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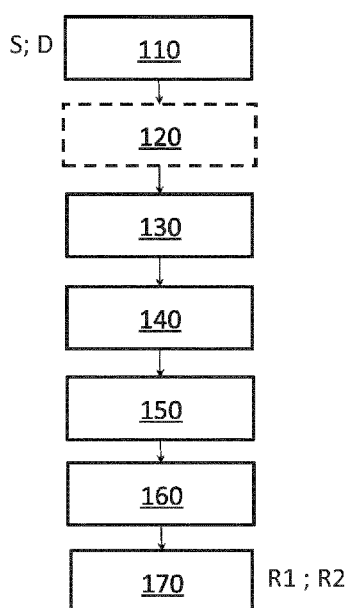
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(54) Title: A COMPUTER-IMPLEMENTED METHOD AND A SYSTEM FOR DETERMINING A ROUTE

Fig.1



(57) Abstract: A computer-implemented method for determining a route, in particular for a vehicle, comprising: obtaining navigation data, a starting point S and a destination point D and determining (110) a plurality of routes between the starting point S and the destination D; obtaining (130) air pollution forecast data for the plurality of routes; obtaining (140) user preference information; determining (150) route score, based on user preference information, for each of the plurality of routes without taking into account the air pollution forecast data, so that a first group of routes is obtained; determining (160) route score, based on user preference information, for each of the plurality of routes with taking into account the air pollution forecast data, so that a second group of routes is obtained; outputting (170) a first route candidate R1 and a second route candidate R2, wherein the first route candidate R1 is the candidate with optimal route score from the first group of routes and the second route candidate R2 is the candidate with optimal route score from the second group of routes. The invention also relates to an associated system for determining a route.

A COMPUTER-IMPLEMENTED METHOD AND A SYSTEM FOR DETERMINING A ROUTE

FIELD OF THE INVENTION

The invention relates to determination of a route. In particular, it relates to determination of a plurality of routes in an environment subject to air pollution. The invention also relates to an associated system for determining a route and computer readable storage medium storing a program of instructions executable by a machine to perform the method.

BACKGROUND OF THE INVENTION

Air pollution is a serious concern for people because of its harmful effects to health – both in physical and psychological sense. Passengers travelling in vehicles are especially at risk, as the vehicles are part of traffic existing in urbanized areas, which tend to have higher concentration of air pollution and higher levels of pollutant gases and particles. Naturally, people commuting on foot, on bicycles or motorcycles are also or even more concerned.

Pollution levels are monitored by government agencies and private entities. The measurements are often provided in form of so called pollution maps. For example, a layer of visually represented information is added to a classic map, so that pollution concentration within a specific area or region can be determined and evaluated. Such maps usually have a set time-resolution, which means that the information is updated for example once an hour or once a day. Pollution map data is obtained for example by measuring pollution with a number of measuring stations or pollution measurement devices of a fixed position.

A typical navigation system, for example vehicle navigation system, is configured to propose one or more route candidates between a starting point and selected destination point. The routes are usually ranked based on several criteria, inter alia distance, time or cost.

SUMMARY OF THE INVENTION

The object of the invention is, among others, a computer-implemented method for determining a route, in particular for a vehicle, comprising: acquiring or obtaining

navigation data, a starting point and a destination point and determining a plurality of routes between the starting point and the destination; acquiring or obtaining air pollution forecast data for the plurality of routes; acquiring or obtaining user preference information; determining route score, based on user preference information, for each of the plurality of routes without taking into account the air pollution forecast data, so that a first group of routes is obtained; determining route score, based on user preference information, for each of the plurality of routes with taking into account the air pollution forecast data, so that a second group of routes is obtained; outputting a first route candidate and a second route candidate, wherein the first route candidate is the candidate with optimal route score from the first group of routes and the second route candidate is the candidate with optimal route score from the second group of routes.

The method may comprise obtaining weather forecast data for the plurality of routes. Determining route score, for each of the plurality of routes may be implemented based on user preference information, without taking into account the weather forecast data and determining route score, based on user preference information, for each of the plurality of routes may be implemented with taking into account the weather forecast data.

The method may further comprise one or more of the following features, taken separately or in combination.

The method can comprise a step of determining from navigation data the travelling time for each of the plurality of routes.

The step of acquiring or obtaining air pollution forecast data may include acquiring air quality indexes for the plurality of routes.

The method may comprise determining a first route score, based on user preference information, for each of the plurality of routes can be implemented without taking into account the air pollution forecast data including air quality indexes, so that a first ranked group of routes is obtained;

The method may comprise calculating exposure factor based on the average air quality index and the travelling time for each route of said first group of routes.

The method may comprise determining a second route score, based on user preference information, for each route of said first group of routes with taking into account the air pollution forecast data including air quality indexes and the calculated exposure factor, so that a second ranked group of routes is obtained.

- 5 The method may be implemented by a system including an on-board computer of the vehicle and/or an information system source of the vehicle and/or an entertainment system of the vehicle and/or a mobile terminal and/or a user interface and/or a navigation services provider and/or a data supplier and/or cloud computing services, said system including communication means, control means and output means.
- 10 Preferably, the steps of acquiring navigation data, a starting point and a destination point and determining a plurality of routes between the starting point and the destination are implemented by the communication means and control means of the system.

For acquiring navigation data, a starting point and a destination point and
15 determining a plurality of routes between the starting point and the destination point, by communication means and control means of the system, for example of a navigation module embedded in the vehicle such as the vehicle entertainment system, and/or through an application on the mobile terminal and/or of the navigation services provider, the method may comprise:

- 20 - setting a starting point and a destination point through a user interface embedded in the vehicle or through an application of the mobile terminal, and/or detecting the current position of the user or vehicle by the navigation module,
- transmitting the starting point and destination point to communication means, for instance of the navigation module,
- 25 - sending a request with communicating the starting point and destination point from the communication means of the navigation module to a navigation services provider for obtaining navigation data, and/or to the cloud or control means embedded in the vehicle, for example part of the on-board computer of the vehicle, for obtaining the plurality of routes,

- receiving by the communication means the navigation data from the navigation services provider and/or the plurality of routes determined by cloud computing services and/or by control means embedded in the vehicle.

5 Preferably, the step of acquiring air pollution forecast data including air quality indexes for the plurality of routes is implemented by the communication means of the system.

Preferably, the air pollution forecast data is at least partly obtained from a pollution map from a data supplier.

