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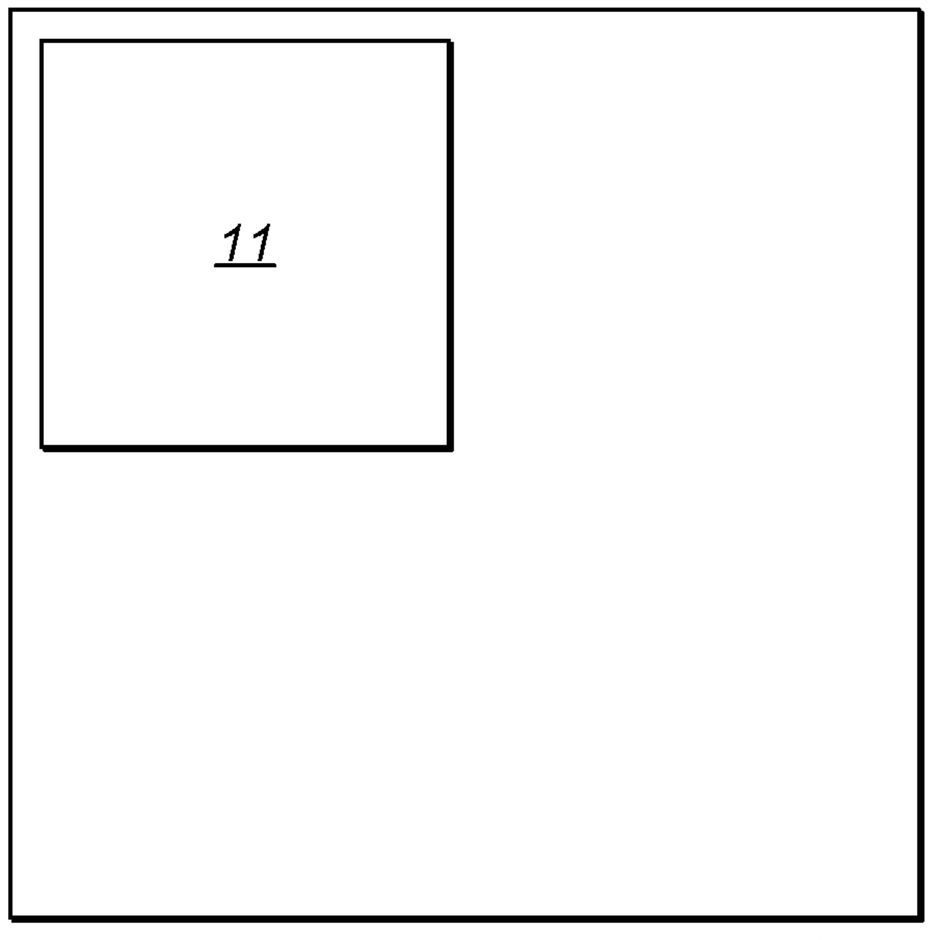

