster to which the input data belongs.

[0025] According to this aspect, by generating metadata of the sensor based on the attribute information of the training data representing the cluster to which the input data belongs out of the clusters of the training data, the calculation load required for generating metadata is suppressed to a low level even in the case where new sensing data is used as input data. In addition, uniformity of the metadata is secured, and thus the calculation load and the communication load required for sensor- application matching are suppressed to a low level.

Advantageous Effects of Invention

[0026] According to the present invention, a metadata generation apparatus, a metadata generation method, and a metadata generation program that can generate metadata of a sensor while reducing the calculation load are provided.

Brief Description of Drawings

[0027] [fig.1]FIG. 1 is a diagram showing the network configuration of a metadata generation apparatus according to an embodiment of the present invention.
[fig.2]FIG. 2 is a diagram showing the physical configuration of the metadata generation apparatus according to the embodiment of the present invention.
[fig.3]FIG. 3 is a functional block diagram of the metadata generation apparatus according to the embodiment of the present invention.
[fig.4]FIG. 4 is a functional block diagram of a learning apparatus that receives a learning request from the metadata generation apparatus according to the embodiment of the present invention.
[fig.5]FIG. 5 is a functional block diagram of a learning result using apparatus that receives a use request from the metadata generation apparatus according to the embodiment of the present invention.
[fig.6]FIG. 6 is a flowchart of first processing executed by the metadata generation apparatus according to the embodiment of the present invention.
[fig.7]FIG. 7 is a flowchart of second processing executed by the metadata generation apparatus according to the embodiment of the present invention.

Description of Embodiments

[0028] Embodiments of the present invention will be described with reference to the attached drawings. Note that in the figures, the same or similar constituent elements are denoted by the same reference numerals.

[0029] Fig. 1 is a diagram showing the network configuration of a metadata generation apparatus 10 according to an embodiment of the present invention. The metadata generation apparatus 10 according to this embodiment is connected to a communication network N, and is connected to one or more sensors 20, a learning apparatus 30, a learning result using apparatus 40 and a sensing data storage DB via the communication network N. The communication network N may be either a wired communication network or a wireless communication network constituted by a wired or wireless line, or may be the Internet or a LAN (Local Area Network).

[0030] The sensor 20 may be either a physical amount sensor that detects a physical amount or an information sensor that detects information. Examples of the physical amount sensor include a camera that detects light and outputs image data or moving image data, a microphone that detects sound and outputs sound data, and a traffic sensor that detects passing of vehicles and outputs traffic volume data indicating the number of vehicles that passed the sensor along with the lapsed time, and includes sensors that detect any other physical amounts and output electric signals. Examples of the information sensor include a sensor that detects a specific pattern in statistical data, and include sensors that detect any other information.

[0031] The sensor 20 may be constituted by a plurality of sub sensors. For example, a traffic sensor that detects passing of vehicles and outputs traffic volume data indicating the number of vehicles that passed the sensor along with the lapsed time may be constituted by a sub sensor that detects passing of vehicles and a sub sensor that measures time. In the present specification, a group of sub sensors that is formed by gathering a plurality of sub sensors and exhibits a predetermined function is simply referred to as a sensor.

[0032] The learning apparatus 30 controls learning of a learning module based on a learning request from the metadata generation apparatus 10. Here, the learning module is a classification device that performs learning so as to classify input data that has been input into one or more clusters, and may be a neural network, for example. The metadata generation apparatus 10 according to this embodiment requests the learning apparatus 30 to train the learning module based on training data including sensing data that has been output from the sensor 20, so as to classify the training data into one or more clusters.

[0033] The learning result using apparatus 40 controls input/output of data to/from the trained learning module, based on a use request from the metadata generation apparatus 10. The metadata generation apparatus 10 according to this embodiment requests, using input data, the learning result using apparatus 40 to cause output data to be output by a learning module after performing learning so as to classify, into one or more clusters, training data including sensing data that has been output from one or more sensors of a plurality of sensors, with sensing data that has been output from another sensor out of the plurality of sensors being used as the input data.

[0034] The sensing data storage DB stores sensing data that has been output by the sensors 20. In Fig. 1, the sensing data storage DB is shown as a single storage, but the sensing data storage DB may be constituted by one or more file servers.

[0035] Fig. 2 is a diagram showing the physical configuration of the metadata generation apparatus 10 according to the embodiment of the present invention. The metadata generation apparatus 10 has a CPU (Central Processing Unit) 10a equivalent to a hardware processor, a RAM (Random Access Memory) 10b equivalent to a memory, a ROM (Read only Memory) 10c equivalent to a memory, a communication interface 10d, an input portion 10e, and a display portion 10f. These constituent elements are connected so as to enable mutual data transmission/reception via a bus.

[0036] The CPU 10a performs execution of a program stored in the RAM 10b or the ROM 10c and calculation and processing of data. The CPU 10a is a calculation apparatus that executes an application for generating metadata. The CPU 10a receives various types of input data from the input portion 10e or the communication interface 10d, and displays calculation results of the input data on the display portion 10f, and stores the

calculation results in the RAM 10b or the ROM 10c.

[0037] The RAM 10b is a data-rewritable storage, and is constituted by a semiconductor storage element, for example. The RAM 10b stores programs such as applications executed by the CPU 10a and data.

[0038] The ROM 10c is a data-read-only storage, and is constituted by a semiconductor storage element, for example. The ROM 10c stores programs such as firmware and data, for example.

[0039] The communication interface 10d is a hardware interface that connects the learning apparatus 10 to the communication network N.

[0040] The input portion 10e accepts input of data from the user, and is constituted by a keyboard, a mouse, or a touch panel, for example.

[0041] The display portion 10f visually displays a result of calculation performed by the CPU 10a, and is constituted by an LCD (Liquid Crystal Display), for example.

[0042] The metadata generation apparatus 10 may be configured by a metadata generation program according to this embodiment being executed by the CPU 10a of a general personal computer. The metadata generation program may be stored in a computer-readable storage medium such as the RAM 10b or the ROM 10c and be provided, or may be provided via the communication network N connected by the communication interface 10d.

[0043] Note that these physical configurations are examples, and do not necessarily need to be independent configurations. For example, the metadata generation apparatus 10 may have an LSI (Large-Scale Integration) acquired by integrating the CPU 10a and the RAM 10b or the ROM 10c.

[0044] Fig. 3 is a functional block diagram of the metadata generation apparatus 10 according to the embodiment of the present invention. The metadata generation apparatus 10 includes a communication portion 11, a control portion 12, a learning request portion 13, a use requesting portion 14, a classification portion 15, and a metadata generation portion 16. Note that functional blocks shown in the figure indicate functions that are exhibited using the physical configurations of the metadata generation apparatus 10, and are not necessarily in one-to-one correspondence with the physical configurations.