10 Preferably, the air pollution forecast data is at least partly obtained from the vehicle's onboard pollution sensors.

Preferably, the air pollution forecast data and/or weather forecast data is at least partly obtained from the vehicle's system information source comprising at least one from the group of: wipers speed, lighting operation, braking efficiency.

15 Preferably, the air pollution forecast data and/or weather forecast data is at least partly obtained from at least one from the group of: meteorological stations, pollution stations with a fixed location, a personal mobile pollution sensors (for instance pollution pods), other vehicles, a satellite, a weather map.

20 In one option, for acquiring air pollution forecast data including air quality indexes for the plurality of routes by communication means of the system, for example of the vehicle's on-board computer and/or of the data supplier of air pollution forecast data and/or from vehicle's onboard pollution sensors, the method may comprise:

25 - sending a request by the communication means for obtaining air pollution forecast data to a data supplier of air pollution forecast data with communicating a specified area and/or to pollution sensing means mounted on the vehicle for obtaining real-time pollution measurement data,

- receiving by the communication means air pollution forecast data from the data supplier and/or the real-time pollution measurement data from the sensing means,

- transmitting by the communication means the acquired air pollution forecast data and/or the real-time pollution measurement data to the control means.

Preferably, the step of acquiring user preference information is implemented by the communication means and/or control means of the system.

In one option, for acquiring user preference information by the communication means and control means of the system, for example of the vehicle's entertainment system or through an application on the mobile terminal, the method may comprise:

- receiving by the communication means and/or the control means, for example of the vehicle's entertainment system or through an application on the mobile terminal, the user preference information from input means, for instance a user interface part of the vehicle entertainment system or of the mobile terminal such as a touch screen,

- possibly transmitting by the communication means the preference information to the control means of the system, embedded in the vehicle, for example part of the on-board computer of the vehicle, or through the application of the smartphone or cloud computing services.

Preferably, the step of determining route score, in particular a first route score, based on user preference information, for each of the plurality of routes without taking into account the air pollution forecast data, is implemented by the communication means and control means of the system.

Preferably, the step of calculating exposure factor based on the average air quality index and the travelling time for each route of said first group of routes, is implemented by the control means of the system.

The method may comprise acquiring air quality indexes at several measuring points for each route, then calculating the average air quality index for each route.

Preferably, the step of determining route score, in particular a second route score, based on user preference information, for each route of said first group of routes with taking into account the air pollution forecast data and the calculated exposure factor, is implemented by the control means of the system.

Preferably, the step of selecting a first route candidate and a second route candidate is implemented by the control means of the system.

Preferably, the step of outputting a first route candidate and a second route candidate is implemented by output means. The output means may or may not be the same as input means.

Outputting a first route candidate and a second route candidate may be by displaying the first route candidate and a second route candidate on a user interface like a screen or a touch screen of a mobile terminal and/or of the vehicle's entertainment system. The output means may be a user interface like a screen or a touch screen of a mobile terminal and/or of the vehicle's entertainment system.

In one option, the exposure factor is calculated applying the formula (a): $E = AQI * dT$, with AQI being the average air quality index, dT being the traveling time in minutes.

The first route candidate with the optimal first route score may be the route candidate with the minimal traveling time or the minimal traveling distance or the minimal cost.

In one option, the second route candidate with optimal second route score is the candidate route with the minimal exposure factor from the second group of routes.

Preferably, the method comprises the step of calculating exposure time with average air quality index less than or equal to a first threshold for each of the first group of routes.

The step of determining a second route score for each of the first group of routes may be implemented with taking into account the exposure time with average air quality index less than or equal to the first threshold calculated, so that said second group of routes is obtained.

The first threshold is for instance 25.

The second route candidate with optimal second route score may be the candidate route with the longest exposure time with average air quality index less than or equal to the first threshold from said second group of routes.

The method may comprise calculating exposure time with average air quality index greater than a second threshold for each of the plurality of routes and/or calculating exposure time with average air quality index greater than the first threshold and less

than or equal to the second threshold for each of the plurality of routes. The second threshold is for instance 50 or 75.

The step of determining a second route score for each of said first group of routes may be implemented with taking into account the exposure time with average air quality index greater than the second threshold and/or the exposure time with average air quality index greater than the first threshold and less than or equal to the second threshold calculated, so that said second group of routes is obtained.

The second route candidate with optimal second route score may be the candidate route with no or the least exposure time with average air quality index greater than the second threshold.

Preferably, the step of calculating exposure factor is based on the average air quality index and the travelling time when a heating and/or ventilating and/or air conditioning installation of the vehicle operates in a fresh air mode for each of said first group of routes, applying the formula (b): $E_{FA} = AQI_{FA} * dT_{FA}$, with AQI_{FA} being the average air quality index when said installation operates in the fresh air mode, dT_{FA} being the traveling time when said installation operates in the fresh air mode in minutes.

In one option, the method may comprise a step of estimating the clogging level of a filter of a heating and/or ventilating and/or air conditioning installation of the vehicle.

The step of determining a second route score for each of said first group of routes may be implemented with taking into account the estimated filter clogging level.

In one option, said installation includes a recirculating flap mobile between an open position and a closed position to operate between a fresh air mode and a recirculating mode, and the method comprises, for estimating the filter clogging level, following steps of:

- acquiring vehicle's parameters, such as average air mass flow and recirculating time based on calculation or the average based on learning,
- acquiring filter parameters data, such as air filter efficiency,

- estimating closing or opening area of recirculating flap based on external pollution and internal carbon dioxide and humidity levels, if possible, otherwise on the average external pollution,

5 - acquiring pollution levels preferably when recirculating flap is open, i.e. while operating in fresh air mode,

- estimating weight of the filter using the obtained filter parameters data, the air pollution forecast data,

- matching the estimated weight with a predefined clogging level, and

- outputting the air filter clogging level estimation.

10 The second route candidate with optimal second route score may be the candidate route with the least filter clogging.

For example, the routes of said first group of routes can be sorted according to the efficiency of the filter and then according to the exposure factor, the exposure factor in fresh air mode, the exposure time with a low AQI, etc...

15 Preferably, the method is iterated based on elapsed time or based on a travelled distance.

Preferably, the method is iterated for each update of air pollution forecast data.

Preferably, the route score, in particular the first and/or second route score, is determined based on at least one criteria selected from the group: distance, duration,
20 cost.

Preferably, the route score for each route of the second group of routes, in particular the second route score, is calculated based on at least one criterion selected from the group: sun exposure, pollution level, allergen exposure, driving conditions.