FIG. 1

11 07 17

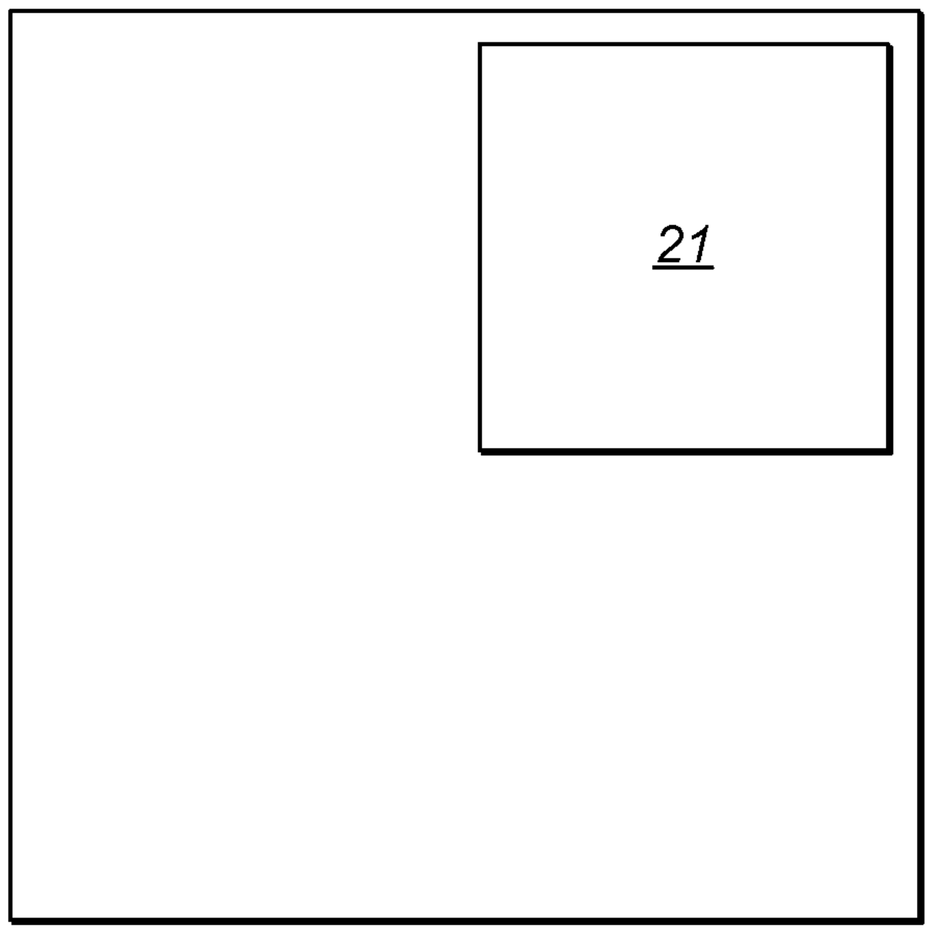

FIG. 2

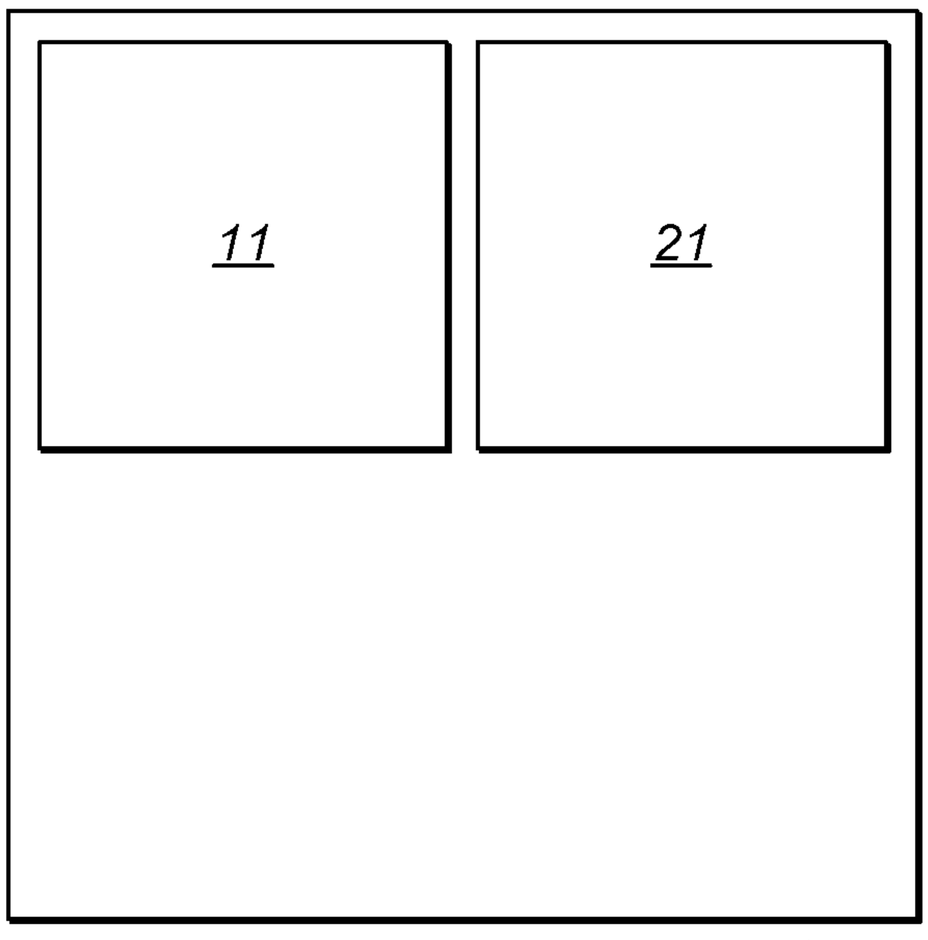

FIG. 3

11 07 17

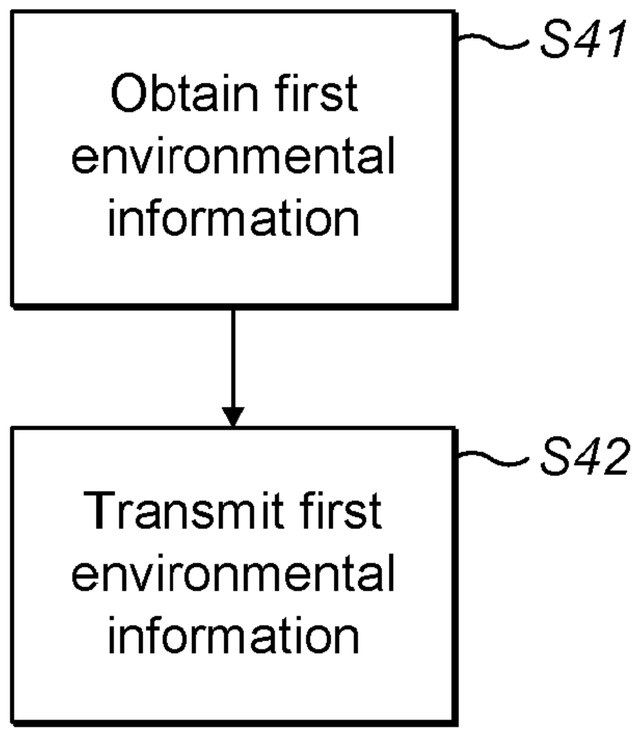

FIG. 4

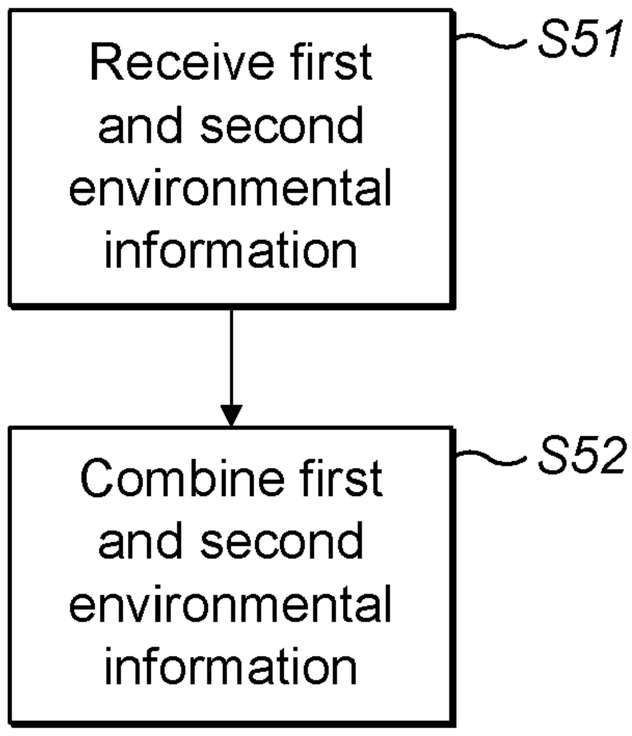

FIG. 5

17 11 07

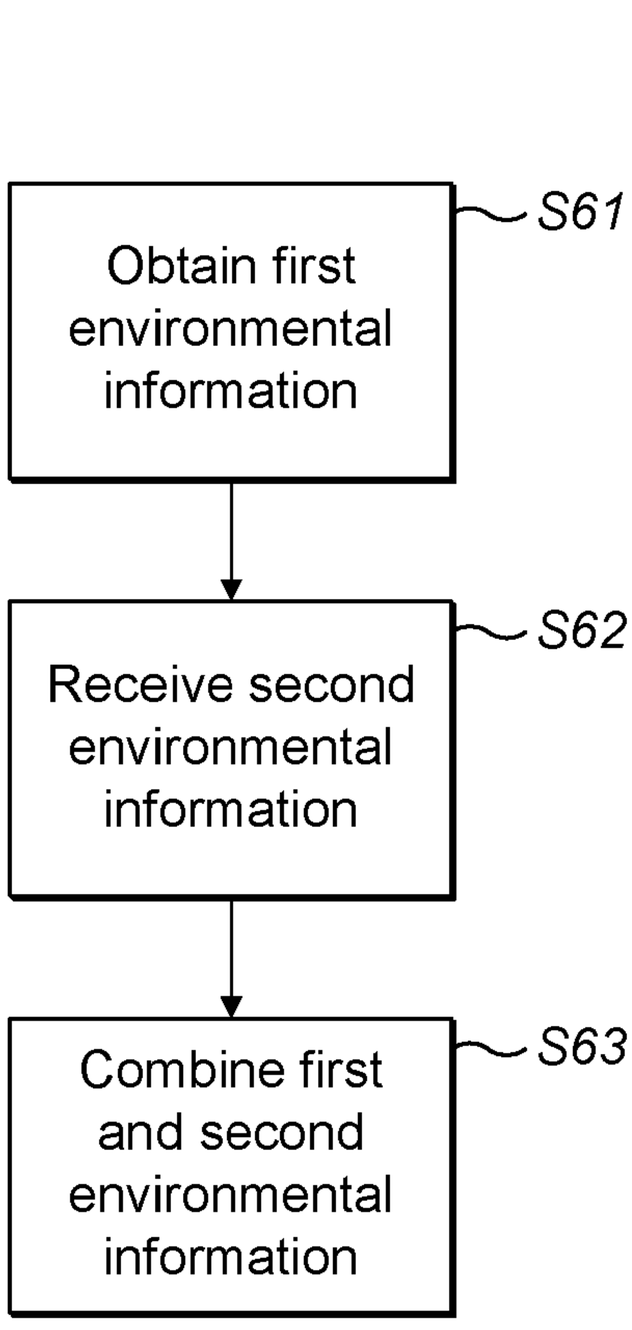

FIG. 6

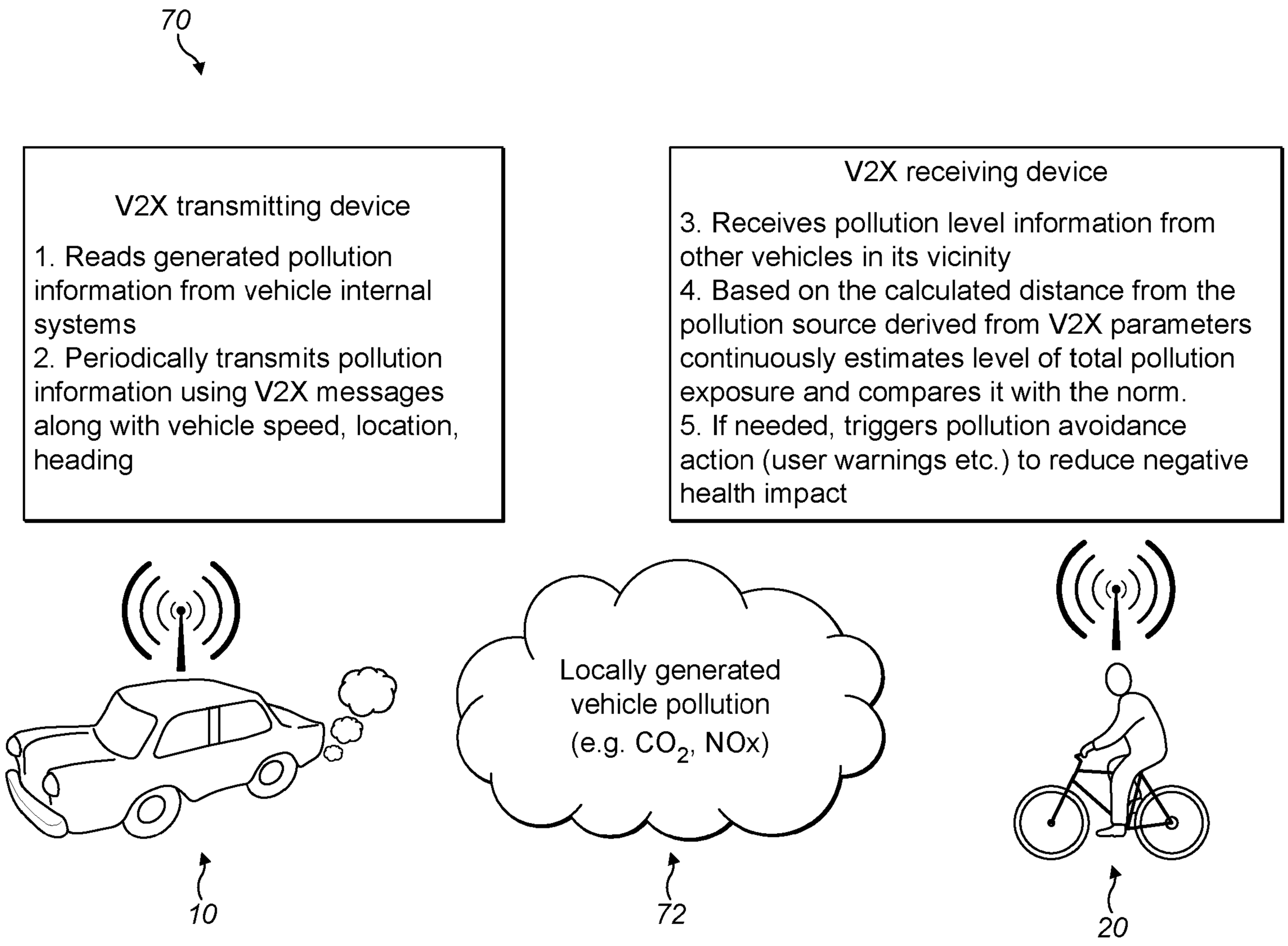
70
V2X transmitting device
1. Reads generated pollution information from vehicle internal systems
2. Periodically transmits pollution information using V2X messages along with vehicle speed, location, heading
V2X receiving device
3. Receives pollution level information from other vehicles in its vicinity
4. Based on the calculated distance from the pollution source derived from V2X parameters continuously estimates level of total pollution exposure and compares it with the norm.
5. If needed, triggers pollution avoidance action (user warnings etc.) to reduce negative health impact
Locally generated vehicle pollution (e.g. CO_2, NOx)
10
72
20