[0045] The communication portion 11 is connected to the external communication network N, and performs data transmission/reception. The control portion 12 controls processing executed by the metadata generation apparatus 10.

[0046] The learning request portion 13 requests the learning apparatus 30 to train a learning module to based on training data including sensing data that has been output from one or more sensors of a plurality of sensors so as to classify the training data into one or more clusters. The learning request portion 13 may request the learning apparatus 30 to

train the learning module by unsupervised learning based on training data so as to classify the training data into one or more clusters, or may request the learning apparatus 30 to train the learning module by supervised learning that uses supervisor data including attribute information of the training data, based on the training data, so as to classify the training data into one or more clusters. The request to the learning apparatus 30 may include designation of training data, designation of a learning module, designation of supervised learning or unsupervised learning, designation of supervisor data if supervised learning is designated, and designation of a time limit for learning performed by the learning module.

[0047] The use requesting portion 14 requests the learning result using apparatus 40 to cause output data to be output by a learning module trained by the learning apparatus 30, using, as input data, sensing data that has been output from another sensor out of the plurality of sensors. The request to the learning result using apparatus 40 may include designation of input data and designation of a trained learning module.

[0048] The classification portion 15 classifies the input data such that the input data belongs to at least one of the one or more clusters of the training data, based on the output data from the learning module acquired by the learning result using apparatus 40. When the training data is classified into N clusters as a result of the learning apparatus 30 training the learning module so as to classify the training data into clusters, the learning result using apparatus 40 uses the learning module trained by the learning apparatus 30 to cause output data for input data including new sensing data to be output by the learning module. The output data may include a degree of belonging of the input data to the N clusters of the training data, and the degree of belonging may be expressed by a numeric value of 0 to 1, for example. Here, degrees of belonging may be independently assigned to the N clusters, and there may be restriction such that the total of the degrees of belonging becomes 1. The classification portion 15 may classify the input data such that input data belongs to at least one of the N clusters, based on the degree of belonging included in the output data. Here, the classification portion 15 may perform classification such that the input data belongs to a cluster whose degree of belonging is larger than or equal to a threshold value, or such that the input data belongs to a cluster whose degree of belonging is largest. The classification portion 15 may perform classification such that the input data belongs to one cluster, or such that the input data belongs to a plurality of clusters. If classification is performed such that the input data belongs to a plurality of clusters, classification may be performed such that the input data belongs to a plurality of clusters at a ratio corresponding to the degrees of belonging.

[0049] The metadata generation portion 16 selects training data that represents one of the one or more clusters of training data, and generates metadata for a sensor that has

output sensing data that is used as training data, based on the attribute information of the selected training data. Here, attribute information of the training data is information indicating the feature of the training data, and may include the type of a physical amount measured by the sensor, the type of the sensor and the type of data. For example, in the case where training data is classified into the N clusters, the metadata generation portion 16 may select training data whose degree of belonging to the cluster is largest out of training data that belong to a specific cluster, as training data representing the cluster.

[0050] In addition, after input data is classified by the classification portion 15 so as to belong to one of one or more clusters of training data, the metadata generation portion 16 generates metadata of a sensor that has output sensing data that is used as input data, based on attribute information of training data representing the cluster to which the input data belongs. For example, if input data is classified so as to belong to one cluster, the metadata generation portion 16 may generate metadata of the sensor based on attribute information of training data representing the one cluster, and if input data is classified so as to belong to a plurality of clusters, the metadata generation portion 16 may generate metadata of a sensor, based on attribute information of training data representing each of the plurality of clusters. In the case of generating metadata of a sensor based on attribute information of training data representing each of a plurality of clusters, the metadata may include data regarding the degree of belonging to a plurality of clusters.

[0051] A plurality of sensors that output sensing data may be sensors installed at specific locations, and attribute information of training data may include information regarding the specific location. For example, a plurality of sensors may be rainfall amount sensors or temperature sensors that are installed at specific locations in a plurality of municipalities, and training data may be data regarding the weather in the municipalities, and attribute information of the training data may include information regarding the specific locations in the municipalities at which the sensors are installed. In such a case, the metadata generation portion 16 generates metadata of a sensor that output sensing data that is used as input data, based on information regarding the specific location representing the cluster to which the input data belongs. Accordingly, metadata can be uniformly generated for sensors installed at various locations, from the viewpoint of the attribute of the installation location, and the calculation load and the communication load required for sensor-application matching are suppressed to a low level. Note that a specific location at which a sensor is located may be in a public place, or may be in a private place. Examples of a sensor that is installed in a public place include a sensor that is installed on a public road, and the user and application are not limited. Examples of a sensor that is installed in a private place include a sensor

installed on a production line in a factory, and is used for a specific application by a specific user.

[0052] For example, a configuration can be adopted in which traffic sensors that detect passing of vehicles, and output traffic volume data indicating the number of vehicles that passed the sensor along with the lapsed time are installed at a plurality of intersections, the traffic volume data can be collected as sensing data, and used as training data. In this case, the plurality of sensors are traffic sensors that are installed at the plurality of intersections, and the sensing data is data regarding the volume of vehicle traffic at the plurality of intersections. The learning request portion 13 requests the learning apparatus 30 to train a learning module so as to classify the training data into one or more clusters, using, as training data, the traffic volume data that has been output from one or more sensors of a plurality of traffic sensors. As a result of training performed by the learning apparatus 30, assume that the traffic volume data is classified into three categories, namely, a cluster in which the traffic volume is relatively large, a cluster in which the traffic volume is moderate, and a cluster in which the traffic volume is relatively small. In this case, the metadata generation portion 16 selects traffic volume data representing each of the cluster in which the traffic volume is relatively large, the cluster in which the traffic volume is moderate and the cluster in which the traffic volume is relatively small. For example, the metadata generation portion 16 selects traffic volume data measured at a first intersection, as traffic volume data representing the cluster in which the traffic volume is relatively large, traffic volume data measured at a second intersection, as traffic volume data representing the cluster in which the traffic volume is moderate, and traffic volume data measured at a third intersection, as traffic volume data representing the cluster in which the traffic volume is relatively small. The metadata generation portion 16 then generates metadata that is based on attribute information of the traffic volume data measured at the first intersection, for a sensor that has output traffic volume data belonging to the cluster in which the traffic volume is relatively large. Here, attribute information of traffic volume data is attribute information of training data, and includes information regarding the first intersection. In addition, the metadata generation portion 16 generates metadata that is based on the attribute information of the traffic volume data measured at the second intersection, for a sensor that has output traffic volume data belonging to the cluster in which the traffic volume is moderate, and generates metadata that is based on attribute information of the traffic volume data measured at the third intersection, for a sensor that has output traffic volume data belonging to the cluster in which the traffic volume is relatively small.