Another object of the invention is a system comprising: communication means and/or
25 control means configured to obtain navigation data, starting point and destination point and plurality of routes between the starting point and destination point, air pollution forecast data for the plurality of routes, user preference information; determine route score, based on user preference information, for each of the plurality

of routes without taking into account the air pollution forecast data so that a first group of routes is obtained; and to determine route score, based on user preference information, for each of the plurality of routes with taking into account the air pollution forecast data so that a second group of routes is obtained; output means configured to output a first route candidate and a second route candidate, wherein the first route candidate is the candidate with optimal route score from the first group of routes and the second candidate is the candidate with optimal route score from the second group of routes.

The communication means and/or control means may also be configured to obtain weather forecast data for the plurality of routes, to determine route score, based on user preference information, for each of the plurality of routes without taking into account the weather forecast data and the air pollution forecast data so that a first group of routes is obtained; and to determine route score, based on user preference information, for each of the plurality of routes with taking into account the weather forecast data and the air pollution forecast data so that a second group of routes is obtained.

The communication means and/or control means may further be configured to implement one or more of the following features, taken separately or in combination:

determine the travelling time for each of the plurality of routes,

acquire air pollution forecast data including air quality indexes for the plurality of routes,

determine a first route score, based on user preference information, for each of the plurality of routes without taking into account the air pollution forecast data including air quality indexes so that a first ranked group of routes is obtained; and

calculate the average air quality index for each route of the first group of routes, and the exposure factor based on the average air quality index and the travelling time for each route of the first group of routes,

determine a second route score, based on user preference information, for each route of the first group of routes with taking into account the air pollution

forecast data including air quality indexes and the calculated exposure factor so that a second ranked group of routes is obtained,

select a first route candidate and a second route candidate, wherein the first route candidate is the candidate with optimal route score from said first group of routes and the second route candidate is the candidate with optimal route score from said second group of routes.

Preferably, the system further comprises pollution sensing means adapted to be mounted on a vehicle, configured to provide real-time pollution measurement data, indicative of pollution levels within the vehicle cabin and/or outside the vehicle's cabin, in its immediate vicinity.

Preferably, the communication means and/or control means are configured to obtain the air pollution forecast data and/or weather forecast data at least partly obtained from the vehicle's system information source comprising at least one from the group of: wipers speed, lighting operation, braking efficiency.

The system may include an on-board computer of the vehicle and/or an information system source of the vehicle and/or an entertainment system of the vehicle and/or a mobile terminal and/or a navigation services provider and/or a data supplier and/or cloud computing services.

Another object of the invention is a computer readable storage medium storing a program of instructions executable by a machine to perform a method as described above.

BRIEF DESCRIPTION OF DRAWINGS

Examples of the invention will be apparent from and described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows a flowchart presenting a first way of implementing the method according to the invention;

Fig. 2 shows an example of outputted route candidates;

Fig. 3 shows a flowchart presenting a second way of implementing the method according to the invention;

Fig. 4 shows a table of results of exposure factor during the raveling time for three example routes;

Fig. 5 shows a table of results of exposure time with a low air quality index and with a high air quality index for three example routes;

- 5 Fig. 6 shows a table of results of exposure factor in a fresh air mode of the vehicle for three example routes;

Fig. 7 schematically shows a graph of routes with segments of different pollution level and depending on whether the vehicle operates in a fresh air mode or a re-circulating air mode;

- 10 Fig. 8 is a table of results of air filter efficiency for the different segments of a first route among routes of Fig. 7;

Fig. 9 is a table of results of air filter efficiency for the different segments of a second route among routes of Fig. 7;

- 15 Fig. 10 is a table of results of air filter efficiency for the different segments of a third route among routes of Fig. 7;

Fig. 11 shows a schematic representation of a system according to invention.

DETAILED DESCRIPTION OF EMBODIMENTS

- The following embodiments are examples. Although the description refers to one or more embodiments, this does not necessarily mean that each reference relates to
20 the same embodiment, or that the features apply only to a single embodiment. Simple features of different embodiments may also be combined or interchanged to provide other embodiments.

- In the description, it is possible to index some elements, such as for example first element or second element. In this case, it is a simple indexing to differentiate and
25 name close but not identical elements. This indexing does not imply a priority of one element with respect to another and such denominations can be interchanged without departing from the scope of the present description. This indexing does not imply any order in time.

First example of the method

Fig. 1 shows a flowchart presenting a first way of implementing the method according to the invention.

Firstly, the method comprises determining 110 a plurality of routes between a starting point S and a destination D. For this purpose navigation data, starting point S and destination point D are obtained. The starting point S can be input manually by the user through user interface or can be obtained from the navigation data automatically, by known means. The user can set the destination point D using a navigation module embedded in the vehicle or through an application of a mobile terminal like a smartphone.

Next, the method can comprise acquiring or obtaining 120 weather forecast data for the plurality of routes.

The method also comprises acquiring or obtaining 130 air pollution forecast data for the plurality of routes.

The weather forecast data concerns most recent weather conditions and forecasted weather conditions. It can include temperature, barometric pressure, wind speed, sun exposure, humidity, visibility, time of sunrise and sunset, ultraviolet (UV) index etc. Information on current and forecasted weather conditions may be taken into account in view of its influence on safety and/or attractiveness to the user. Some weather conditions may imply worse driving conditions, which in turn imply worse safety.

The air pollution forecast data concerns most recent pollution levels and forecasted pollution levels. More precisely, outside pollution data, indicative of pollution level outside the vehicle's cabin, can be acquired. Preferably, it is at least partly acquired or obtained from a pollution map from a data supplier. Such pollution map data can comprise information on particulate matter levels, carbon monoxide, sulfur oxides, nitrogen oxides, ozone, spread over a defined geographical area. It is also envisaged that this pollution map data may be supplemented with information on pollens and allergens.

Additionally, the air pollution forecast data may be at least partly obtained from the vehicle's onboard pollution sensors. In particular, these sensors can output data

indicative of pollution levels outside the vehicle cabin, in the immediate vicinity of the vehicle. The data can be then used for real-time adjustment of the forecast, e.g. using machine learning models. The data obtained by measurements from the vehicle's onboard pollution sensors might also be sent to a cloud and then obtained
5 by other users.

In one option, the air pollution forecast data and/or weather forecast data is at least partly obtained from the vehicle's system information source.