FIG. 7

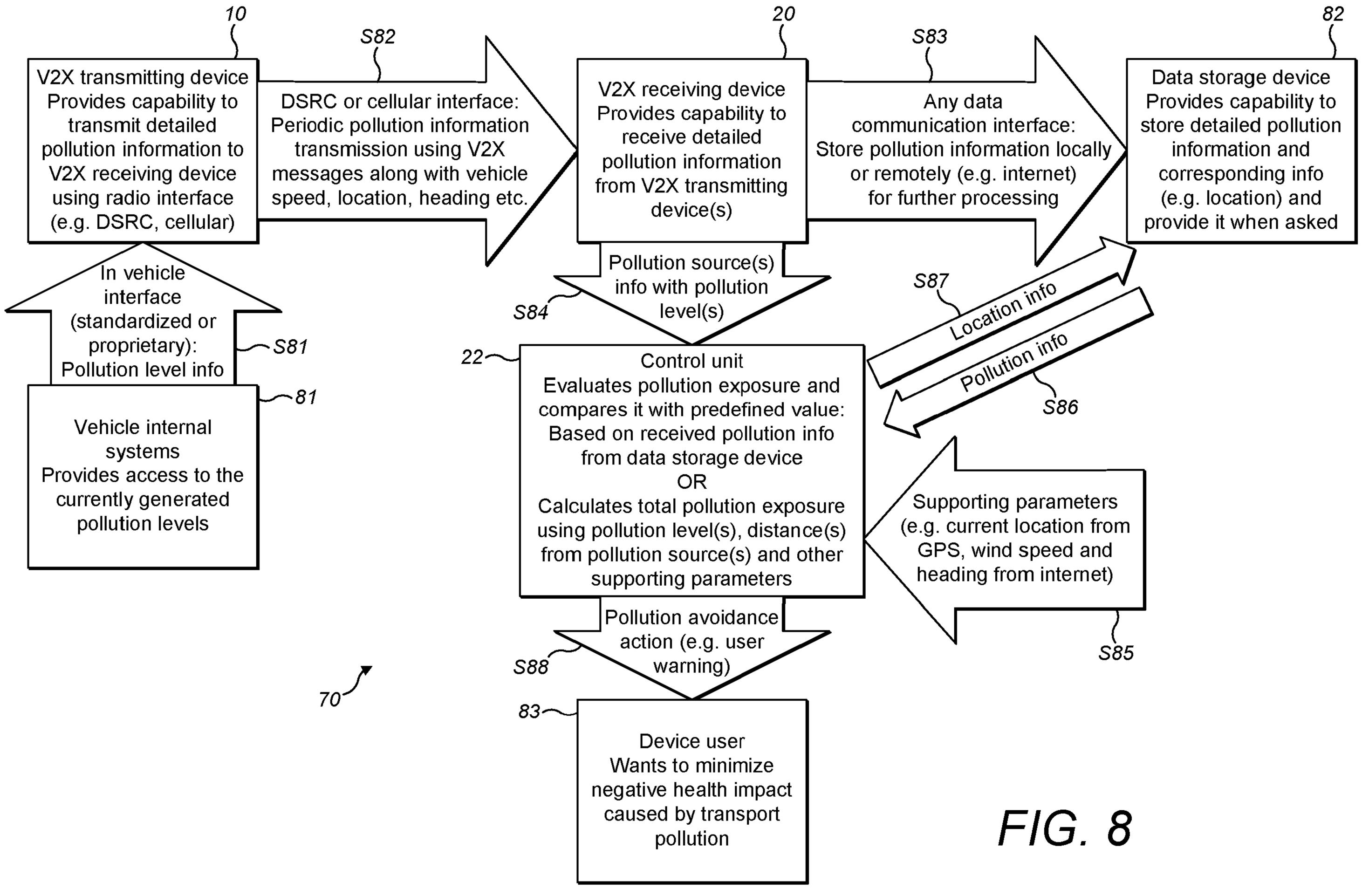
10
V2X transmitting device
Provides capability to transmit detailed pollution information to V2X receiving device using radio interface (e.g. DSRC, cellular)
S82
DSRC or cellular interface:
Periodic pollution information transmission using V2X messages along with vehicle speed, location, heading etc.
20
V2X receiving device
Provides capability to receive detailed pollution information from V2X transmitting device(s)
S83
Any data communication interface:
Store pollution information locally or remotely (e.g. internet) for further processing
82
Data storage device
Provides capability to store detailed pollution information and corresponding info (e.g. location) and provide it when asked
In vehicle interface (standardized or proprietary):
Pollution level info
S81
81
Vehicle internal systems
Provides access to the currently generated pollution levels
Pollution source(s) info with pollution level(s)
S84
S87
Location info
Pollution info
S86
22
Control unit
Evaluates pollution exposure and compares it with predefined value:
Based on received pollution info from data storage device
OR
Calculates total pollution exposure using pollution level(s), distance(s) from pollution source(s) and other supporting parameters
Supporting parameters (e.g. current location from GPS, wind speed and heading from internet)
S85
Pollution avoidance action (e.g. user warning)
S88
83
Device user
Wants to minimize negative health impact caused by transport pollution
70

FIG. 8

Atmospheric dispersion calculator
Air pollution control stacks equation formulas
Solving for plume contaminant concentration at a point in space

$$C(x,y,z)=\frac{Q}{2\pi u\sigma_y\sigma_z}\, e^{-\frac{y^2}{2\sigma_y^2}}\left(e^{-\frac{(z+H)^2}{2\sigma_z^2}}+e^{-\frac{(z-H)^2}{2\sigma_z^2}}\right)$$

Inputs:

Pollution rate emission rate (Q)		gram/second
Average wind speed (u)		meter/second
y direction plume standard deviation (σ_y)		meter
z direction plume standard deviation (σ_z)		meter
y position (y)		meter
z position (z)		meter
Effective stach height (H)		meter

FIG. 9

Environmental monitoring

Field

The present invention relates to environmental monitoring and to methods and apparatuses for environmental monitoring. In particular, the present invention relates to environmental monitoring based on a plurality of environmental information sources.

Background to the Invention

Poor air quality may typically be considered a public health problem as long-term exposure, for example by humans, animals and/or plants, to polluted air may be detrimental. For example, poor air quality may have negative health effects on humans: lung ageing may be accelerated, lung capacity may decrease and/or functionality impaired; asthma, bronchitis, emphysema or cancer may develop; and/or life span may be reduced. Road transport, for example vehicles such as passenger vehicles such as motorbikes, cars, or buses or goods vehicles such as lorries, may be significant sources of pollution such as air pollution, greenhouse effect gases and/or noise pollution. Despite enhancements in vehicle efficiencies, the automotive sector may still be responsible for a very significant portion of pollution caused to the environment. As an example, in Europe, road transport or vehicles account for almost one fifth of Europe's green house gas emissions, and many European cities suffer a concentration of air pollutants that exceed European Union standards.

For example, air pollutants from vehicles, such as carbon dioxide, carbon monoxide or nitrogen oxides, along with traffic noise, are considered challenging aspects of urban transport systems. Congested city traffic scenarios such as traffic jams may be especially critical, and may affect public health in at least two different ways. For example, Vulnerable Road Users (VRUs) such as pedestrians, cyclists, and motorbike users in city traffic may be exposed to relatively higher risks of pollution due to their physical location close (i.e. proximity) to vehicle exhausts and lack of air filtering systems, such as cabin air filtering systems that may be included in vehicles. For example, vehicle drivers and/or passengers may be exposed, intermittently or continuously, to relatively higher pollution levels without information about these pollution levels and hence may be exposed to corresponding health risks. Vehicle cabin air filtering systems and/or cabin air recirculation systems may reduce pollution exposure, but may not be available or operational in all vehicles.

