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(54) Title: METHOD FOR ESTABLISHING COMMUNICATION WITH A TARGET DEVICE HAVING WIRELESS CONNECTIVITY CAPABILITY

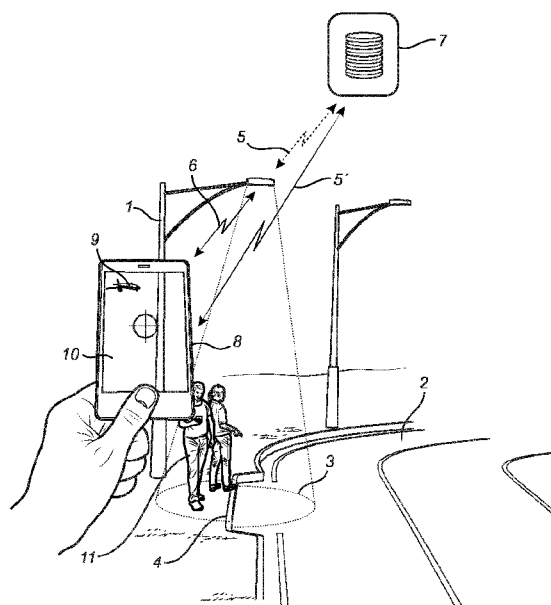


Fig. 1

(57) Abstract: A method for establishing communication (6) with a target device (1) having wireless connectivity capability within a limited communication range using an augmented reality user device (8). The target device is a lighting device. The method comprises executing on the user device an augmented reality software, the augmented reality software prompting the user of the augmented reality user device (8) to approach the target device (1), and establishing, once the augmented reality user device (8) is within the limited communication range of the target device (1), a communication connection (6) between the user device (8) and the target device (1); then, when the communication connection is established, exchanging service data for the target device between the user device and the target device via the established communication connection, wherein said service data comprises one or more of types of data selected from a group comprising: - instructions to connect the target device to a target network, - a software image for maintenance of the software of the target device, and - configuration data for configuring the operation of the target device.

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Method for establishing communication with a target device having wireless connectivity capability

FIELD OF THE INVENTION

The present invention relates to service and/or maintenance of devices having wireless connectivity, in particular but not exclusively illumination devices such as light poles.

BACKGROUND OF THE INVENTION

Outdoor lighting systems may include smartpoles. That is *inter alia* to say light poles with wireless communication capabilities, e.g., using GSM, LTE or the like, and are permanently connected to the cloud or standalone light poles that operate and communicate independently. There can be situations in which cloud connected outdoor lighting poles can malfunction and lose their backend cloud connectivity. Troubleshooting or configuring of these luminaires are done by sending technicians to the site of light poles which is both expensive and time consuming. That is to say, if communication is lost a technician may need to visit the light poles just for reinitializing communication, or to collect debug logs or configure them with certain parameters such as scheduling information or light level. Also, visual inspection is needed to check if there are any damages to the light poles or if new light points are to be installed to cover the street with optimal light levels.

If the light pole is in a remote location this may be rather time consuming for the technician and therefore costly for the operator of the light-poles.

In connection with lighting, it is known to use augmented reality when configuring or servicing electrical installations in buildings. In this respect US2020/0265647 discloses a system for determining the location of lighting and other parts of an electrical installation and labeling them in the augmented reality for easy identification during configuration or service. This is a mere labeling for identification at a known location once the technician has arrived there, so the problem of the costs of the technician going there remains.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome this problem, and to provide a method and a device allowing the maintenance of light poles without a technician visiting them at their location.

5 According to a first aspect of the invention, this and other objects are achieved by a method for establishing communication between an augmented reality device and a target device having wireless connectivity capability within a limited communication range, wherein the target device is a lighting device, wherein the augmented reality device having a digital data processing capability and a wireless connectivity capability, the wireless
10 connectivity capability being compatible with the wireless connectivity capability of the target device, the method comprising:

executing on the augmented reality device an augmented reality software, prompting, using the augmented reality software, the user of the augmented reality device to approach the target device, and

15 establishing, once the augmented reality device is within the limited communication range of the target device, a communication connection between the augmented reality device and the target device, and

when the communication connection is established, exchanging service data for the target device between the user device and the target device via the established
20 communication connection,

wherein said service data comprises one or more of types of data selected from a group comprising:

- instructions to connect the target device to a target network,
- a software image for maintenance of the software of the target device, and
- 25 - configuration data for configuring the operation of the target device.