In particular, the weather forecast data is at least partly obtained from the vehicle's system information source comprising at least one from the group of: wipers speed,
10 lighting operation, braking efficiency. In other words, the data is obtained in an indirect manner from the vehicle on-board information system. For example, a currently set wipers speed may be indicative of raining intensity. The set lightening parameters may be indicative of visibility in front of the vehicle. The measured braking efficiency may be indicative of road conditions, and for example be correlated
15 with rain, ground frost etc.

In one option, the air pollution forecast data and/or weather forecast data is at least partly obtained from at least one from the group of: meteorological stations, pollution stations with a fixed location, a personal mobile pollution sensors (pollution pods), other vehicles, a satellite, an open source pollution or weather maps.

20 In the next step, the method comprises obtaining 140 user preference information. The user preference information may relate for example to the distance, duration or a cost of the trip. These preferences may be grouped into a first group of preferences.

The user preference information may relate for example also to pollution levels and possibly weather. These preferences may be grouped into a second group of
25 preferences. In particular, the second group of preferences may relate to sun exposure, pollution level, allergen exposure, safety (driving conditions). For example, the user may input preference information indicating preference of a route with maximized sun exposure, with limited cloud coverage of the sky, with minimized pollution level. Alternatively, the user may input preference information indicating
30 preference of a route with good driving conditions and limited sun exposure.

It is also envisaged that a third group of preferences may be formed, which could relate to attractiveness of the route in view of preferred sport activities, points of interest exposure, nature/urban ratio exposure, type of terrain etc.

In the next step, the method comprises determining 150 route score, based on user preference information, for each of the plurality of routes without taking into account the weather forecast data if previously obtained and without taking into account the air pollution forecast data, so that a first group of routes is obtained. In other words, a first route score is determined for each of the plurality of routes only based on the first group of preferences. What follows is that, preferably, the route score is determined based on at least one criterion selected from the group: distance, duration, cost - in a known manner. The method may comprise a step of ranking the routes based on their determined route scores, so that the first group of routes is obtained.

The method may comprise calculating the travelling time for each route of the first group of routes.

In the next step, the method comprises determining 160 route score, based on user preference information, for each of the plurality of routes with taking into account the weather forecast data and the air pollution forecast data, so that a second group of routes is obtained. In other words, a second route score is determined for each of the plurality of routes based on the first group of preferences and the second group preferences. What follows is that, preferably, the route score is additionally determined based on at least one criterion selected from the group: sun exposure, pollution level, allergen exposure, safety (driving conditions). The method may comprise a step of ranking the routes based on their determined second route scores, so that the second group of routes is obtained.

The first group of routes is not necessarily all obtained before implementing the step 160 of determining the second route scores. The steps 150, 160 of determining route scores can be implemented at least partly at the same time.

Analogously, if a third group of preferences is present, the method can comprise determining route score for each of the plurality of routes based on the first group of

preferences, the second group preferences and the third group of preferences, so that a third group of routes is obtained.

In the next step, the method comprises selecting and outputting 170 a first route candidate R1 and a second route candidate R2, wherein the first route candidate R1 is the candidate with optimal route score from the first group of routes and the second route candidate R2 is the candidate with optimal route score from the second group of routes. The determination of the optimal candidate in both cases can be carried out by known optimal route determination algorithms. The optimal route score in both cases may be for example that which corresponds most closely to the selected preference information parameters. The second route candidate R2 in any case needs to take into account more parameters than the first route candidate R1. The first route candidate R1 and the second route candidate R2 may or may not be the same.

The outputting can be done through displaying on the user interface, such as a touch screen of the vehicle's on-board computer and/or of a portable communication device or mobile terminal as a smartphone.

Analogously, if a third group of preferences is present, the method can comprise selecting and outputting a third route candidate which is the candidate with optimal route score from third group of routes.

Preferably, part of the steps or all the steps can be iterated based on elapsed time or based on a travelled distance. Alternatively or additionally, the method can be iterated for each update of air pollution forecast data. The iterations are explained in relation to Fig. 2

The above-described method can be carried out by means of cloud computing. In particular, at least part of the steps can be carried out in the cloud, with transmitting the route candidates to the user.

Fig. 2 shows an example of outputted route candidates R1 and R2. A starting point S and a destination point D are obtained. In this case, the starting point S can be the current geographical position of the vehicle. A plurality of routes is available between the starting point S and the destination point D. It is shown in Fig. 2 that a first route candidate R1 and a second route candidate R2 are outputted. The first route

candidate R1 is shorter and could take less time to travel between starting S and destination D points. However, based on additional, second group of preferences, the second route candidate R2 is outputted together with the first route candidate R1. In this case, the second route candidate R2 is different from the first route candidate R1. The user can thus choose between the route candidates, while having more insight about the consequences of the choice. Alternatively, the second route candidate R2 and the first route candidate R1 can be the same.

In Fig. 2 the frequency of iterations of the method or its selected steps along the routes R1, R2 can be observed – the occurrences of iterations are visualised by means of update points Fp. When the vehicle reaches these points along the routes R1, R2, an iteration of the method or its selected steps takes place and the updated data is obtained. In particular, the updated pollution and/or weather forecast data can be obtained when the vehicle is at update points Fp to propose any new optimal route candidates, which take into account new information. The iteration, as explained above, can be based preferably on air pollution forecast data update rate. However, the distribution of update points Fp can be also based on elapsed time, e.g. once every minute for trips calculated for less than 1 hour and once every ten minutes for longer trips. The distribution of update points Fp can be also based on a travelled distance or traffic information update from the navigation service provider or other basis. For obtaining optimal second route candidate R2, the AQI value, a weather index or others can be calculated for each point, then combined together to form scores for each point and then the average score is calculated for each route. Next, the route with the best (e.g. highest) average is selected as the optimal second route candidate R2. In any case, the second route candidate R2 is a compromise between the best score and additional time with respect to the first route candidate R1. It is envisaged that the second route candidate is constrained to add for example 10% of travelling time for short trips which do not exceed 30 minutes, 5% for trips between 30min and 2h and then 2% for longer trips. In other words, the second route candidate R2 is constrained to a specific range of additional time with respect to the first route candidate R1.

Second example of the method

Fig. 3 shows a flowchart presenting a second way of implementing the method according to the invention. The differences with respect to the first way of implementing the method described above are specified hereafter.

Pollution data also relate to air quality indexes for the defined geographical area.

- 5 As described above, the first group of preferences may group the user preference information relating for example to the distance, duration or a cost of the trip.

The user preference information may relate for example also to pollution levels such as air quality indexes and possibly weather. These preferences may be grouped into the second group of preferences.