Furthermore, current pollution regulatory measures may not be complied with, for example by the transport sector such as vehicle manufacturers, and/or may only apply to currently manufactured vehicles. Provision of effective solutions to pollution problems may be limited by

a complexity of measuring vehicle emissions and/or current exhaust emission testing approaches may not be effective. While standardised measurements in laboratories may be typically used to measure that vehicles meet, for example, regulated limits for exhaust emissions, official measurement procedures may not be representative of actual vehicle use, for example, real driving conditions.

Hence, there is a need to improve monitoring of the environment, particularly with respect to pollution due to vehicles. In this way, for example, vehicle drivers, passengers and/or VRUs may be better informed of pollution levels.

Summary of the Invention

It is one aim of the present invention, amongst others, to provide environmental monitoring which at least partially obviates or mitigates at least some of the disadvantages of the prior art, whether identified herein or elsewhere. For example, the present invention may provide for sharing of environmental information, enabling vehicle pollution crowdsourcing by which actions may be taken in response to pollution exposure. In this way, environmental monitoring may be improved.

A first aspect of the invention provides a transmitter device comprising a transmitter;
wherein the transmitter device is arranged to obtain first environmental information; and
wherein the transmitter device is arranged to control the transmitter to transmit the first environmental information.

A second aspect of the invention provides a receiver device comprising a receiver;
wherein the transceiver device is arranged to control the receiver to receive first environmental information and second environmental information; and
wherein the transceiver device is arranged to combine the first environmental information and the second environmental information.

A third aspect of the invention provides a transceiver device comprising a transmitter and a receiver;
wherein the transceiver device is arranged to obtain first environmental information;
wherein the transceiver device is arranged to control the receiver to receive second environmental information; and
wherein the transceiver device is arranged to combine the first environmental information and the second environmental information.

A fourth aspect of the invention provides a method of transmitting information, the method comprising:
obtaining first environmental information; and
transmitting the first environmental information.

A fifth aspect of the invention provides a method of receiving information, the method comprising:
receiving first environmental information and second environmental information; and
combining the first environmental information and the second environmental information.

A sixth aspect of the invention provides a method of transceiving information, the method comprising:
obtaining first environmental information;
receiving second environmental information; and
combining the first environmental information and the second environmental information.

A seventh aspect of the invention provides a network comprising a transmitter device and a receiver device.

An eighth aspect of the invention provides a receiver device comprising a receiver;
wherein the receiver device is arranged to control the receiver to receive first environmental information; and
wherein the receiver device is arranged to determine a pollution exposure based on the first environmental information.

A ninth aspect of the invention provides a method of receiving information, the method comprising:
receiving first environmental information; and
determining a pollution exposure based on the first environmental information.

Detailed Description of the Invention

According to the present invention there is provided a transmitter device, a receiver device and a transceiver device as set forth in the appended claims. Also provided is a method of transmitting information, a method of receiving information and a method of transceiving information. Other features of the invention will be apparent from the dependent claims, and the description that follows.

Throughout this specification, the term “comprising” or “comprises” means including the component(s), unit(s), module(s), feature(s) or integer(s) specified but not to the exclusion of the presence of other components, units, modules, features or integers.

The term “consisting of” or “consists of” means including the component(s), unit(s), module(s), feature(s) or integer(s) specified but excluding other components, units, modules, features or integers.

Whenever appropriate, depending upon the context, the use of the term “comprises” or “comprising” may also be taken to include the meaning “consists essentially of” or “consisting essentially of”, and also may also be taken to include the meaning “consists of” or “consisting of”.

The optional features set out herein may be used either individually or in combination with each other where appropriate and particularly in the combinations as set out in the accompanying claims. The optional features for each aspect or exemplary embodiment of the invention, as set out herein are also applicable to all other aspects or exemplary embodiments of the invention, where appropriate. In other words, the skilled person reading this specification should consider the optional features for each aspect or exemplary embodiment of the invention as interchangeable and combinable between different aspects and exemplary embodiments.

The first aspect of the invention provides a transmitter device comprising a transmitter;
wherein the transmitter device is arranged to obtain first environmental information; and
wherein the transmitter device is arranged to control the transmitter to transmit the first environmental information.

In this way, the first environmental information may be shared by the transmitter device. In this way, vehicle pollution crowdsourcing may be implemented, in which, for example, coordinated utilization of multiple vehicle emission measurements may be shared within a geographic area to obtain reliable estimations of air pollutant concentrations at locations where direct measurement is not available. In this way, pollution mapping may be implemented. In addition, these measurements and/or estimations may be utilized to provide action triggers, for example, to relevant applications used by Cooperative Intelligent Transport Systems (C-ITS) ecosystem users such as V2X enabled devices used by vehicles, infrastructure and/or VRUs, in order to monitor, control, reduce and/or minimize human pollution exposure. Vehicle pollution crowdsourcing may be defined as a process by which vehicles share, for example periodically, respective environmental information such as currently generated pollution levels, using, for example, V2X-based ad hoc communication.

It should be understood that the first environmental information may include pollution information, for example atmospheric or air pollution information related to gaseous and/or particulate matter and/or noise levels. In an example embodiment, the first environmental information comprises information related to one selected from a list consisting of: carbon dioxide (CO_2), hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM), nitrogen oxides (NO_X), sulphur dioxide (SO_2), volatile organic compounds (VOCs), ozone and noise. The information may be an amount, for example a concentration, a relative concentration (e.g. ppm, ppb), a rate of change of concentration, a rate of emission in g/s or g/km, or a level, for example a noise level in dBa.

It should be understood that the transmitter device may support V2X communication. V2X standard include: ETSI Cooperative Awareness Basic Service (EN 302 637-2); SAE J2735 - Dedicated Short Range Communications (DSRC) Message Set Dictionary; and 3GPP TR 22.885 Study on LTE support for Vehicle to Everything (V2X) services. V2X communication includes vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-pedestrian (V2P) communication. For example, the transmitter device may be suitable for or included in a vehicle, infrastructure or a pedestrian device. That is, the transmitter device may be suitable for or included in or near a source of pollution to be monitored. In addition, V2X devices refer to any equipment able to transmit and/or receive V2X messages regardless of the underlying communication technology and independently of other functions that the V2X devices may have. The V2X devices may include, for example, devices fitted or retrofitted to vehicles, devices included in infrastructure such as traffic lights, traffic signs, road gantries and VRU devices such as smartwatches, smartphones, tablets, personal GPS navigation devices or wearable devices. In an example embodiment, the transmitter device comprises a V2X device. In an example embodiment, the transmitter device is a V2X device. In an example embodiment, the first environmental information may be transmitted as a V2X communication.

The transmitter device may be arranged to control the transmitter to transmit according to a broadcast protocol, for example communication protocols used in C-ITS (e.g. ETSI Cooperative Awareness Basic Service (EN 302 637-2); SAE J2735 - Dedicated Short Range Communications (DSRC) Message Set Dictionary). In an example embodiment, the transmitter device is arranged to control the transmitter to transmit according to a C-ITS communication protocol. The C-ITS communication protocols may be modified to include the first environmental information.

The transmitter device may obtain the first environmental information from a sensor, for example, a carbon dioxide (CO_2) sensor, a hydrocarbons (HC) sensor, a carbon monoxide (CO) sensor, a particulate matter (PM) sensor, a nitrogen oxides (NO_X) sensor, a sulphur

dioxide (SO_2) sensor, or a noise sensor. The transmitter device may obtain the first environmental information directly or indirectly from such a sensor. For example, where the transmitter device is included in a vehicle, the transmitter device may obtain the first environmental information from the vehicle. For example, the transmitter device may obtain the first environmental information from a vehicle Engine Control Unit (ECU), ISO Controller Area Network (CAN) bus or On-board diagnostics (OBD) port of the vehicle. The transmitter device may comprise such a sensor, as described above.

It should be understood that the transmitter may be a wireless transmitter. In an example embodiment, the transmitter comprises a wireless transmitter. In an example embodiment, the transmitter is a wireless transmitter. The first environmental information may be transmitted wirelessly. The first environmental information may be transmitted using Dedicated Short Range Communication (DSCR) radio access technology, for example based on ETSI ITS-G5 or IEEE 802.11p standards. The first environmental information may be broadcast by the transmitter device as a message or as part of a message, such as an ETSI Cooperative Awareness Basic Service (EN 302 637-2); SAE J2735 - Dedicated Short Range Communications (DSRC) Message Set Dictionary. In one example embodiment, the transmitter device is arranged to control the transmitter to transmit a message, wherein the message comprises the first environmental information. In one example embodiment, the transmitter device is arranged to control the transmitter to periodically transmit a message, wherein the message comprises the first environmental information. For example, the first environmental information may be broadcast periodically, for example, every second, every minute, every hour. In one example embodiment, the transmitter device is arranged to control the transmitter to transmit a message in response to a request to transmit the message.