According to a second aspect of the invention, this and other objects are achieved by an augmented reality device for establishing communication with a target device having wireless connectivity capability within a limited communication range, wherein the target device is a lighting device, the augmented reality device comprising:

30 digital data processing hardware and circuitry providing wireless connectivity capability, the wireless connectivity capability being adapted to be compatible with the wireless connectivity capability of the target device,

an augmented reality software adapted to be executed by the digital data processing hardware,

the augmented reality software being adapted to, when executed on the digital data processing hardware,

prompting a user of the augmented reality device to approach the target device,

5 once the augmented reality device is within the limited communication range of the target device establishing a communication connection between the augmented reality device and the target device, and

 when the communication connection is established, exchanging service data for the target device between the user device and the target device via the established
10 communication connection,

wherein said service data comprises one or more of types of data selected from a group comprising:

- instructions to connect the target device to a target network,
- a software image for maintenance of the software of the target device, and
- 15 - configuration data for configuring the operation of the target device.

According to a third aspect of the invention, this and other objects are achieved by a system comprising a target device having wireless connectivity capability within a limited communication range, and a device according to the second aspect of the invention.

20 According to a fourth aspect of the invention, this and other objects are achieved by the use of a device according to the second aspect of the invention for at least one of exchanging service data with a target device having wireless connectivity capability within a limited communication range, recording data about the target device, and recording data about the area around the target device.

25 In all aspects of the invention this may obviate the need to send a technician to check or service the target device. Instead, the user of the augmented reality device may be prompted to visit the location of the target, thereby allowing the communication capability to temporarily substitute the lost communication of the target device, and in turn allowing service of the target device via the augmented reality user device. This can be performed by
30 any user of the augmented reality user device irrespective of the user's technical knowledge about the target device, and in fact without the user being aware of it.

The method further comprises exchanging service data for the target device between the user device and the target device via the established communication connection once the communication connection is established. This allows the exchange with the target

device via the augmented reality device even when the target device has lost its main communication connection to the cloud.

In an embodiment of the first aspect of the invention the user device is a portable user device. A portable user device is advantageous because it has a high mobility, that is to say can be quickly and almost unrestrictedly be held in any desired orientation and position in the vicinity of the target device. Moreover, portable devices such as smart phones are almost ubiquitous in large parts of the world.

In an embodiment of the first aspect of the invention the user device comprises location determination capabilities providing current location data, and the augmented reality software uses the current location data to prompt the user to approach the target device. This allows the augmented reality software on any one of multiple augmented reality devices within reasonable distance from the target device to be prompted to approach the target device, and hence increases the chances of establishing communication.

In an embodiment of the first aspect of the invention the augmented reality software further prompts the user to remain within the limited communication range of the target device for a time period sufficient to exchange the service data. This increases the chances that communication is completed and accordingly that the actions needed for the target device to resume proper operation will be completed too.

In another embodiment, if the time required to service a target device is large, multiple users are prompted to approach the target device location. A "shared" gamification experience is created with multiple users around such that they interact/play with each other via the same augmented reality content. The servicing of the target device is parallelized across multiple users to speed up the process.

In an embodiment of the first aspect of the invention the augmented reality software prompts the user to record data about one or more of the target device and the area around the target device. This allows a higher level of maintenance or service than simply restart, upgrade, update or the like of the target device, e.g., checking that the target device fulfils its desired purpose, e.g., that a smart light pole illuminates the surroundings in the desired manner.

In an embodiment of the first aspect of the invention the augmented reality software further prompts the user to follow a pre-defined path within the limited communication range of the target device for a time period sufficient to record the data. This may ensure that the entire target device or the area around it is properly surveyed, e.g., that a

smart light pole is fully checked for damage, or that the illumination of the entire area around it is checked.

In an embodiment of the first aspect of the invention the service data comprises one or more of types of data selected from a group comprising:

- 5
- instructions to connect the target device to a target network,
 - a software image for maintenance of the software of the target device,
 - configuration data for configuring the operation of the target device.

10 In an embodiment of the second aspect of the invention, the augmented reality software is further adapted to prompt the user to remain within the limited communication range of the target device for a time period sufficient to exchange the service data.

In an embodiment of the second aspect of the invention the augmented reality software prompts the user to record data about one or more of the target device and the area around the target device. This allows a higher level of maintenance or service than simply restart, upgrade, update or the like of the target device, e.g., checking that the target device
15 fulfils its desired purpose, e.g., that a smart light pole illuminates the surroundings in the desired manner.