- 10 Alternatively or in addition to the examples regarded the second group of preferences previously given, the user may input preference information relating to the air quality index, such as preferences to avoid routes with a long exposure to high pollution levels, namely with high air quality index, for instance greater than 50 or 75, and/or to whether consider the average air quality index during the whole travelling time or
15 when operating in fresh air mode in the case of a vehicle comprising a heating and/or ventilating and/or air conditioning installation able to operate in a fresh air mode. Said installation generally includes a re-circulation flap also named recycling flap mobile between an open position and a closed position to operate between the fresh air mode and a re-circulating mode.

- 20 Alternatively or in addition, in order to prevent or limit exposure of vehicle passengers to polluted air, said installation generally comprises one or more filters for the air which is introduced into the cabin. The user may input preferences information about the efficiency of such air filter of said installation, for instance indicating preference of a route that limits the clogging of the air filter and/or degrades the least the air filter
25 performance.

It is also envisaged that a third group of preferences may be formed, which could relate to attractiveness of the route in view of preferred sport activities, points of interest exposure, nature/urban ratio exposure, type of terrain etc.

- In the step of determining 150, a first route score is determined, based on user
30 preference information, for each of the plurality of routes without taking into account

the weather forecast data if previously obtained and without taking into account the air pollution forecast data including the air quality indexes, so that a first group of routes is obtained. In other words, similarly to the first embodiment, a first route score is determined for each of the plurality of routes only based on the first group of preferences. The method may comprise a step of ranking the routes based on their determined first route scores, so that the first group of routes is obtained.

The next step of determining a second route score, is based on user preference information, for each route of the first group of routes with taking into account the air pollution forecast data, in particular the calculated exposure factor E ; E_{FA} , and possibly the weather forecast data, so that a second group of routes is obtained. In other words, a second route score is determined for each of the plurality of routes based on the first group of preferences and the second group preferences. The method may comprise a step of ranking the routes based on their determined second route scores, so that the second group of routes is obtained.

For obtaining the second route candidate R_2 , the air quality index, and possibly a weather index or others can be calculated for each measuring point, then combined together to form scores for each measuring point and then the average score is calculated for each route.

For that purpose, according to a preferred embodiment, the method comprises at least a step of calculating an exposure factor E ; E_{FA} based on the average air quality index and the travelling time dT ; dT_{FA} for each route of the first group of routes.

The exposure factor E may be calculated for the whole traveling time. As an alternative, for a vehicle comprising a heating and/or ventilating and/or air conditioning installation able to operate in a fresh air mode, the exposure factor E_{FA} may be calculated based on the average air quality index and the travelling time dT_{FA} when said installation operates in the fresh air mode for each route of the first group of routes.

What follows is that, preferably, the route score may be additionally determined based on at least one criterion selected from the group: sun exposure, pollution level, allergen exposure, safety (driving conditions).

In one option, the method further comprises a step of calculating 160b exposure time with air quality index less than or equal to a first threshold, for instance 25, for each route of the first group of routes. The first threshold can be predetermined, set by the user, or advised by world health organization.

- 5 The method can further comprise a step of calculating 160c exposure time with air quality index greater than a second threshold, for instance 50 or 75, for each route of the first group of routes. The second threshold can be predetermined, set by the user, or advised by world health organization. The second threshold can also be set depending on the sensitivity of the user and/or passengers in the vehicle.
- 10 The method can also comprise a step of calculating 160d exposure time with air quality index greater than the first threshold and less than or equal to the second threshold for each route of the first group of routes.

In another option, for said installation including an air filter, the method may comprise a step of estimating 160e the air filter clogging level for each route of the first group
15 of routes.

These embodiments relating to the steps 160a to 160e are described in more detail in the following description.

Thus, the step of determining 160 a second route score can be implemented with also taking into account the exposure time with average air quality index less than or
20 equal to the first threshold, and/or avoiding routes exposed to high air quality indexes, for instance greater than 50 or 75, and/or taking into account the clogging and the efficiency of the air filter of said installation. In other words, the step of determining 160 a second route score can be implemented using the information determined and collected after implementing one or more of the steps 160a to 160e.

25 Alternatively or additionally to steps 160a to 160e, the second route candidate R2 is a compromise between the best score and additional time with respect to the first route candidate R1. As previously described, it is envisaged that the second route candidate is constrained to add for example 10% of travelling time for short trips which do not exceed 30 minutes, 5% for trips between 30min and 2h and then 2% for
30 longer trips. In other words, the second route candidate R2 is constrained to a specific range of additional time with respect to the first route candidate R1.

Analogously, if a third group of preferences is present, the method can comprise determining a third route score for each route of the plurality of routes based on the first group of preferences, the second group preferences and the third group of preferences, so that a third group of routes is obtained.

- 5 The previous description of the step of selecting and outputting 170 a first route candidate R1 and a second route candidate R2 applies for the second way of implementing the method.

For instance, the first route candidate with the optimal first route score may be the route candidate with the minimal traveling time or the minimal traveling distance or
10 the minimal cost.

As non-limitative examples, the second route candidate with optimal second route score may be the candidate route from the second group of routes with the minimal exposure factor, or with the longest exposure time with average air quality index less than or equal to the first threshold, with no or the least exposure time with average air
15 quality index greater than the second threshold, or with the least filter clogging.

Analogously, if a third group of preferences is present, the method can comprise selecting and outputting a third route candidate which is the candidate with optimal route score from third group of routes.

The embodiments relating to the steps 160a to 160e are described hereafter in more
20 detail with reference to figures 4 to 10.

Fig. 4 shows a table of results illustrating a first embodiment according to which the exposure factor E is calculated for the whole traveling time, for each route of the first group of routes.

Three example routes Ra, Rb, Rc are given for illustration in a non-limited way.

- 25 For each route Ra, Rb, Rc, air quality indexes can be acquired at several measuring points, then the average air quality index is calculated for each route. The distance between the measuring points can be set depending on the type of road, for instance they can be close or more frequent in a more polluted area such as the city, while farther apart from each other in country side. As a simple example, the measuring

points can be every 3meters to 50meters in city or 10meters to 250-500meters in country or every minute.

The whole travelling time is obtained for each route, for example thanks to a navigation module.

5 In the example given, in a merely illustrative way:

- route Ra is exposed to an average air quality index AQI of 45 for instance, during a total traveling time dT of 60minutes,
- route Rb is exposed to an average air quality index AQI of 30 for instance, during a total traveling time dT of 80minutes,
- 10 - route Rc is exposed to an average air quality index AQI of 40 for instance, during a total traveling time dT of 70minutes.