A periodicity of broadcasting and/or content, for example type or breadth, of the first environmental information may be determined by at least one of a vehicle speed, proximity of other vehicles and/or road users, location, environment type, priority or request. For example, where the transmitter device is included in a vehicle, the first environmental information may be broadcast below a predetermined speed of the vehicle, such as a typical average vehicle speed in congestion or city traffic. For example, where the transmitter device is included in a vehicle, the first environmental information may be broadcast if other vehicles and/or road users are in the proximity of the vehicle, such as if other vehicles and/or road users are detected in a vicinity of the vehicle. For example, the first environmental information may be broadcast if a vehicle V2X modem of the vehicle receives V2X signals from other neighbouring vehicles or similar information from other on-board sensors, for example RADAR, LIDAR or camera. For example, where the transmitter device is included in a vehicle, the first environmental information may be broadcast according to a map based location and/or type of environment of the vehicle. For example, in high speed motorway and/or rural scenarios,

pollution information may be less relevant than compared, for example, with a traffic jam in an urban, city or the pollution control area. For example, where the transmitter device is included in a vehicle, the first environmental information may be broadcast according to a C-ITS application priority, such that a priority of the first environmental information may be reduced relative, for example, to information related to road traffic and/or safety related. For example, where the transmitter device is included in a vehicle, the first environmental information may be broadcast in response to an external request. For example, in a pollution control area, V2X road infrastructure may request passing vehicles to provide the first environmental information and the first environmental information may be broadcast in response to the request.

The message may include additional information. For example, the message may include location information and/or identifier information of the transmitter device. For example, where the transmitter device is included in a vehicle, the message may include safety critical or operational information, such as vehicle speed, vehicle location, vehicle acceleration, vehicle heading and/or physical vehicle parameters. Such safety critical or operational information may, for example, support C-ITS applications, avoid vehicle collisions, improve transport efficiency and/or comfort and/or support cooperative driving (i.e. vehicle platooning). For example, the message may include atmospheric and/or weather related information, such as temperature, pressure, wind speed, wind direction, humidity or altitude. Additionally and/or alternatively, atmospheric and/or weather related information may be acquired from another provider, such as the Internet.

It should be understood that a typical communication range of DSRC depends on the application and/or the environment but may be up to 300 – 500 metres. In general, C-ITS applications may be designed to be technology agnostic and hence, the first environmental information may be transmitted via any supporting communication technology employed for V2X such as cellular Long Term Evolution (LTE) Device-to-Device and/or 5G.

The second aspect of the invention provides a receiver device comprising a receiver;
wherein the receiver device is arranged to control the receiver to receive first environmental information and second environmental information; and
wherein the receiver device is arranged to combine the first environmental information and the second environmental information.

In this way, environmental information from a plurality of sources, for example vehicles, may be combined by the receiver device. In this way, sensors for example pollution sensors may not be required by the receiving device since the first environmental information and the second environmental information is received by the receiver device, thereby reducing a cost and/or size of the receiving device. That is, environmental information may be received, for

example, in a location where no pollution measurement is available. In this way, pollution exposure control may be improved, for example for VRUs. In this way, environmental information may be monitored by the receiver device, for example, periodically or continuously since the environmental information may be received periodically or continuously from one or more transmitter devices, for example.

The first environmental information may be as described previously. The second environmental information may be similar to the first environmental information. That is, a content of the second environmental information may be as described previously with respect to the first environmental information. The receiver may receive a plurality of environmental information.

The receiver device may comprise a control unit. The receiver device may comprise a processor and a memory. The receiver device may comprise a storage. The receiver device may be communicatively coupleable to a remote storage.

The receiver device may combine the first environmental information and the second environmental information by mathematical processing such as arithmetic addition, averaging or weighted averaging. For example, levels of nitrogen oxides (NO_X) included in the first environmental information and the second environmental information may be summed.

It should be understood that the receiver device may support V2X communication, as described previously. For example, the receiver device may be suitable for or included in a vehicle, infrastructure or a VRU device. That is, the receiver device may be suitable for or included in or near a source of pollution to be monitored. In an example embodiment, the receiver device comprises a V2X device. In an example embodiment, the receiver device is a V2X device. In an example embodiment, the first environmental information and/or the second environmental information may be received as V2X communications.

The receiver device may be arranged to control the receiver to receive according to communication protocols used in C-ITS. In an example embodiment, the receiver device is arranged to control the receiver to receive according to a C-ITS communication protocol. The communication protocols may be modified to include the first environmental information and/or the second environmental information.

It should be understood that the receiver may be a wireless receiver. In an example embodiment, the receiver comprises a wireless receiver. In an example embodiment, the receiver is a wireless receiver. The first environmental information and/or the second environmental information may be received wirelessly. The first environmental information

and/or the second environmental information may be received using DSCR radio access technology, as described previously. The first environmental information and/or the second environmental information may be received as a message or as part of a message, such as an ETSI Cooperative Awareness Basic Service (EN 302 637-2) messages; SAE J2735 - Dedicated Short Range Communications (DSRC) Message Set Dictionary. In one example embodiment, the receiver device is arranged to control the receiver to receive a message, wherein the message comprises the first environmental information and/or the second environmental information.

In an example embodiment, the receiver device is arranged to determine, for example evaluate or estimate, a pollution exposure based on the combined first environmental information and second environmental information. The pollution exposure may be determined as described below.

The receiver device may be arranged to forward the determined pollution exposure, for example to a storage device and/or a remote server which may, for example, aggregate pollution exposures from different receiver devices in different locations or area.

In an example embodiment, the receiver device is arranged to initiate an action in response to the determined pollution exposure. For example, the receiver device may be arranged to initiate an action in response to the determined pollution exposure, if the determined pollution exposure is above an expected or normal or predetermined value. For example, the receiver device may be arranged to initiate an action such as a warning, a response or a notification. For example, where the receiver device is included in a VRU device, a warning may be displayed to a user about a level of negative health impact, for example low / medium / high compared with normal, such that the user may change route or location to reduce or minimise pollution exposure. For example, where the receiver device is included in a vehicle, a window of the vehicle may be closed, a cabin air recirculation system of the vehicle may be enabled, a motorbike helmet air filter may be enabled, and/or a preventive measure may be enabled to reduce or minimise pollution exposure. For example, where the receiver device is included in infrastructure such as V2I enabled traffic lights, the determined pollution exposure may be displayed to pedestrians.

In an example embodiment, the receiver device is arranged to determine the pollution exposure based on the combined first environmental information and second environmental information, according to a model, for example, a pollution dispersion model of the environment.

In an example embodiment, the receiver device is arranged to determine a distance from a pollution source, based on the first environmental information, the second environmental information and/or the combined first environmental information and second environmental information. For example, the receiver device may be arranged to determine the distance from a pollution source, for example a vehicle, according to information included in or with the first environmental information and/or the second environmental information. For example, the first environmental information and/or the second environmental information may be included in a message or messages received from one or more transmitter devices, as described above, and the message or the messages may include safety critical or operational information, such as vehicle speed, vehicle location (e.g. based on GPS coordinates), vehicle acceleration, vehicle heading and/or physical vehicle parameters. The receiver device may be arranged to estimate, calculate or compute a distance from the pollution source, based on this information, for example vehicle location. The receiver device may be arranged to estimate, calculate or compute the distance from the pollution source, based on speed, location (e.g. based on GPS coordinates), acceleration, heading and/or vehicle parameters of the receiver device. In this way, a distance from the receiver device to the pollution source may be determined. The determined distance may be used to model a pollution dispersion between the pollution source and the receiver device and/or another pollution exposure location. Additionally and/or alternatively, the distance may be determined by deriving a physical distance according to a radio path loss model based on a transmit power and a receive power. For example, the transmit power may be included in the message received by the receiver device and/or the receiver device may be arranged to obtain the receive power.

Pollution dispersion in the environment may be modelled mathematically and may consider, for example, gases such as carbon dioxide (CO_2), hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NO_X), sulphur dioxide (SO_2), particulate matter (PM), and noise. For example, vehicle generated gases such as carbon dioxide (CO_2) and nitrogen oxides (NO_X), may be considered more critical in terms of negative impact on human health, and the pollution exposure may be modelled by the receiver device according to a Gaussian air pollutant dispersion equation, such as described by:
https://en.m.wikipedia.org/wiki/Atmospheric_dispersion_modeling#Gaussian_air_pollutant_dispersion_equation.
Additionally and/or alternatively, the pollution exposure may be modelled by the receiver device according to a simplified Gaussian air pollutant dispersion equation, as described below. Additionally and/or alternatively, the pollution exposure may be modelled by the receiver device according to model adopted to support V2X C-ITS applications. Additionally, for other types of pollution such as particulate matter (PM) or noise, the receiver device may model dispersion of such other types of pollution according to other dispersion models. For example, the dispersion modelling may be based on a simple approach, for example assuming

uniform pollutant distribution in a predefined vicinity of a vehicle and using, for example, an average value of pollution in an area. Alternatively, the dispersion modelling may be based on a more sophisticated methods, as detailed below. For example, a pollution level estimation model and/or measurement unit may correspond with current regulatory limit values. For example, in EU First Daughter Directive 2010 (99/30/EC), the limit for nitrogen dioxide is defined as '200 µg m-3 with no more than 18 exceedences per year'.