In an embodiment of the second aspect of the invention the augmented reality software further adapted to prompt the user to follow a pre-defined path within the limited communication range of the target device for a time period sufficient to record the data. This
20 may ensure that the entire target device or the area around it is properly surveyed, e.g., that a smart light pole is fully checked for damage, or that the illumination of the entire area around it is checked.

It is noted that the invention relates to all possible combinations of features recited in the claims.

25

BRIEF DESCRIPTION OF THE DRAWINGS

This and other aspects of the present invention will now be described in more detail, with reference to the appended drawings showing embodiment(s) of the invention.

Fig. 1 shows an embodiment of the invention implemented in a smart phone.

30 As illustrated in the figures, the sizes of layers and regions are exaggerated for illustrative purposes and, thus, are provided to illustrate the general structures of embodiments of the present invention. Like reference numerals refer to like elements throughout.

DETAILED DESCRIPTION

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which currently preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these

Turning first to Fig. 1 a target device 1 exemplified by smart light pole is shown next to a road 2 illuminating a local area 3 such as the vicinity of a bus stop 4. The target device 1 is equipped with connectivity hardware and software for long range data communication 5 such as GSM or LTE or other 3G 4G or 5G communication, that will allow communication beyond a local radius of e.g., half a kilometer to in principle anywhere in the world, i.e., an unlimited range for any practical purpose. The target device 1 is also equipped with connectivity hardware and software for short or limited range data communication 6, such as Bluetooth®, Zigbee, Wi-Fi, that will allow at best communication over a few hundred meters and no more than half a kilometer.

Under normal circumstances communication will take place between a control centre 7 and the target device via the long-range data communication 5. This allows service, maintenance, updates, direct control, etc. of the target device 1. However, if for some reason the long-range data communication 5 fails (as indicated by the dashed line in Fig.1) and this connectivity is lost, these are no longer possible and the target device 1 needs to be visited, even if it is for a simple restart of the communication software of the target device 1.

However, as illustrated an augmented reality device 8 capable of both long-range data communication 5' and limited range data communication 6 may be used to substitute the failed normal long-distance communication 5 between the target device and the control centre 7. The augmented reality device 8 may be any kind of augmented reality device 8 with appropriate communication capabilities, but currently a smart phone executing appropriate software. Smart phones are light, hand-held, highly mobile, ubiquitous among people in large parts of the world. Moreover, smartphones typically comprise the necessary communication capabilities for long range communication 5' and limited range communication 6, a Global Navigation Satellite System (GNSS) receiver, a camera or even other recording devices such as LIDAR. If the problem with the target device 1 is one that can be resolved if an augmented reality device 8 can be brought into the area of limited range communication of the target device area, the need to send a technician may be obviated, even

if the user of the augmented reality device 8 has no technical skills. That is to say by just about anyone having a smartphone executing an appropriate software, if the user of the smartphone can be nudged towards visiting the target device 1. This can be achieved by gamification, that is to say, the augmented reality software is so presented to the user that the user has a reason to install and run the software and the software then prompts the user to perform certain acts as part of a game or other delectation. Prompting in this sense meaning any kind of information presented to the user in order to trigger the performance of a desired action. Prompting, may include audible signaling, e.g., for indicating that a game is available, written instructions for specific actions, and the presentation of virtual objects on the display for the user to interact with in an intuitive manner.

A reason to install the augmented reality software could be rewards obtained for the user for playing the game and performing certain acts. This need not be direct economic benefits in the form of credits or shopping discounts but could in remote areas without an electricity grid be the right to charge the batteries of the augmented reality device from the target device, e.g., charging a smartphone from a stand-alone smart light pole equipped with photovoltaic cells and battery for nighttime illumination.

A way of drawing the user's intention to the existence of the augmented reality software in the first place could be easy to scan QR codes on the target devices 1 or elsewhere e.g. on stickers.