Next, the exposure factor E is calculated for each route applying the formula (a):

(a) $E = AQI * dT$; with AQI being the average air quality index and dT being the traveling time in minutes.

15 As a result, the exposure factor E is 2700 for route Ra, 2400 for route Rb, 2800 for route Rc.

The second route candidate R2 may be the candidate with the minimal exposure factor E. The method thus comprises a step of comparing the calculated exposure factors E each other to determine the lowest. In this example merely illustrative, the
20 route Rb has the lowest exposure factor and can be determined as the second route candidate R2.

Alternatively, the exposure factor can be weighed by the additional time implied by the lower average air quality index. If the user has input preferences information not to exceed a certain threshold percentage of additional travelling time, for instance 5%
25 for trips between 30minutes and 2hours, then the method comprises a step of calculating the additional time compared to the first route candidate R1 and to compare with the threshold percentage.

In the example of Fig. 4, the cleanest route regarding the exposure factor E is route Rb, with additional 20minutes of traveling time, in case of a first route candidate R1

with an hour traveling time for example. The additional 20minutes exceed the 5% allowed in the user preferences for example.

The second route candidate R2 can be a compromise between the best score and additional time. In this case, route Ra is preferred even if the average air quality index is higher than the average air quality index of route Rb, because the route Rb has too long travelling time and the route Rc has the highest exposure factor.

Fig. 5 shows a table of results illustrating a second embodiment according to which the selection of the cleanest route is not just based on the average air quality index, but the exposure factor is weighed by air quality index levels.

For instance, the selection of the second route candidate as the clean route is also based on the exposure time $dT_{AQI \leq 25}$ and/or the number of measuring points with the air quality index below or equal to a first threshold, for instance 25. In other words, the second route candidate is the route candidate exposed the most of time to an air quality index below or equal to 25.

In the example of Fig. 5, in a merely illustrative way, routes Ra and Rb are exposed to an average air quality index AQI of 45 for instance during 60minutes, and route Rc is exposed to an average air quality index AQI of 39 for instance during 70minutes.

The exposure factor E is calculated for each route applying the formula (a) and is 2700 for routes Ra and Rb, and 2710 for route Rc.

The method can comprise a step of comparing the air quality indexes acquired at the different measuring points along each route to the first threshold. Next, the exposure time $dT_{AQI \leq 25}$ while the air quality index is less than or equal to a first threshold, for instance 25, can be calculated.

In the example of Fig. 5, the route Ra has an exposure time $dT_{AQI \leq 25}$ of 36minutes with the air quality index below or equal to the first threshold, the route Rb has no exposure time with the air quality index below or equal to the first threshold, and the route Rc has an exposure time $dT_{AQI \leq 25}$ of 17.5minutes with the air quality index below or equal to the first threshold.

The method can comprise a step of comparing the exposure time $dT_{AQI \leq 25}$ with the air quality index below or equal to the first threshold of each route, and then the

route with the longest exposure time $dT_AQI \leq 25$ with such a very good air quality index is selected as the clean route. In the example of Fig. 3, the route Ra exposed 36 minutes to an average air quality index below or equal to 25 is the second route candidate.

- 5 Alternatively or in addition, depending on the user profile and possibly depending on passengers in the vehicle, the user may input preferences information to avoid routes with air quality index above a second threshold, for instance 75 or 50 if there is at least one sensitive person inside the car, e.g. with asthma and/or allergens sensitivity.
- 10 The method can comprise a step of comparing the air quality indexes acquired at the different measuring points along each route to the second threshold. Next, the exposure time $dT_AQI > 50$ or the number of measuring points with air quality index greater than the second threshold, for instance 50, can be calculated.

15 In the example of Fig. 3, the route Ra has an exposure time $dT_AQI > 50$ of 24 minutes with the air quality index above the second threshold, the routes Rb and Rc have no exposure time $dT_AQI > 50$ with the air quality index above the second threshold.

The method can comprise a step of comparing the exposure time $dT_AQI > 50$ with the air quality index above the second threshold of each route, and then the route with a long exposure time $dT_AQI \leq 25$ with a very good air quality index and with a
20 limited exposure time $dT_AQI > 50$ with a bad air quality index is selected as the clean route. In the example of Fig. 5, the route Rc can be selected as the second route candidate R2, because the route Ra has the longest time with a bad air quality and the route Rb is not exposed to a good air quality.

25 In alternative or in addition, according to a third embodiment, the selection of the second route candidate or clean route can be based on what the user and possible passengers in the vehicle will actually breathe inside the vehicle's cabin. Indeed, the real exposition of the user and passengers of the vehicle depends on the pollution level that enters into the cabin of the vehicle, meaning while fresh air from outside circulates into the cabin, and not necessarily on the entire pollution level outside the
30 vehicle along the whole trip. Fig. 6 shows a table of results illustrating this third

embodiment according to which the selection of the clean route is based on the operation of said installation in a fresh air mode.

For that purpose, the method may comprise one or more steps for anticipating for each route of the first group of routes, where said installation will operate in a fresh
5 air mode, meaning with the recycling flap in the open position, along the trip.

Such anticipation or forecasting opening zones of the recycling flap into fresh air mode can be done by any known method.

According to one embodiment, for each route of the first group of routes, less polluted areas can be identified based on the pollution data acquired including the air
10 quality indexes, possibly combined with information from outside the vehicle or weather forecast data. In these identified areas, the re-circulation flap will be switched in the open position for operating in the fresh air mode.

Otherwise, in case the air quality inside the vehicle cabin is better than at least one predetermined threshold, the re-circulation flap will be switched in the closed position
15 for operating in the re-circulation mode.

The air quality inside the vehicle can be determined thanks to many data, such as number of passenger, temperature target inside the car, carbon dioxide concentration CO₂ level, and humidity level inside the car. In a non-limited way, for that purpose, data relative to initial conditions or parameters inside the vehicle cabin
20 can be measured or acquired, particularly carbon dioxide concentration CO₂, temperature, relative humidity inside the vehicle cabin. For instance, they can be set equal to the corresponding parameters outside the vehicle cabin. Further, the number of passengers inside the vehicle cabin can be determined for instance by a passenger detection module. Then, the carbon di-oxide concentration CO₂,
25 respectively relative humidity, inside the vehicle cabin at any time can be determined based on the value of the initial parameter added up to the ratio of produced CO₂ flow, respectively produced water H₂O flow, based on the number of passengers inside the vehicle cabin, to the ventilation flow multiplied by the time. The results can be compared to the at least one threshold limit in order to define where the recycling
30 flap has to switch between open or close position.