[0053] Furthermore, the metadata generation portion 16 generates metadata for another traffic sensor out of the plurality of traffic sensors, or specifically, a traffic sensor

whose sensing data was not used as training data. For example, if traffic volume data is measured using a traffic volume sensor that is installed at a fourth intersection and has not been used for collecting training data out of the plurality of traffic sensors, the use requesting portion 14 requests the learning result using apparatus 40 to cause output data to be output by a learning module trained by the learning apparatus 30, using the traffic volume data for the fourth intersection as input data. The output data may be data regarding degrees of belonging indicating degrees to which the traffic volume data of the fourth intersection belongs to the cluster in which the traffic volume is relatively large, the cluster in which the traffic volume is moderate and the cluster in which the traffic volume is relatively small. The classification portion 15 classifies, based on output data, the traffic volume data of the fourth intersection so as to belong to at least one of the cluster in which the traffic volume is relatively large, the cluster in which the traffic volume is moderate and the cluster in which the traffic volume is relatively small. Assume that the classification portion 15 classified the traffic volume data of the fourth intersection into the cluster in which the traffic volume is relatively large. In that case, the metadata generation portion 16 generates metadata of a traffic volume sensor installed at the fourth intersection, based on the attribute information of the traffic volume data measured at the first intersection representing the cluster in which the traffic volume is relatively large.

[0054] In this manner, metadata can be uniformly generated for traffic volume sensors installed at various locations, from the viewpoint of the feature of volume of vehicle traffic, and the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0055] In addition, in the case where a plurality of sub sensors are grouped together and function as a single sensor as in the case where a traffic sensor is constituted by a sub sensor that detects passing of vehicles and a sub sensor that measures time, the metadata generation portion 16 may generate metadata for the single sensor. Accordingly, metadata is uniformly generated for the single sensor, and it is not necessary to perform application matching on each of the plurality of sub sensors, and thus the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0056] Fig. 4 is a functional block diagram of the learning apparatus 30 that receives a learning request from the metadata generation apparatus 10 according to the embodiment of the present invention. The learning apparatus 30 has a function for causing learning based on learning request information, and acquiring a new capability as a learning result. The learning apparatus 30 includes a learning control portion 131, a neural network 132, a learning result extraction portion 133, a communication portion 134, and a learning result output portion 135. Here, the neural network 132 is an

example of a learning module, and the learning apparatus 30 may have a learning module other than a neural network.

[0057] The learning control portion 131 controls the neural network 132 so as to perform learning based on a learning request received from the metadata generation apparatus 10. The learning control portion 131 trains the neural network 132 by supervised learning or unsupervised learning according to the learning request. A learning result for the neural network 132 is extracted by the learning result extraction portion 133, and is output by the learning result output portion 135 via the communication portion 134.

[0058] Fig. 5 is a functional block diagram of the learning result using apparatus 40 that receives a use request from the metadata generation apparatus 10 according to the embodiment of the present invention. The learning result using apparatus 40 has a function for providing a new capability to the user using a learning result. The learning result using apparatus 40 includes a learning result input portion 231, a neural network setting portion 232, a neural network 233, a control portion 234, an input portion 235, a communication portion 236, a data acquiring portion 237, and an output portion 238. Here, the neural network 233 is an example of a learning module, and the learning result using apparatus 40 may include a learning module other than a neural network, and in that case, the neural network setting portion 232 will be replaced by a portion that sets a learning module other than a neural network.

[0059] The learning result input portion 231 receives input of a learning result. The learning result input portion 231 receives, via the communication portion 236, a learning result that is output by the learning result output portion 135 of the learning apparatus 30. The neural network setting portion 232 performs setting corresponding to a use request from the metadata generation apparatus 10, on the neural network 233. The control portion 234 controls the data acquiring portion 237 and the input portion 235 so as to input data designated in the use request to the neural network 233, and causes output data to be output. The output data from the neural network 233 is output by the output portion 238 to the metadata generation apparatus 10 via the communication portion 236.

[0060] Fig. 6 is a flowchart of first processing executed by the metadata generation apparatus 10 according to the embodiment of the present invention. The first processing is processing for generating metadata for one or more sensors that output sensing data included in training data. Initially, the metadata generation apparatus 10 designates training data based on an instruction received from the user (step S10).

[0061] The metadata generation apparatus 10 determines whether or not supervised learning is to be requested to the learning apparatus 30 (step S11). Whether or not supervised learning is to be requested to the learning apparatus 30 may be determined based on an

instruction received from the user. If it is determined that supervised learning is to be requested to the learning apparatus 30 (step S11: Yes), the metadata generation apparatus 10 designates supervisor data based on the instruction received from the user (step S12). The learning request portion 13 of the metadata generation apparatus 10 requests the learning apparatus 30 to train a learning module by supervised learning based on the designated training data and supervisor data (step S13).

[0062] On the other hand, if it is determined that supervised learning is not to be requested to the learning apparatus 30 (step S11: No), the learning request portion 13 of the metadata generation apparatus 10 requests the learning apparatus 30 to train a learning module by unsupervised learning based on the designated training data (step S14).

[0063] In either case, the metadata generation apparatus 10 receives classification of training data into one or more clusters, from the learning apparatus 30 (step S15). The metadata generation portion 16 of the metadata generation apparatus 10 then selects training data representing the clusters (step S16), and generates metadata for the sensor that has output sensing data included in the training data, based on the attribute information of the selected training data (step S17).

[0064] With the metadata generation apparatus 10 according to this embodiment, by classifying the training data into clusters, and generating metadata of the sensor based on the attribute information of the training data representing the clusters, metadata can be uniformly generated for a large amount of sensing data.

Due to uniformity of the metadata being secured, the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0065] In addition, by the learning request portion 13 requesting the learning apparatus 30 for unsupervised learning, it is possible to autonomously classify training data using a learning module, and to generate metadata based on more objective classification. In addition, it is not necessary to prepare supervisor data, and thus there is no processing load or communication load for generating or collecting supervisor data, and it is not necessary to secure a storage capacity for storing supervisor data.

[0066] On the other hand, by the learning request portion 13 requesting the learning apparatus 30 for supervised learning, training data can be classified in consideration of existing attribute information, and metadata can be generated while making wide use of existing information. In addition, it is not necessary to assign meaning to output data from the learning module, and thus calculation and communication do not have to be performed in order to interpret the output data, and the processing load and the communication load are suppressed.