Assuming that the control centre 7 becomes aware of failed long-distance communication 5 with a target at a given known location and one or more users have an augmented reality device running the augmented reality software these users may be called to assistance. That is to say based, e.g., on current information sent to the control centre 7 about the position of augmented reality devices 8 running the augmented reality software, the control center 7 may notify the users of augmented reality devices 8 in reasonable distance of the target device 1, but still outside the range of the limited range data communication 6 that a game is about to begin. Alternatively, for more privacy, the location of the target device 1 may be broadcast to all augmented reality devices running the software, and the software may then determine whether the augmented reality device is in reasonable distance from the target device 1 and prompt the user to start the game. The location information may be provided by a built-in GNSS, the current cell of a cellular communication system, signal strength or triangulation using base stations in the long-range communication system, known Wi-Fi network locations etc. Privacy issues are a matter of consent by the user, and at least for the use necessary for carrying out the invention, the user will have given consent in

advance to the use of the augmented reality device 8, e.g., when installing the software on a smartphone.

If the user responds, the augmented reality software on the augmented reality device will prompt the user to approach the target device 1, e.g., by using a marker on a map or a beacon overlay generated on an image recorded by a camera of the augmented reality device 8. The beacon may e.g., be an animal or airplane to track or follow and eventually catch or shoot down at the target location. Alternatively, it is just a beacon until the user arrives in the vicinity of the target device, the game then changes to another character.

If the user successfully tracks or follows the beacon and arrives within the range of the limited range data communication 6 of the target device 1 the augmented reality software may unbeknown to the user establish limited range data communication 6 with the target device 1. This allows the target device 1 to communicate with the control centre 7 via the augmented reality device 8 using the established limited range data communication 6 from the target device 1 to the augmented reality device 8 and the long-range communication 5' from the augmented reality device 8 to the control centre 7, or vice versa. The gaming may change for this, e.g., by increasing difficulty or by introduction of a new game or game phase, so as to ensure that the user stays in the vicinity of the target device 1 for a time period sufficient for completing the communication, and exchange of whatever service data are necessary between the control centre 7 and the target device 1. Such service data is to be understood broadly and may include:

- instructions to connect the target device 1 to a target (wireless) network,
- a software image for maintenance of the software of the target device 1, e.g., for updating or upgrading the software of the target device 1,
- configuration data for configuring the operation of the target device 1 (e.g., lighting control data or lighting control routines when the target device is a lighting device),
- instructions for software reset or restart and/or self-test to the target device 1,
- auxiliary data such as rain measurements, traffic statistics, sunshine statistics, battery health data for photovoltaic stand-alone light poles, time of recording etc.

Alternatively, the user could be simply informed to remain static from the moment that a stable connection on the limited range communication 6 is detected (e.g., "remain at your position to receive extra credits or game points" in writing or audio).

In another alternative, if the time required to service a target device 1 is large, multiple users 11 are prompted to approach the target device location. A "shared" gamification experience is created with multiple users 11 around such that they interact/play

with each other via the same augmented reality content. The servicing of the target device 1 is parallelized across multiple users 11 to speed up the process.

This change of gameplay could involve presenting moving or stationary virtual object on or around the target device 1 to be shot down or captured by tapping or swiping on the display if the display is a touch screen.

Having prompted the user to approach the target device and establish a communication connection, it may be advantageous to further prompt the user to perform further actions even if these require a prolonged stay. This could involve changing the game further, e.g., increasing difficulty even further or by the introduction of a new game or game phase. In such a new game phase the augmented reality software may prompt the user to aim the augmented reality device 8 in different directions and move around the target device 1 to e.g., acquire images from many angles thereof, or of the vicinity thereof, and send them to the control centre 7. Images are to be understood not only as visual images, but may include, e.g., LIDAR scans and other virtual images. All such images may also be considered service data in the sense of the present application. This could be done by moving an animated figure, such as the aforementioned animal or airplane animation around on the display of the augmented reality device in a manner prompting the user to follow a predetermined path, so as to ensure that every detail is covered. This will allow inspection of the target device 1 for physical damage at the control centre 7. It will also be possible to assess whether, e.g., the illumination 3 from a smart light pole is suitable, sufficient and in accordance with the purpose, e.g., properly illuminates the waiting passengers at a bus stop 4 and their surroundings.

Although, in the present description the augmented reality device 8 has been exemplified by as smartphone, it should be understood that such augmented reality devices are known in the art, and not be discussed in much further detail. In general, an augmented reality device 8 comprises a display 10 for rendering a virtual environment comprising one or more virtual objects 9. The display 10 may be a (semi-) transparent see-through display, wherein the user can see the physical environment through the display 10, and wherein the display 10 is configured to render the virtual environment comprising one or more virtual objects 9 as an overlay on the physical environment. The display 10 may be integrated in the (semi-) transparent see-through display, or the virtual environment may be projected on the display 10. Alternatively, augmented reality device 8 may comprise a camera configured to continuously capture images of the physical environment and render the images on the

display 10, while rendering the virtual environment and/or the virtual objects 9 as an overlay on the images.