Three example routes Ra, Rb, Rc are given for illustration in a non-limited way. Similarly to the first embodiment, for each route Ra, Rb, Rc, air quality indexes can be acquired at several measuring points, then the average air quality index is calculated for each route. Further, the whole travelling time is obtained, for example
5 from the navigation device.

In the example given, in a merely illustrative way:

- route Ra is exposed to an average air quality index AQI of 30 for instance, with a total traveling time dT of 60minutes,
- route Rb is exposed to an average air quality index AQI of 50 for instance,
10 with a total traveling time dT of 55minutes,
- route Rc is exposed to an average air quality index AQI of 50 for instance, with a total traveling time dT of 60minutes.

Considering the pollution along the whole trip, the exposure factor E calculated for each route applying the formula (a) would be 1800 for route Ra, 2750 for route Rb,
15 3000 for route Rc.

According to the first embodiment, the second route candidate R2 would be the candidate with the minimal exposure factor E, that is to say route Ra.

Alternatively, the third embodiment only takes into account the pollution level that will enter into the cabin, when said installation will operate in a fresh air mode according
20 to the forecasting opening zones of the recycling flap into fresh air mode. In the example given in a merely illustrative way:

- route Ra is exposed to an average air quality index in fresh air mode AQI_FA of 30 for instance, during 30minutes,
- route Rb is exposed to an average air quality index in fresh air mode AQI_FA
25 of 50 for instance, during 20minutes,
- route Rc is exposed to an average air quality index in fresh air mode AQI_FA of 25 for instance, during 30minutes.

Next, the exposure factor E_FA in the fresh air mode is calculated for each route applying the following formula (b):

(b) $E_FA = AQI_FA * dT_FA$; with AQI_FA being the average air quality index when said installation operates in the fresh air mode, dT_FA being the traveling time when said installation operates in the fresh air mode in minutes.

As a result, the exposure factor E_FA in the fresh air mode is 900 for route Ra, 1000
5 for route Rb, 750 for route Rc.

The second route candidate R2 may be the candidate with the minimal exposure factor E_FA in the fresh air mode. The method thus comprises a step of comparing the calculated exposure factors E_FA in the fresh air mode each other to determine the lowest. In this example merely illustrative, the route Rc has the lowest exposure
10 factor E_FA in the fresh air mode and can be selected as the second route candidate.

As an alternative or in addition to any previous embodiment, according to yet another embodiment regarding figures 7 to 10, the air filter clogging level C_{filter} and/or the efficiency of the air filter AFE depending on seen pollutants along each route can be
15 taken into account.

On the sketch illustrated on Fig. 7, three example routes Ra, Rb, Rc are shown in a non-limited way. Each route is segmented depending on parameters such as the operating mode, i.e. fresh air mode or re-circulating mode, and the outside pollution level, namely the air quality indexes.

In this example, route Ra is segmented into seven zones Z1 to Z7, route Rb is segmented into five zones Z1 to Z5, and route Rc is segmented into five zones Z1 to Z5.
20

On Fig. 7, when said installation operates in a re-circulating mode, the segments of the routes are drawn in solid lines, when said installation operates in a fresh air mode the segments are differentiated depending on the air quality index for instance. For
25 good air quality indexes, for instance below or equal to 25, the segments are drawn with dashed lines. For medium air quality indexes, for instance between 25 and 50 included, the segments are drawn in solid lines with triangle symbols. For bad air quality indexes, for instance above 50 or 75, the segments are drawn in dotted lines
30 with square symbols.

Fig. 8 shows a table of results of the air filter clogging level C_{filter} and the air filter efficiency AFE for the route Ra depending on the pollutants seen on the different zones Z1 to Z7 along the trip.

Fig. 9 shows a table of results of the air filter clogging level C_{filter} and the air filter efficiency AFE for the route Rb depending on the pollutants seen on the different zones Z1 to Z5 along the trip.

Fig. 10 shows a table of results of the air filter clogging level C_{filter} and the air filter efficiency AFE for the route Rc depending on the pollutants seen on the different zones Z1 to Z5 along the trip.

For each route Ra, Rb, Rc, the estimation of the air filter clogging level C_{filter} (figures 8 to 10) can be calculated according to any known manner.

As an example, for estimating the air filter clogging level C_{filter} , the method may comprise a step of obtaining or acquiring vehicle parameters data, indicative of the vehicle operation. In particular, the vehicle parameters data comprises parameters of one air quality system of the vehicle. The air filter is generally part of the vehicle air quality system of the vehicle. The vehicle air quality system parameters may be selected from a group comprising: air mass flow through said installation, filter parameters data, recirculation rate or recirculating time of air mass flow or separation of the cabin.

The recirculation rate or time can be based on calculation or the average based on learning.

By separation of the cabin it is meant the ratio between pollutants entering the cabin and pollutants leaving the cabin back into the recycling air flow.

The air filter parameters may comprise filter separation efficiency or air filter efficiency AFE and/or active area of the air filter. In other words, the filter separation efficiency and the active area of the filter may be combined into a single parameter.

The method may further comprise a step of estimating the closing or opening area of recirculating flap, for instance as previously described in reference to the third embodiment. This can be based on external pollution and internal carbon dioxide and humidity levels, if possible, otherwise on the average external pollution.

In the next step, the method may comprise estimating weight of the air filter using obtained data, in particular using the vehicle's parameters data such as the air mass flow through said installation, the recirculation rate of air mass flow, the air filter parameters data like the air filter separation efficiency, the active area of filter, the concentration/ separation of the cabin, and using the air pollution forecast data such as the pollution level outside, preferably when the recirculating flap is in the open position, i.e. while said installation operates in the fresh air mode, the pollution data being either measured by sensor or obtained/acquired from pollution data provider and/or using the pollution level inside the cabin, for example measured by a vehicle on-board sensor.

As previously stated, the pollution data relate to air quality indexes. They may as well relate to particulate matters levels of different sizes PM1, PM2.5, PM10, to emissions of nitrogen oxide NO_x, carbon monoxide CO, carbon dioxide CO₂, sulfur dioxide SO₂, Ozone, Volatile Organic Compounds VOC, allergens and others.

The estimation function can associate the clogging of the air filter with the weight of the air filter. Thus, the estimated weight of the filter will be indicative of its clogging level.