[0067] Fig. 7 is a flowchart of second processing executed by the metadata generation apparatus 10 according to the embodiment of the present invention. The second

processing is processing for generating metadata for a sensor that outputs sensing data that is not included in training data. Initially, the metadata generation apparatus 10 designates, as input data, sensing data that is not included in training data, based on an instruction received from the user (step S20).

[0068] Furthermore, the metadata generation apparatus 10 designates a learning result of the learning apparatus 30 based on the instruction received from the user (step S21). The use requesting portion 14 of the metadata generation apparatus 10 then inputs the designated input data to a trained learning module in which the designated learning result is set, and requests the learning result using apparatus 40 to cause output data to be output (step S22).

[0069] After that, the metadata generation apparatus 10 receives output data from the learning module, caused by the learning result using apparatus 40 (step S23). The classification portion 15 of the metadata generation apparatus 10 classifies the input data such that the input data belongs to one of the one or more clusters of the training data, based on the output data. The metadata generation portion 16 of the metadata generation apparatus 10 then specifies training data representing the cluster to which the input data belongs (step S25), and generates metadata of the sensor that has output the input data based on the attribute information of the specified training data (step S26).

[0070] With the metadata generation apparatus 10 according to this embodiment, by generating metadata of a sensor based on the attribute information of the training data representing the cluster to which the input data belongs out of the clusters of the training data, the calculation load required for generating metadata is suppressed to a low level even in the case where new sensing data is used as input data. In addition, uniformity of the metadata is secured, and thus the calculation load and the communication load required for sensor-application matching are suppressed to a low level.

[0071] The foregoing embodiment is for the purpose of facilitating understanding of the present invention, and is not to be interpreted as limiting the present invention. Each constituent element of the embodiment and the arrangement, material, condition, shape, size and the like thereof are not limited to those illustrated, and can be changed as appropriate. In addition, configurations indicated by different embodiments can be partially replaced or combined.

[0072] In addition, a portion or the entirety of the foregoing embodiment can be described as Additional Remarks below, but is not limited there to.

[0073] Additional Remark 1

A metadata generation apparatus including at least one memory and at least one item of hardware processor connected to the memory, wherein the hardware processor:

requests, using input data, a learning result using apparatus to cause output data to be

output from a learning module after performing learning so as to classify, into one or more clusters, training data including sensing data that has been output from one or more sensors of a plurality of sensors, with sensing data that has been output from another sensor out of the plurality of sensors being used as the input data,
classifies the input data such that the input data belongs to at least one of the one or more clusters, based on the output data, and
generates metadata of a sensor that outputs the sensing data that is used as the input data, based on attribute information of training data representing a cluster to which the input data belongs.

[0074] Additional Remark 2

A metadata generation method including:

requesting, using input data, a learning result using apparatus to cause output data to be output from a learning module after performing learning so as to classify, into one or more clusters, training data including sensing data that has been output from one or more sensors of a plurality of sensors, with sensing data that has been output from another sensor out of the plurality of sensors being used as the input data,

classifying the input data such that the input data belongs to at least one of the one or more clusters, based on the output data, and

generating metadata of a sensor that outputs the sensing data that is used as the input data, based on attribute information of training data representing a cluster to which the input data belongs.

Reference Signs List

[0075] 10 metadata generation apparatus
10a CPU
10b RAM
10c ROM
10d Communication interface
10e Input portion
10f Display portion
11 Communication portion
12 Control portion
13 Learning request portion
14 Use requesting portion
15 Classification portion
16 Metadata generation portion
20 Sensor
30 Learning apparatus

40 Learning result using apparatus
131 Learning control portion
132 Neural network
133 Learning result extraction portion
134 Communication portion
135 Learning result output portion
231 Learning result input portion
232 Neural network setting portion
233 Neural network
234 Control portion
235 Input portion
236 Communication portion
237 Data acquiring portion
238 Output portion

Claims

[Claim 1] A metadata generation apparatus comprising:
a use requesting portion that requests, using input data, a learning result using apparatus to cause output data to be output by a learning module trained so as to classify, into one or more clusters, training data including sensing data output from one or more sensors of a plurality of sensors, with sensing data output from another sensor out of the plurality of sensors being used as the input data;
a classification portion that classifies the input data such that the input data belongs to at least one of the one or more clusters, based on the output data; and
a metadata generation portion that generates metadata of the other sensor that outputs the sensing data that is used as the input data, based on attribute information of training data representing the cluster to which the input data belongs.

[Claim 2] The metadata generation apparatus according to claim 1,
wherein at least one of the plurality of sensors is constituted by a plurality of sub sensors.

[Claim 3] The metadata generation apparatus according to claim 1 or 2, further comprising:
a learning request portion that requests a learning apparatus to train a learning module based on the training data so as to classify the training data into one or more clusters,
wherein the metadata generation portion selects training data representing one of the one or more clusters, and generates metadata of the one or more sensors that output the sensing data that is used as the training data based on attribute information of the selected training data.

[Claim 4] The metadata generation apparatus according to claim 3,
wherein the learning request portion requests the learning apparatus to train the learning module by unsupervised learning based on the training data so as to classify the training data into one or more clusters.

[Claim 5] The metadata generation apparatus according to claim 3,
wherein the learning request portion requests the learning apparatus to train the learning module by supervised learning in which supervisor data including the attribute information of the training data is used, based on the training data, so as to classify the training data into one or

more clusters.