In this way, environmental information from a plurality of sources, for example vehicles, may be combined by the receiver device and a pollution exposure at the receiver device and/or at another pollution exposure location may be determined, for example by modelling of pollution dispersion in the environment using distances between the sources and the receiver device.

The third aspect of the invention provides a transceiver device comprising a transmitter and a receiver;

wherein the transceiver device is arranged to obtain first environmental information;

wherein the transceiver device is arranged to control the receiver to receive second environmental information; and

wherein the transceiver device is arranged to combine the first environmental information and the second environmental information.

In this way, the first environmental information obtained by the transceiver device may be combined by the transceiver device with the received second environmental information.

The first environmental information and the second environmental information may be as described previously. The transceiver device may be arranged as described previously with respect to the transmitter device and/or the receiver device.

In an example embodiment, the transceiver device is arranged to obtain the first environmental information by controlling the receiver to receive the first environmental information. In an example embodiment, the transceiver device is arranged to control the transmitter to transmit the first environmental information. For example, the transceiver device may be arranged to transmit the first environmental information as described previously with respect to the transmitter device. For example, the transceiver device may forward the first environmental information. For example, the transceiver device may receive the first environmental information and the second environmental information and transmit the first environmental information and/or the second environmental information. In this way, the first environmental information and/or the second environmental information may be shared by the transceiver device.

The fourth aspect of the invention provides a method of transmitting information, the method comprising:

obtaining first environmental information; and

transmitting the first environmental information.

The first environmental information may be as described previously.

The step of obtaining the first environmental information may comprise obtaining the first environmental information from a sensor, as described previously. Additionally and/or alternatively, the step of obtaining the first environmental information may comprise obtaining information from a vehicle ISO Controller Area Network (CAN) bus or On-board diagnostics (OBD) port of a vehicle.

The step of transmitting the first environmental information may comprise transmitting the first environmental information as a V2X communication. The step of transmitting the first environmental information may comprise transmitting the first environmental information according to communication protocols used in C-ITS. The step of transmitting the first environmental information may comprise wirelessly transmitting the first environmental information, for example using Dedicated Short Range Communication (DSCR) radio access technology, for example based on ETSI ITS-G5 or IEEE 802.11p standards. The first environmental information may be broadcast as a message or as part of a message, such as an ETSI Cooperative Awareness Message or a SAE Basic Safety Message. The first environmental information may be broadcast periodically. A periodicity of broadcasting and/or content, for example type or breadth, of the first environmental information may be as described previously.

The fifth aspect of the invention provides a method of receiving information, the method comprising:

receiving first environmental information and second environmental information; and

combining the first environmental information and the second environmental information.

The first environmental information may be as described previously. The second environmental information may be similar to the first environmental information. That is, a content of the second environmental information may be as described previously with respect to the first environmental information.

The step of receiving the first environmental information and the second environmental information may comprise wirelessly receiving the first environmental information and/or the second environmental information, for example, using DSCR radio access technology, as

described previously. The step of receiving the first environmental information and the second environmental information may comprise receiving the first environmental information and/or the second environmental information according to communication protocols used in C-ITS. The step of receiving the first environmental information and the second environmental information may comprise receiving the first environmental information and/or the second environmental information asa message or as part of a message, such as an ETSI Cooperative Awareness Message or a SAE Basic Safety Message.

The step of combining the first environmental information and the second environmental information may comprise mathematical processing, as described previously.

In an example embodiment, the method includes determining, for example evaluating or estimating, a pollution exposure based on the combined first environmental information and second environmental information. In an example embodiment, the method includes determining the pollution exposure, based on the combined first environmental information and second environmental information, according to a model, for example, a pollution dispersion model of the environment. The pollution exposure may be determined as described below. In an example embodiment, the method includes forwarding the determined pollution exposure, for example to a storage device and/or a remote server which may, for example, aggregate pollution exposures from different receiver devices in different locations or area. In an example embodiment, the method includes initiating an action in response to the determined pollution exposure, for example if the determined pollution exposure is above an expected or normal or predetermined value, as described previously. In an example embodiment, the method includes determining a distance from a pollution source, based on the first environmental information, the second environmental information and/or the combined first environmental information and second environmental information, as described previously.

The sixth aspect of the invention provides a method of transceiving information, the method comprising:

obtaining first environmental information;

receiving second environmental information; and

combining the first environmental information and the second environmental information.

The steps of obtaining first environmental information, receiving second environmental information and/or combining the first environmental information and the second environmental information may be as described previously.

The seventh aspect of the invention provides a network comprising a transmitter device and a receiver device.

The transmitter device and/or the receiver device may be as described previously.

In an example embodiment, the network comprises a plurality of transmitter devices. In an example embodiment, the network comprises a plurality of receiver devices. In an example embodiment, the network comprises a plurality of transmitter devices and a plurality of receiver devices.

The eighth aspect of the invention provides a receiver device comprising a receiver;
wherein the receiver device is arranged to control the receiver to receive first environmental information; and
wherein the receiver device is arranged to determine a pollution exposure based on the first environmental information.

The receiver device may be as described previously with respect to receiving the first environmental information and/or to determine the pollution exposure based on the first environmental information.

The ninth aspect of the invention provides a method of receiving information, the method comprising:
receiving first environmental information; and
determining a pollution exposure based on the first environmental information.

The steps of receiving first environmental information and/or determining a pollution exposure based on the first environmental information may be as described previously.

Brief description of the drawings

For a better understanding of the invention, and to show how exemplary embodiments of the same may be brought into effect, reference will be made, by way of example only, to the accompanying diagrammatic Figures, in which:

Figure 1 schematically depicts a transmitter device according to an exemplary embodiment of the invention;

Figure 2 schematically depicts a receiver device according to an exemplary embodiment of the invention;

Figure 3 schematically depicts a transceiver device according to an exemplary embodiment of the invention;

Figure 4 schematically depicts a method of transmitting information according to an exemplary embodiment of the invention;

Figure 5 schematically depicts a method of receiving information according to an exemplary embodiment of the invention;

Figure 6 schematically depicts a method of transceiving information according to an exemplary embodiment of the invention;

Figure 7 schematically depicts a network according to an exemplary embodiment of the invention;

Figure 8 schematically depicts a network according to another exemplary embodiment of the invention, in use; and

Figure 9 schematically depicts a method of modelling a pollution exposure by the receiver device of Figure 2.

Detailed Description of the Drawings

Figure 1 schematically depicts a transmitter device 10 according to an exemplary embodiment of the invention. The transmitter device 10 comprises a transmitter 11. The transmitter device 10 is arranged to obtain first environmental information. The transmitter device 10 is arranged to control the transmitter 11 to transmit the first environmental information. In this exemplary embodiment, the transmitter device 10 is included in a vehicle (not shown). In this way, the first environmental information may be shared by the transmitter device 10 as described above, for example, for vehicle pollution crowdsourcing.

In detail, the first environmental information includes pollution information, for example atmospheric or air pollution information related to gaseous and/or particulate matter and/or noise levels, including one or more of carbon dioxide (CO_2), hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM), nitrogen oxides (NO_X), sulphur dioxide (SO_2), or noise, as described previously. The first environmental information includes levels of these pollutants, as described previously.

The transmitter device 10 supports V2X communication for vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-pedestrian (V2P) communication. For example, the transmitter device may be included in a vehicle, infrastructure or a VRU device, as described previously. The transmitter device 10 controls the transmitter 11 to transmit according to communication protocols used in C-ITS, in which the communication protocols are modified to include the first environmental information. The transmitter 11 is a wireless transmitter using Dedicated Short Range Communication (DSCR) radio access technology, based on ETSI ITS-G5 or IEEE 802.11p standards.

The transmitter device 10 obtains the first environmental information from a sensor (not shown), for example, a carbon dioxide (CO_2) sensor, a hydrocarbons (HC) sensor, a carbon monoxide (CO) sensor, a particulate matter (PM) sensor, a nitrogen oxides (NO_X) sensor, a sulphur dioxide (SO_2) sensor, or a noise sensor. The transmitter device 10 obtains the first environmental information indirectly from the sensor. Particularly, the transmitter device 10 is communicatively coupled to an On-board diagnostics (OBD) port of the vehicle and the transmitter device 10 is arranged to read sensor values via the OBD port.

The first environmental information is broadcast by the transmitter device 10 as part of an ETSI Cooperative Awareness Message. The transmitter device 10 is arranged to control the transmitter 11 to periodically transmit the message. Additionally, the transmitter device 10 is arranged to control the transmitter 11 to transmit the message in response to a request to transmit the message.