The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications
5 and variations are possible within the scope of the appended claims. For example, the augmented reality device 8 need not be handheld but could be part of a vehicle with a display, e.g., a vehicle with a Head Up Display (HUD). Also, the changes in difficulty and/or gameplay could be gradual depending on the progress in analysis of the data received at the control centre 7.

10 Additionally, variations to the disclosed embodiments can be understood and effected by the skilled person in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent
15 claims does not indicate that a combination of these measures cannot be used to advantage.

CLAIMS:

1. A method for establishing communication between an augmented reality device and a target device having wireless connectivity capability within a limited communication range, wherein the target device is a lighting device, wherein the augmented reality device having a digital data processing capability and a wireless connectivity capability, the wireless connectivity capability being compatible with the wireless connectivity capability of the target device, the method comprising:

executing on the augmented reality device an augmented reality software, prompting, using the augmented reality software, the user of the augmented reality device to approach the target device,

establishing, once the user device is within the limited communication range of the target device, a communication connection between the augmented reality device and the target device, and

when the communication connection is established, exchanging service data for the target device between the user device and the target device via the established communication connection,

wherein said service data comprises one or more of types of data selected from a group comprising:

- instructions to connect the target device to a target network,
- a software image for maintenance of the software of the target device, and
- configuration data for configuring the operation of the target device.

2. A method according to claim 1, wherein the augmented reality device is a portable augmented reality device.

3. A method according to any one of the preceding claims, wherein the augmented reality device comprises location determination capabilities providing current location data, and wherein

the augmented reality software uses the current location data to prompt the user to approach the target device.

4. A method according to any one of the preceding claims, wherein
the augmented reality software further prompts the user to remain within the
limited communication range of the target device for a time period sufficient to exchange the
5 service data.

5. Method according to any one of the preceding claims, wherein the augmented
reality software prompts the user to record data about one or more of the target device and
the area around the target device.

6. A method according to claim 5, wherein
the augmented reality software further prompts the user to follow a pre-
defined path within the limited communication range of the target device for a time period
sufficient to record the data.

7. An augmented reality device for establishing communication with a target
device having wireless connectivity capability within a limited communication range,
wherein the target device is a lighting device, the augmented reality device comprising:
digital data processing hardware and circuitry providing wireless connectivity
20 capability, the wireless connectivity capability being adapted to be compatible with the
wireless connectivity capability of the target device,
an augmented reality software adapted to be executed by the digital data
processing hardware,
the augmented reality software being adapted to, when executed on the digital
25 data processing hardware,
prompting a user of the augmented reality device to approach the target
device,
once the augmented reality device is within the limited communication range
of the target device establishing a communication connection between the augmented reality
30 device and the target device, and
when the communication connection is established, exchanging service data
for the target device between the user device and the target device via the established
communication connection,

wherein said service data comprises one or more of types of data selected from a group comprising:

- instructions to connect the target device to a target network,
- a software image for maintenance of the software of the target device, and
- 5 - configuration data for configuring the operation of the target device.