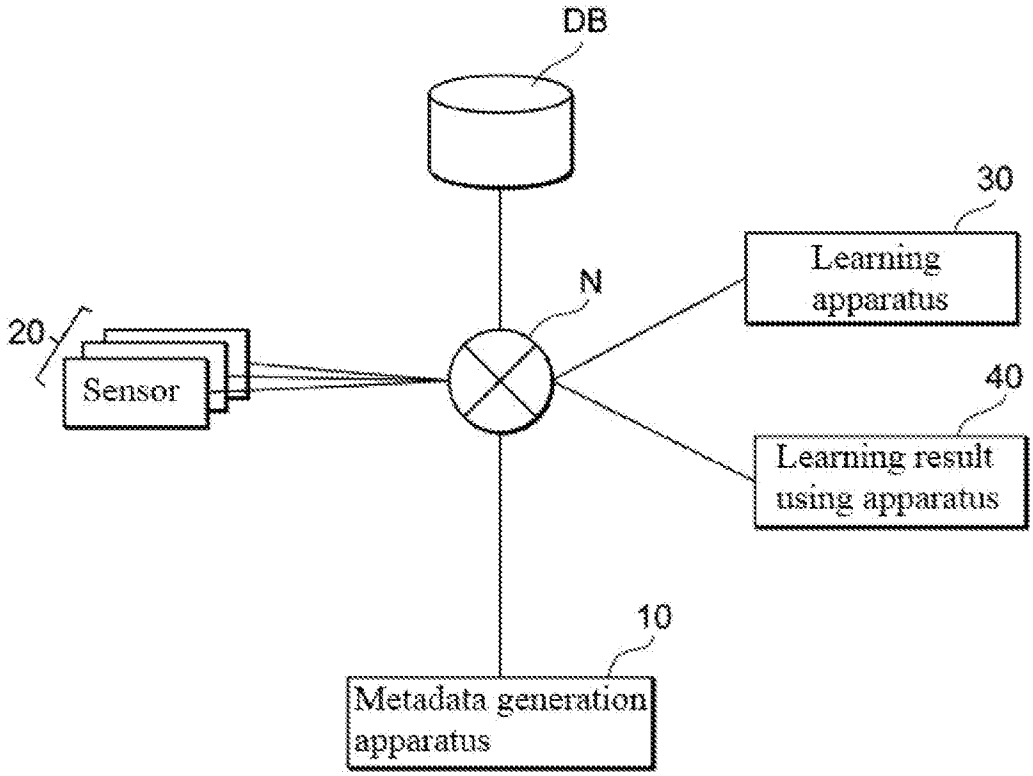
[Claim 6] The metadata generation apparatus according to any one of claims 1 to 5,
wherein the plurality of sensors are sensors installed at specific locations, and
the attribute information of the training data includes information regarding the specific locations.

[Claim 7] The metadata generation apparatus according to claim 6,
wherein the sensing data is data regarding a volume of vehicle traffic at a specific location.

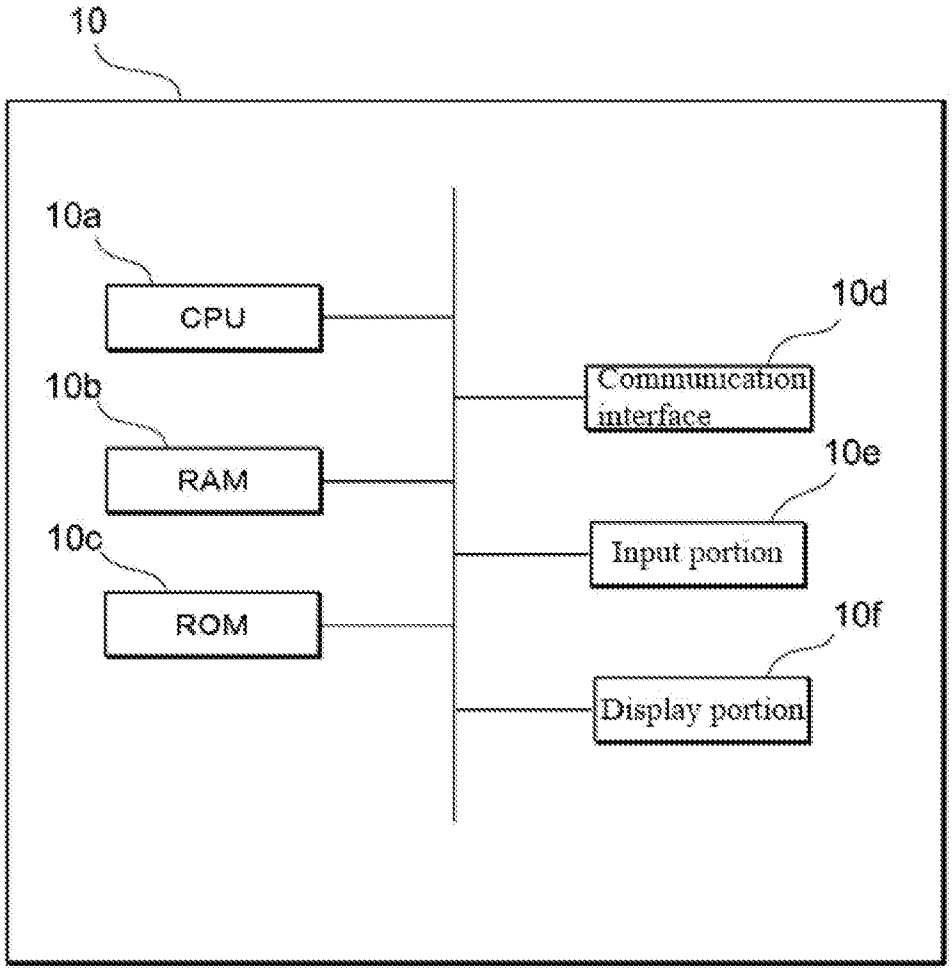
[Claim 8] A metadata generation method comprising:
requesting, using input data, a learning result using apparatus to cause output data to be output by a learning module trained so as to classify, into one or more clusters, training data including sensing data output from one or more sensors of a plurality of sensors, with sensing data output from another sensor out of the plurality of sensors being used as the input data;
classifying the input data such that the input data belongs to at least one of the one or more clusters, based on the output data; and
generating metadata of the other sensor that outputs the sensing data that is used as the input data, based on attribute information of training data representing the cluster to which the input data belongs.

[Claim 9] A metadata generation program that causes a computer to function as:
a use requesting portion that requests, using input data, a learning result using apparatus to cause output data to be output by a learning module trained so as to classify, into one or more clusters, training data including sensing data output from one or more sensors of a plurality of sensors, with sensing data output from another sensor out of the plurality of sensors being used as the input data;
a classification portion that classifies the input data such that the input data belongs to at least one of the one or more clusters, based on the output data; and
a metadata generation portion that generates metadata of the other sensor that outputs the sensing data that is used as the input data, based on attribute information of training data representing the cluster to which the input data belongs.