The periodicity of broadcasting the first environmental information is to be determined by at least one of the vehicle speed, proximity of other vehicles and/or road users, vehicle location, environment type, priority or request. The transmitter device 10 is arranged to transmit the first environmental information below a predetermined speed of the vehicle. The transmitter device 10 is arranged to transmit the first environmental information if other vehicles and/or road users determined to be in the proximity of the vehicle. The transmitter device 10 is arranged to transmit the first environmental information if a vehicle V2X modem of the vehicle receives V2X signals from other neighbouring vehicles or similar information from other on-board sensors, for example RADAR, LIDAR or camera. The transmitter device 10 is arranged to transmit the first environmental information according to a map based location and/or type of environment of the vehicle. The transmitter device 10 is arranged to transmit the first environmental information according to a C-ITS application priority, such that a priority of the first environmental information may be reduced relative, for example, to information related to road traffic and/or safety related. The transmitter device 10 is arranged to transmit the first environmental information in response to an external request. For example, in a pollution control area, V2X road infrastructure may request passing vehicles to provide the first

environmental information and the first environmental information may be broadcast in response to the request.

The message transmitted by the transmitter device 10 includes additional information, including location information and/or identifier information of the transmitter device 10. In addition, the message includes safety critical or operational information, such as vehicle speed, vehicle location, vehicle acceleration, vehicle heading and/or physical vehicle parameters.

Figure 2 schematically depicts a receiver device 20 according to an exemplary embodiment of the invention. The receiver device 20 comprises a receiver 21. The receiver device 20 is arranged to control the receiver 21 to receive first environmental information and second environmental information. The receiver device 20 is arranged to combine the first environmental information and the second environmental information. In this exemplary embodiment, the receiver device 20 is included in a VRU device (not shown). In this way, the first environmental information and the second environmental information may be combined by the receiver device 20, as described above. In this way, environmental information from a plurality of sources, for example vehicles, may be combined by the receiver device 20. In this way, sensors for example pollution sensors may not be required by the receiving device 20 since the first environmental information and the second environmental information is received by the receiver device 20, thereby reducing a cost and/or size of the receiving device 20. In this way, pollution exposure control may be improved, for example for VRUs.

The first environmental information is as described previously. The second environmental information is as described previously with respect to the first environmental information.

In detail, the receiver device 20 supports V2X communication, as described previously. The first environmental information and/or the second environmental information are received as V2X communications, according to communication protocols used in C-ITS in which the communication protocols are modified to include the first environmental information and/or the second environmental information.

The receiver device 20 also includes a control unit 22 (not shown).

The receiver 21 is a wireless receiver. The first environmental information and/or the second environmental information are received by the receiver device 20 using DSCR radio access technology, as described previously. The first environmental information and/or the second environmental information are received as part of an ETSI Cooperative Awareness Message.

The receiver device 20 combines the first environmental information and the second environmental information by mathematical processing the first environmental information and the second environmental information. For example, levels of nitrogen oxides (NO_X) included in the first environmental information and the second environmental information are summed by the receiver device 20.

The receiver device 20 is arranged to determine a pollution exposure based on the combined first environmental information and second environmental information. The pollution exposure is determined as described below with reference to Figures 9 – 11. The receiver device 20 is arranged to forward the determined pollution exposure, for example to a storage device and/or a remote server which may, for example, aggregate pollution exposures from different receiver devices in different locations or area. The receiver device 20 is arranged to initiate an action in response to the determined pollution exposure, for example if the determined pollution exposure is above an expected or normal or predetermined value provided from a storage. The receiver device 20 is arranged to trigger the VRU device to display a warning to a user about a level of negative health impact, for example low / medium / high compared with normal, such that the user may change route or location to reduce or minimise pollution exposure.

The receiver device 20 is arranged to determine a distance from a pollution source, based on the first environmental information, the second environmental information and/or the combined first environmental information and second environmental information. The receiver device 20 is arranged to determine the distance from the pollution source, for example a vehicle, according to information included in or with the first environmental information and/or the second environmental information. The receiver device 20 is arranged to calculate a distance from the pollution source, based on vehicle speed, vehicle location, vehicle acceleration, vehicle heading and/or physical vehicle parameters included in the received message. The receiver device 20 may be arranged to calculate a distance from the pollution source, based on speed, location, acceleration, heading and/or physical parameters related to the receiver device 20.

In this way, environmental information from a plurality of sources, for example vehicles, is combined by the receiver device 20 and a pollution exposure at the receiver device 20 and/or at another pollution exposure location may be determined, for example by modelling of pollution dispersion in the environment using distances between the sources and the receiver device 20.

Figure 3 schematically depicts a transceiver device 30 according to an exemplary embodiment of the invention. The transceiver device 30 comprises a transmitter 11 and a receiver 21. The

transceiver device 30 is arranged to obtain first environmental information, as described previously with respect to the transmitter device 10. The transceiver device 30 is arranged to control the receiver 21 to receive second environmental information, as described previously with respect to the receiver device 20. The transceiver device 30 is arranged to combine the first environmental information and the second environmental information, as described previously with respect to the receiver device 20.

In detail, the first environmental information and the second environmental information are as described previously. The transceiver device 30 is arranged as described previously with respect to the transmitter device 10 and the receiver device 20. In this exemplary embodiment, the transceiver device 30 is included in a vehicle (not shown). In this way, the first environmental information obtained by the transceiver device 30 may be combined by the transceiver device 30 with the received second environmental information.

The transceiver device 30 is arranged to obtain the first environmental information by controlling the receiver 21 to receive the first environmental information. The transceiver device 30 is arranged to control the transmitter 11 to transmit the first environmental information. In this way, the first environmental information and the second environmental information may be shared by the transceiver device 30. In this way, the first environmental information and the second environmental information may be shared by the transceiver device 30 as described above, for example, for vehicle pollution crowdsourcing.

Figure 4 schematically depicts a method of transmitting information according to an exemplary embodiment of the invention.

In detail, at step S41, first environmental information is obtained, as described previously. At step S42, the first environmental information is transmitted, as described previously.

In this way, the first environmental information may be shared. In this way, vehicle pollution crowdsourcing may be implemented, in which, for example, coordinated utilization of multiple vehicle emission measurements may be shared within a geographic area to obtain reliable estimations of air pollutant concentrations at locations where direct measurement is not available. In addition, these measurements and/or estimations may be utilized to provide action triggers, for example, to relevant applications used by Cooperative Intelligent Transport Systems (C-ITS) ecosystem users such as V2X enabled devices used by vehicles, infrastructure and/or VRUs, in order to monitor, control, reduce and/or minimize human pollution exposure.

Figure 5 schematically depicts a method of receiving information according to an exemplary embodiment of the invention.

In detail, at step S51, first environmental information and second environmental information is received, as described previously. At step S52, the first environmental information and the second environmental information are combined, as described previously.

In this way, environmental information from a plurality of sources, for example vehicles, may be combined. In this way, pollution exposure control may be improved, for example for VRUs.

Figure 6 schematically depicts a method of transceiving information according to an exemplary embodiment of the invention.

In detail, at step S61, first environmental information is obtained, as described previously. At step S62, second environmental information is received, as described previously. At step S63, the first environmental information and the second environmental information are combined, as described previously.

In this way, the first environmental information obtained by the transceiver device may be combined by the transceiver device with the received second environmental information. In this way, vehicle pollution crowdsourcing may be implemented.

Figure 7 schematically depicts a network 70 comprising the transmitter device 10 of Figure 1 and the receiver device 20 of Figure 2 according to an exemplary embodiment of the invention.

In detail, the transmitter device 10 is included in a vehicle and the receiver device 20 is included in a VRU device. The transmitter device 10 is arranged to read first environmental information 72 from an internal system of the vehicle via the OBD port, as described previously. The transmitter device 10 is arranged to periodically transmit the first environmental information, together with vehicle speed, location and heading information. The receiver device 20 is arranged to receive the first environmental information, transmitted by the transmitter device 10, together with the vehicle speed, location and heading information. The receiver device 20 is arranged to determine a distance between from the receiver device 20 to the transmitter device 10. The receiver device 20 is arranged to determine a pollution exposure based on the first environmental information. The receiver device 20 is arranged to compare the determined pollution exposure with a normal or expected value. The receiver device 20 is arranged to trigger an action based on the comparison, so as to reduce a negative health impact to the VRU.

Figure 8 schematically depicts the network of Figure 7, in use.

In detail, the transmitter device 10 obtains first environmental information from a vehicle system 81 at step S81 via an interface such as an OBD port. At step S82, the transmitter device 10 transmits the first environmental information via DSRC or cellular communications as a V2X broadcast message, together with vehicle speed, location and heading information. The receiver device 20 receives the V2X broadcast message comprising the first environmental information, together with the vehicle speed, location and heading information. At step S83, the first environmental information is stored locally and/or remotely in storage 82. At step S84, the first environmental information, together with the vehicle speed, location and heading information, is used by a control unit 22 (which may be a part of the receiver device 20) to determine a pollution exposure. The control unit 22 may obtain additional parameters such as current location, wind speed and heading at S87, for use in determining the pollution exposure. The control unit 22 may compare the determined pollution exposure with a predefined value, such as a value provided from the storage 82 at step S86. Alternatively, the control unit 22 may determine a total pollution exposure using pollution level(s), distance(s) from pollution sources and the additional parameters. Vehicle location information is stored in the storage 82 at step S87. At step S88, a pollution avoidance action such as a warning is communicated to a user 84.