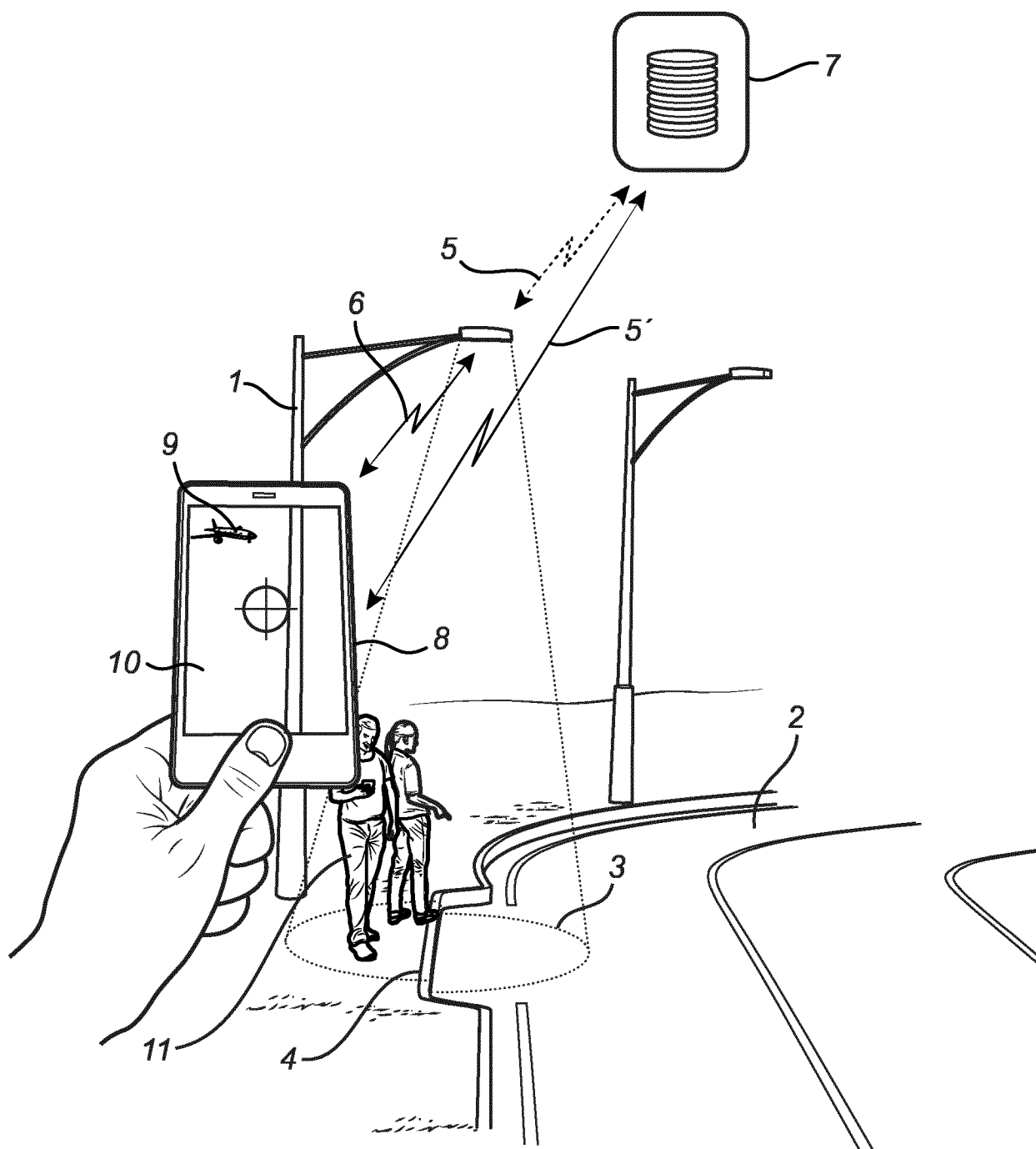
8. A device according to claim 7, wherein
the augmented reality software is further adapted to prompt the user to remain
within the limited communication range of the target device for a time period sufficient to
10 exchange the service data.

9. A device according to any one of claims 7 or 8, wherein the augmented reality
software prompts the user to record data about one or more of the target device and the area
around the target device.

10. A device according to claim 9, wherein
the augmented reality software further adapted to prompt the user to follow a
pre-defined path within the limited communication range of the target device for a time
period sufficient to record the data.

11. A system comprising a target device having wireless connectivity capability
within a limited communication range, and a device according to any one of claims 7 to 10.

12. The use of a device according to any one of claims 7 to 10 for at least one of
25 exchanging service data with a target device having wireless connectivity capability within a
limited communication range, recording data about the target device, and recording data
about the area around the target device.

*Fig. 1*

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/066350

A. CLASSIFICATION OF SUBJECT MATTER					
INV.	H05B47/19	H05B47/21	H05B47/23	H04W4/021	H04W4/029
	H04W4/38	H04W4/80	H04W76/19	H04W76/15	H04W4/02
	H04W88/04	H04W76/16			
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) H05B H04W					
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					
C. DOCUMENTS CONSIDERED TO BE RELEVANT					
Category*	Citation of document, with indication, where appropriate, of the relevant passages				Relevant to claim No.
X	US 2022/407666 A1 (LIM CHAIGIL [KR] ET AL) 22 December 2022 (2022-12-22) paragraphs [0062] - [0064], [0080] - [0090], [0102] - [0112], [0178] - [0245]; figures 2-6, 12-17 -----				1 - 12
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.					
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "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 22 August 2024			Date of mailing of the international search report 26/09/2024		
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016			Authorized officer Waters, Duncan		

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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