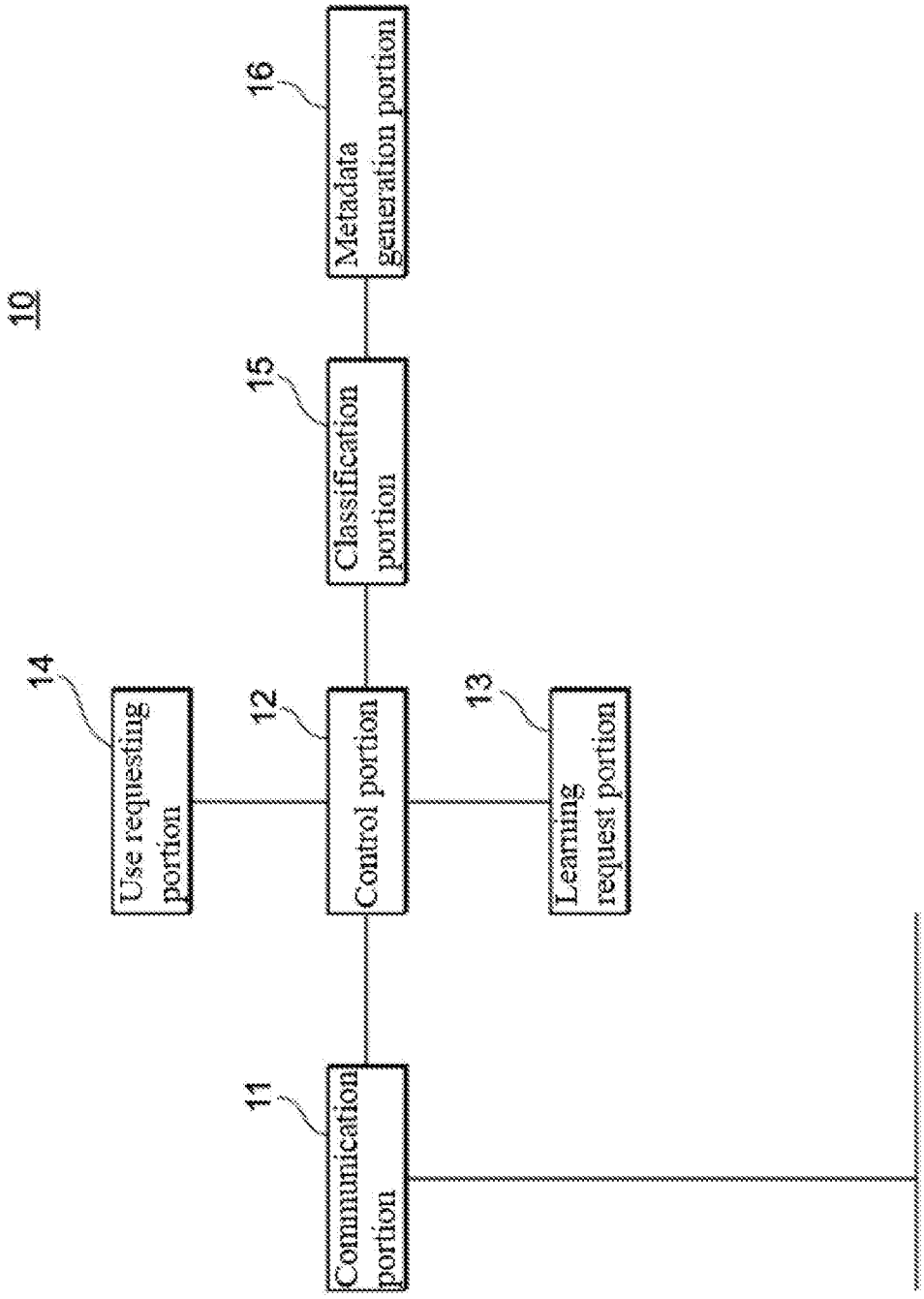
[Fig. 1]


DB
30
Learning apparatus
N
20
Sensor
40
Learning result using apparatus
10
Metadata generation apparatus

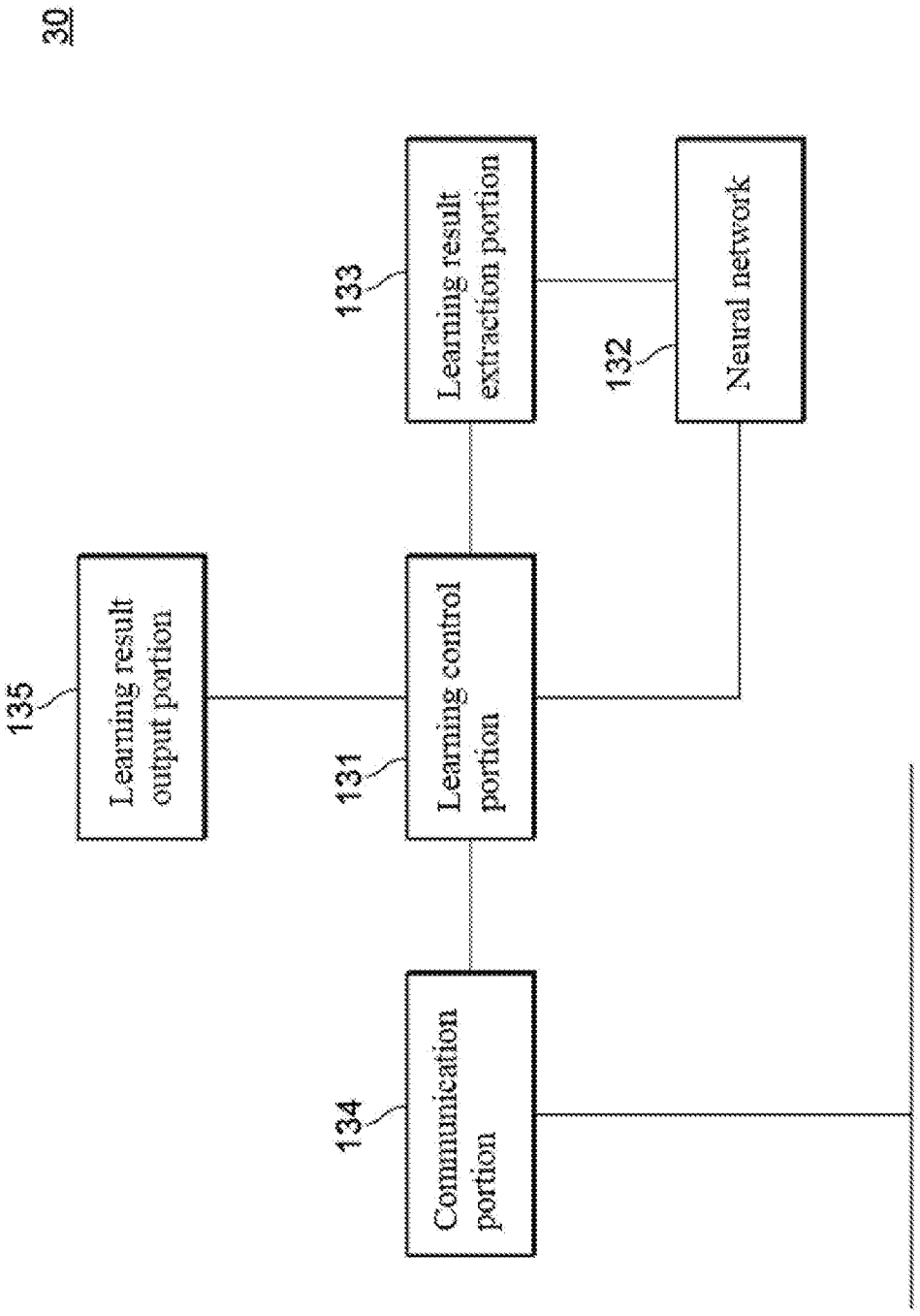
[Fig. 2]