Figure 9 schematically depicts a method of modelling a pollution exposure by the receiver device 20 of Figure 2.

As described previously, pollution dispersion in the environment may be modelled mathematically and may consider, for example, gases such as carbon dioxide (CO_2), hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NO_X), sulphur dioxide (SO_2), particulate matter (PM), and noise. The pollution exposure may be modelled by the receiver device 20 according to a Gaussian air pollutant dispersion equation, as described previously. In this exemplary embodiment, the pollution exposure is modelled by the receiver device 20 according to a simplified Gaussian air pollutant dispersion equation, as shown in Figure 9, according to:

http://www.ajdesigner.com/phpdispersion/point_space_equation.php#ajscroll.

Such a model is shown schematically, for example, in:

https://en.wikipedia.org/wiki/Fundamentals_of_Stack_Gas_Dispersion.

In detail, the equation presented in Figure 9 is solved for unknown (x) to calculate a contaminant concentration at ground level along a plume centerline when an emission source is at ground level, may be determined, for example, according to:

http://www.ajdesigner.com/phpdispersion/emission_source_ground_equation.php.

There are many dispersion models available for calculating the atmospheric pollution dispersion. The major parameters (but not limited to) used in these models are

Pollution rate emission rate (Q)
Average wind speed (u)
Y direction plum standard deviation (σy)
Z direction plum standard deviation (σz)
Y position y
Z position z
Effective stack height H in a buoyant Gaussian air pollutant dispersion plume.

For example, a contaminant concentration $C(x, 0,0)$ at ground level along the plume centerline when an emission source is at ground level may be given by:

$$C(x, 0,0) = \frac{Q}{\pi u \sigma_y \sigma_z}$$

In this equation, the receiver device 20 derives the following parameters from:

Pollution emission rate Q [g/s] – value periodically received from the transmitter device 20;
Average wind speed u [m/s] – computed from adding polluting vehicle speed vector (speed and heading info), vehicle exhaust speed (could be vehicle specific and either transmitted as part of V2X messages or for simplicity some typical default value could be used) and natural atmospheric wind vector (if needed); and
Y, Z directions plume standard deviation $\sigma_y \sigma_z$ [m] - may be vehicle specific and either transmitted as part of V2X messages or for simplicity some typical default value could be used.

While a dispersion model has been described, it will be appreciated that any dispersion model for stationary sources, for example stationary point sources, or non-stationary sources, for example non-stationary point sources, may be employed.

Although a preferred embodiment has been shown and described, it will be appreciated by those skilled in the art that various changes and modifications might be made without departing from the scope of the invention, as defined in the appended claims and as described above.

In summary, the invention provides a transmitter device and a receiver device. The transmitter device is arranged to obtain and transmit environmental information. The receiver device is

arranged to receive environmental information, from one or more transmitter devices. The receiver device is arranged to combine the received environmental information and may be arranged to determine a pollution exposure based on the combined environmental information. In this way, an action may be taken in response to the determined pollution exposure to reduce health risks, for example.

In other words, the invention provides for sharing of environmental information, such as pollution information, between devices, such as transmitter, receiver and/or transceiver devices. In addition, the shared environmental information may be combined, for example by receiver and/or transceiver devices, allowing pollution exposures to be determined. In this way, actions may be taken according to the determined pollution exposures, for example, for VRUs. In this way, the shared environmental information, depending on the application context, may be used to trigger corresponding high pollution avoidance actions aimed at reducing the negative human exposure level. In this way, new types of C-ITS applications related to VRUs, Smart Cities, Smart Mobility, mHealth, or Internet of Things may be supported, in which detailed local pollution information control or management may be required to improve transport user experience and protect health. In this way, large-scale pollution estimation in, for example, Smart Cities may be achieved and/or pollution levels may be monitored by geographic areas and/or appropriate pollution reduction mechanism triggered.

Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. A network comprising a first V2X device comprising a transmitter and a second V2X device comprising a receiver;

wherein the first V2X device is arranged to obtain first environmental information from a vehicle Engine Control Unit (ECU), ISO Controller Area Network (CAN) bus or On-board diagnostics (OBD) port of a vehicle;

wherein the second V2X device is arranged to request the first environmental information from the first V2X device;

wherein the first V2X device is arranged to control the transmitter to broadcast the first environmental information in response to the request from the second V2X device;

wherein the second V2X device is arranged to control the receiver to receive the first environmental information;

wherein the second V2X device is arranged to determine a distance from a pollution source according to information included in or with the first environmental information;

wherein the second V2X device is arranged to use the determined distance to model a pollution dispersion between the pollution source and the second V2X device;

wherein the second V2X device is arranged to control the receiver to receive second environmental information;

wherein the second V2X device is arranged to combine the first environmental information and the second environmental information;

wherein the second V2X device is arranged to determine a pollution exposure based on the combined first environmental information and second environmental information; and

wherein the second V2X device is arranged to initiate an action in response to the determined pollution exposure.

2. The network according to claim 1, wherein the first V2X device is arranged to control the transmitter to broadcast the first environmental information according to a broadcast protocol modified to include the first environmental information and wherein the second V2X device is arranged to control the receiver to receive according to the broadcast protocol modified to include the first environmental information.

3. The network according to any of claims 1 to 2, wherein the first environmental information comprises information related to one or more selected from a list consisting of: carbon dioxide (CO_2), hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM), nitrogen oxides (NO_X), sulphur dioxide (SO_2), volatile organic compounds (VOCs), ozone and noise.

4. The network according to any of claims 1 to 3, wherein the action is a warning, a response or a notification.

5. The network according to claim 4, wherein when the second V2X device is included in a VRU device, the second V2X device is arranged to: display the warning to a user about a level of negative health impact.

6. The network according to claim 4, wherein when the second V2X device is included in a vehicle, the second V2X device is arranged to: close a window of the vehicle, enable a cabin air recirculation system of the vehicle, enable a motorbike helmet air filter, and/or enable a preventive measure to reduce or minimise pollution exposure.

7. The network according to claim 4, wherein when the second V2X device is included in infrastructure, the second V2X device is arranged to: display the determined pollution exposure to pedestrians.

8. The network according to any of claims 1 to 7, wherein the network comprises a plurality of first V2X devices and/or a plurality of second V2X devices.

9. A method of transceiving information in a network comprising a first V2X device comprising a transmitter and a second V2X device comprising a receiver, the method comprising:

obtaining, by the first V2X device, first environmental information from a vehicle Engine Control Unit (ECU), ISO Controller Area Network (CAN) bus or On-board diagnostics (OBD) port of a vehicle;

requesting, by the second V2X device, the first environmental information from a first V2X device comprising a transmitter;

broadcasting, by the first V2X device, the first environmental information in response to the request from the second V2X device;

receiving, by the second V2X device, the first environmental information, broadcast by the first V2X device in response to the request;

determining, by the second V2X device, a distance from a pollution source according to information included in or with the first environmental information;

using, by the second V2X device, the determined distance to model a pollution dispersion between the pollution source and the device;

receiving, by the second V2X device, second environmental information;

combining, by the second V2X device, the first environmental information and the second environmental information; and

determining, by the second V2X device, a pollution exposure based on the combined first environmental information and second environmental information; and

initiating, by the second V2X device, an action in response to the determined pollution exposure.

10. The method according to claim 9, wherein transmitting, by the first V2X device, the first environmental information comprises broadcasting the first environmental information according to a broadcast protocol modified to include the first environmental information and wherein receiving, by the second V2X device, the first environmental information is according to the broadcast protocol modified to include the first environmental information.

11. The method according to any of claims 9 or 10, wherein the first environmental information comprises information related to one or more selected from a list consisting of: carbon dioxide (CO_2), hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM), nitrogen oxides (NO_X), sulphur dioxide (SO_2), volatile organic compounds (VOCs), ozone and noise.

12. The method according to any of claims 9 to 11, wherein the action is a warning, a response or a notification.

13. The method according to claim 12, wherein when the second V2X device is included in a VRU device, the method comprises displaying, by the second V2X device, the warning to a user about a level of negative health impact.

14. The method according to claim 12, wherein when the second V2X device is included in a vehicle, the method comprises closing, by the second V2X device, a window of the vehicle, enabling, by the second V2X device, a cabin air recirculation system of the vehicle, enabling, by the second V2X device, a motorbike helmet air filter, and/or enabling, by the second V2X device, a preventive measure to reduce or minimise pollution exposure.

15. The network according to claim 12, wherein when the second V2X device is included in infrastructure, the method comprises displaying, by the second V2X device, the determined pollution exposure to pedestrians.

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