10
10a
CPU
10d
Communication interface
10b
RAM
10e
Input portion
10c
ROM
10f
Display portion

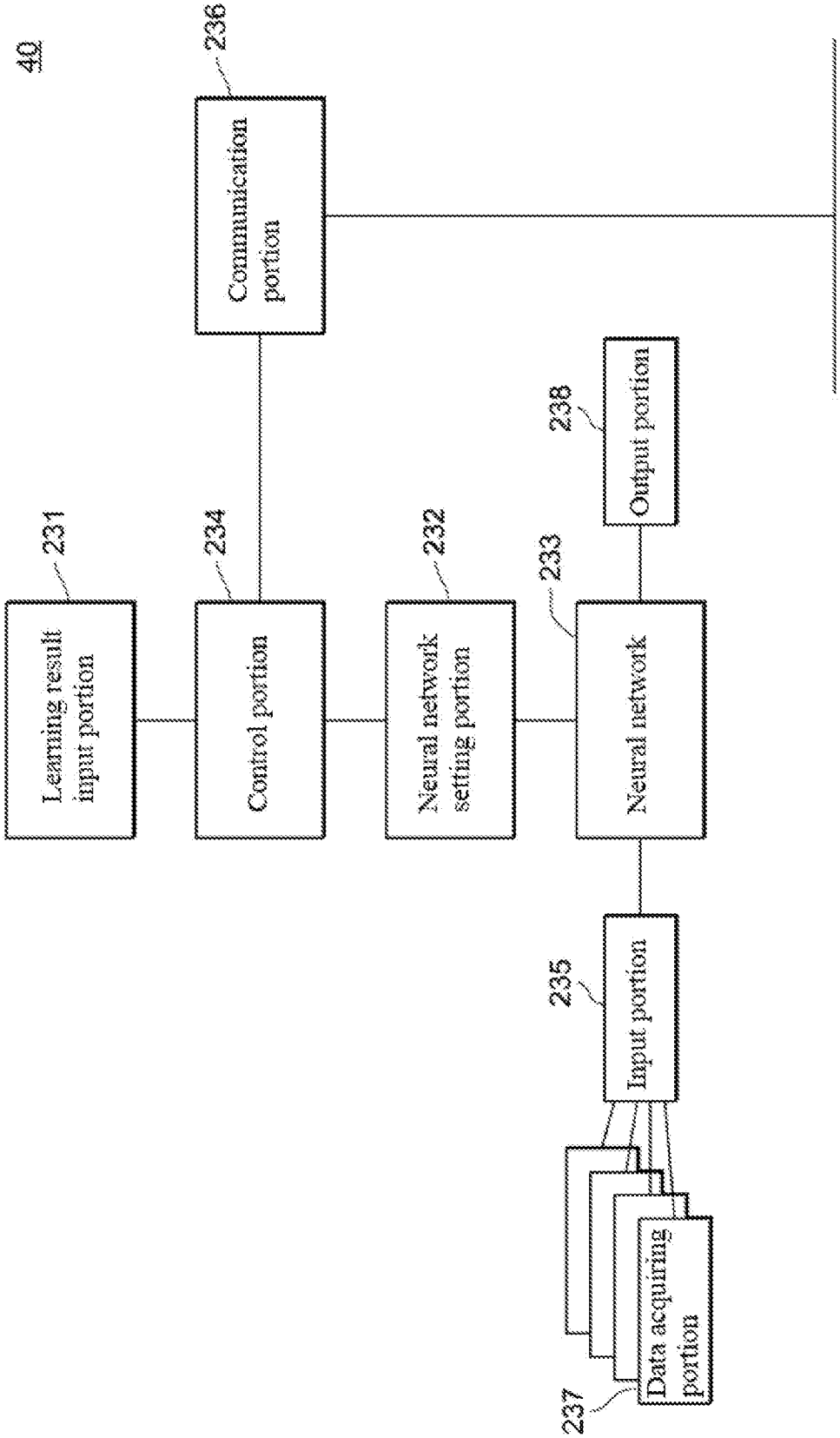
[Fig. 3]


10
16
Metadata generation portion
15
Classification portion
14
Use requesting portion
12
Control portion
13
Learning request portion
11
Communication portion

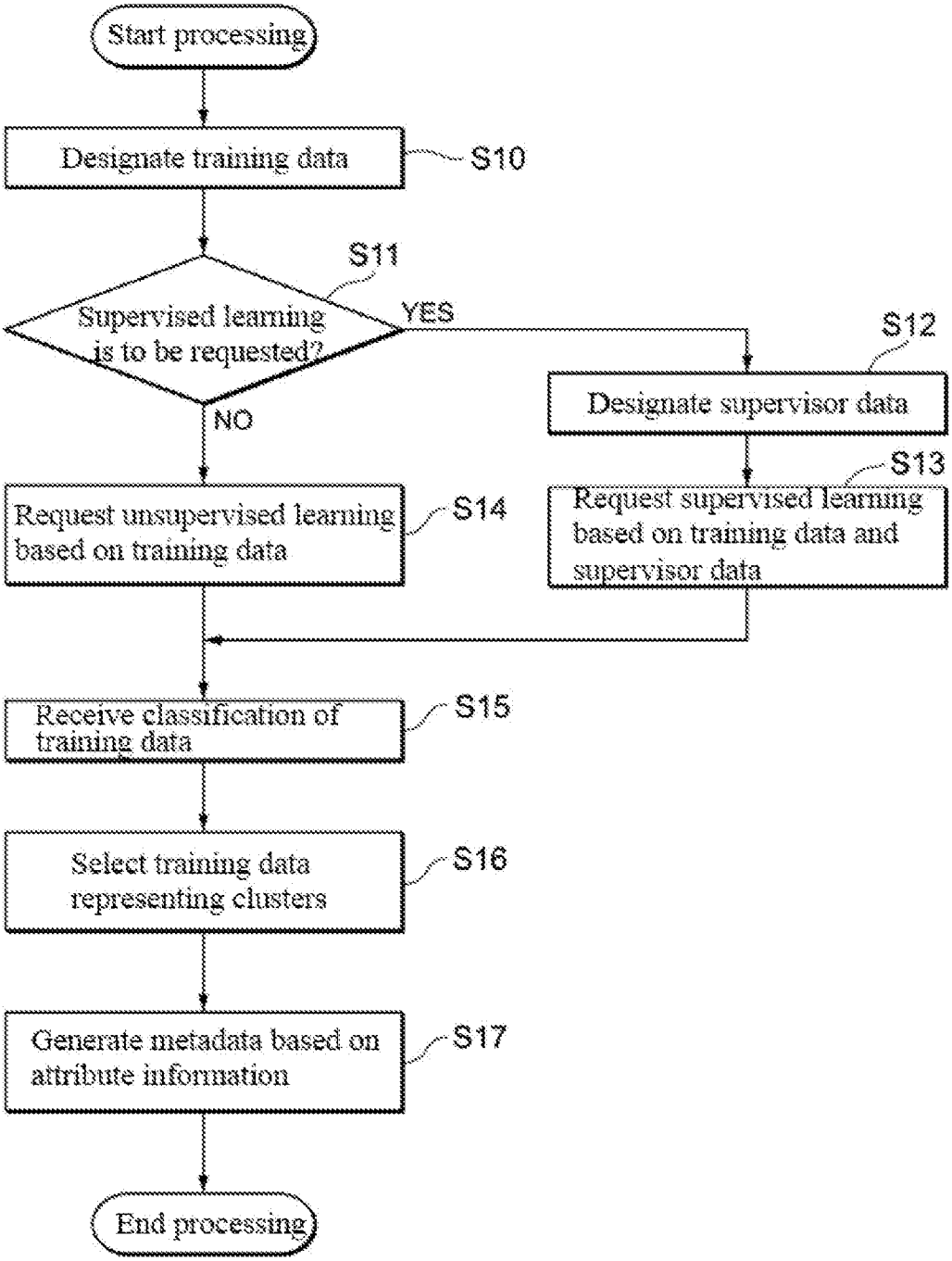
[Fig. 4]


30
Learning result extraction portion
133
Neural network
132
Learning result output portion
135
Learning control portion
131
Communication portion
134

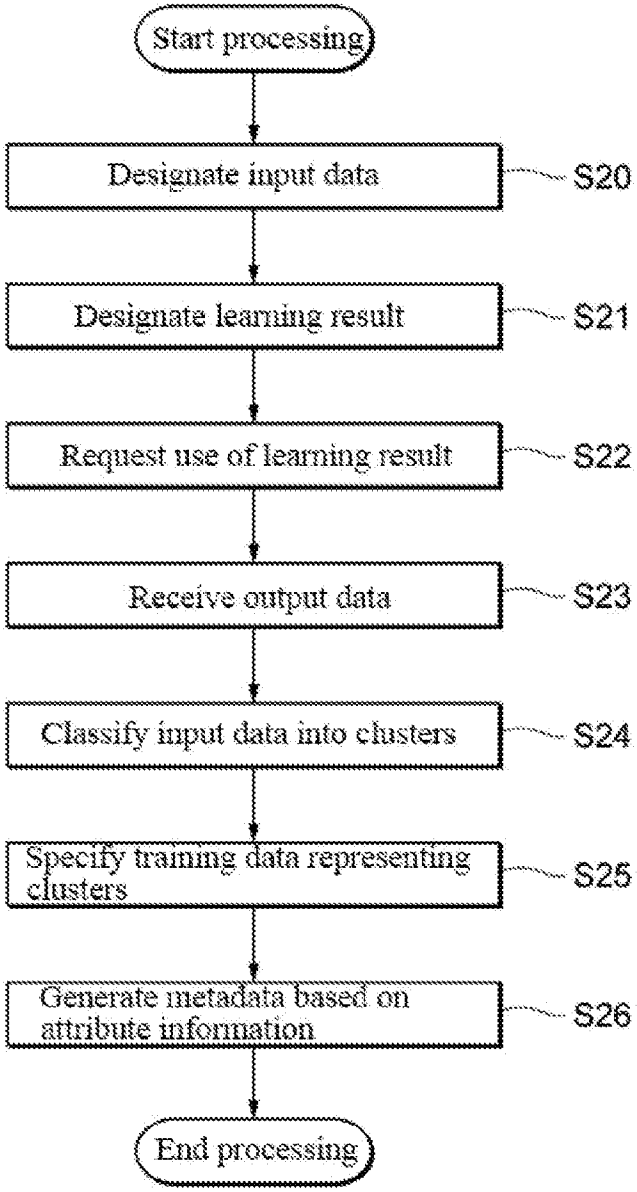
[Fig. 5]


40
236
Communication portion
231
Learning result input portion
234
Control portion
232
Neural network setting portion
233
Neural network
238
Output portion
235
Input portion
237
Data acquiring portion

[Fig. 6]


Start processing
Designate training data
S10
S11
Supervised learning is to be requested?
YES
NO
S12
Designate supervisor data
S13
Request supervised learning based on training data and supervisor data
Request unsupervised learning based on training data
S14
Receive classification of training data
S15
Select training data representing clusters
S16
Generate metadata based on attribute information
S17
End processing

[Fig. 7]


Start processing
Designate input data
S20
Designate learning result
S21
Request use of learning result
S22
Receive output data
S23
Classify input data into clusters
S24
Specify training data representing clusters
S25
Generate metadata based on attribute information
S26
End processing

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2018/008684

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F17/30
ADD.

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)
G06F

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2017/001928 A1 (BUILDPULSE INC [US]) 5 January 2017 (2017-01-05) paragraph [0013] - paragraph [0022] -----	1-9
A	Behzad Shahshahani ET AL: "Purdue e-Pubs CLASSIFICATION OF MULTI-SPECTRAL DATA BY JOINT SUPERVISED- UNSUPERVISED LEARNING", Purdue University, Purdue e-Pubs, ECE Technical Reports, 1 January 1994 (1994-01-01), pages 1-190, XP055470425, West Lafayette, Indianna Retrieved from the Internet: URL:https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1173&context=ecetr [retrieved on 2018-04-25] the whole document -----	1-9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 May 2018	14/05/2018

Name and mailing address of the ISA/	Authorized officer
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5

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/JP2018/008684

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2017001928 A1	05-01-2017	CA 2991224 A1	05-01-2017
		GB 2554841 A	11-04-2018
		US 2017003668 A1	05-01-2017
		WO 2017001928 A1	05-01-2017