If the amount of collected data is not sufficient, the estimation of the air filter clogging level can be based on kilometers travelled since last filter replacement or first installation, the number of days since last filter replacement or first installation, and the pollution level outside, either measured by a sensor mounted on the vehicle or obtained from pollution data provider, or both.

The coefficients necessary to estimate filter weight based on obtained data such as the abovementioned parameters, can be evaluated and updated during a step of calibrating the system, in which the estimated filter's weight is compared with a measured filter's weight.

In general, the estimation of the air filter clogging level C_{filter} can be calculated according to the following formula (c):

$$(c) : C_{filter} = \sum_i \alpha_i \cdot X_i + \sum_{i,j} \beta_{i,j} \cdot X_i \cdot X_j$$

where X_i and X_j are above described parameters, while α_i and β_{ij} are identified by filter weighing.

Then, the method may comprise a step of matching the estimated weight with a predefined clogging level. The clogging levels can be stored in the system and be associated with a determined weight, for example with particular weight ranges.

In the next step, the routes can be sorted according to the efficiency of the air filter and/or the clogging level estimation and then according to the exposure factor, the additional traveling time, the exposure factor in fresh air mode, the exposure time with a low air quality index, or any previous embodiment.

The method thus comprises a step of comparing the estimated air filter clogging C_{filter} and/or the air filter efficiency AFE of the routes Ra, Rb, Rc to determine the lowest.

In terms of filter lifetime and efficiency of the air filter, routes Rb and Rc with 10g of filter clogging C_{filter} and 90% of air filter efficiency AFE are better than route Ra with 15g of filter clogging C_{filter} and 85% of air filter efficiency AFE.

In the example given on Fig. 9, in a merely illustrative way, for zones Z1, Z3, Z5 of route Rb, said installation may operate in the re-circulating mode, while operating in a fresh air mode for zones Z2, Z4.

The average air quality index can be calculated for the whole travelling time as explained above regarding the first embodiment or while operating in a fresh air mode as described above regarding the third embodiment.

In the case the average air quality index is calculated in the fresh air mode, for route Rb, the exposure factor in the fresh air mode is calculated for zones Z2, Z4.

For instance, the average air quality index is 25 for zone Z2 during 10minutes, and is 75 for zone Z4 during 10 minutes. Thus, the exposure factor in the fresh air applying the formula (b) is 1000 for route Rb.

In the example given on Fig. 10, in a merely illustrative way, for zones Z1, Z3, Z5 of route Rc, said installation may operate in the re-circulating mode, while operating in a fresh air mode for zones Z2, Z4.

The average air quality index can be calculated for the whole travelling time as explained above regarding the first embodiment or while operating in a fresh air mode as described above regarding the third embodiment.

In the case the average air quality index is calculated in the fresh air mode, for route Rc, the exposure factor in the fresh air mode is calculated for zones Z2, Z4.

For instance, the average air quality index for each of zones Z2, Z4 is 50 and the time is 10minutes. Thus, the exposure factor in the fresh air applying the formula (b) is 1000 for route Rc.

The method thus comprises a step of comparing the calculated exposure factors in the fresh air mode of the routes Rb, Rc to determine the lowest.

In this example, both routes Rb and Rc have the same exposure factor in the fresh air mode. The routes Rb and Rc can be sorted according to another criterion as previously described, for instance depending on the quality of the air, namely as described in the second embodiment on how many times the average air quality index is below or equal to 25 and possibly how many times it is above 75 or 50, or depending on the travelling time.

Thus in this case, combining the travelling time 50minutes for route Rb and 60minutes for route Rc, the exposure time with a good air quality, and the air filter lifetime, the second route candidate is route Rb.

Further, in one option, the method may comprise generating control signals for subsequent operation of the recycling flap in the fresh air mode or in the re-circulating mode when the vehicle reaches corresponding locations. For instance if the user chooses to travel following the outputted second route candidate R2, which is route Rb in the previous example, the control signals may be for operation of the recycling flap in the fresh air mode when the vehicle reaches areas Z2, Z4 and for operation of the recycling flap in the re-circulating mode when the vehicle reaches areas Z1, Z3, Z5.

In alternative or in addition, the method may further comprise outputting the filter clogging level. The outputting can be carried out directly into a vehicle air quality system so that it can adapt its operation parameters. Further or alternatively, the

clogging level can be outputted to visual and/or sound indication components of the vehicle or any other alerting signaling means, so that the vehicle user can be informed about the need to replace the filter.

5 The order of at least part of the steps of the method can be reversed without departing from the scope of the present description. Some steps may for example be performed at the same time.

Preferably, part of the steps or all the steps can be iterated based on elapsed time or based on a travelled distance. Alternatively or additionally, the method can be iterated for each update of air pollution forecast data.

10 The explanation of the iterations explained above in relation to Fig. 2 also apply to the second way of implementing the method.

Additionally, for obtaining the second route candidate R2, the air quality index, possibly a weather index or others can be calculated for each point Fp, then combined together to form scores for each point and then the average score is
15 calculated for each route. At least, the air quality index can be acquired for each point Fp, then the average air quality index is calculated.

Next, the route with the best or optimal score is selected as the second route candidate R2 as previously described.

20 The above-described method according to one or the other of the embodiments can be carried out by means of cloud computing. In particular, at least part of the steps can be carried out in the cloud, with transmitting the route candidates to the user.

Alternatively or in addition, the method can be carried out by means of on-board computer of the vehicle and/or an information system source of the vehicle and/or an entertainment system of the vehicle. In particular, at least part of the steps can be
25 carried out through the on-board means of the vehicle, with transmitting information, such as the desired destination, the user preferences, pollution levels measurements and possible information of the vehicle operation, to the cloud.

Alternatively or in addition, the method can be carried out by means of any hand held or portable communication device or mobile terminal, such as for example but not
30 limited to laptop, smart phones and the likes. Such portable communication device or

mobile terminal can be carried by the vehicle occupants. It may be communicably coupled to the vehicle via a communication network such as for example, but not limited to, WIFI, Bluetooth® and the likes. In particular, at least part of the steps can be carried out through an application of such portable communication device or mobile terminal, with transmitting information, such as the desired destination and the user preferences, to the cloud.

Alternatively or in addition, the method may also be carried out at least partly by means of a remoter server such as a navigation services provider and/or a data supplier of air pollution forecast data like pollution maps, and/or possibly a data supplier of weather forecast data. In particular, the navigation services provider can receive a request for obtaining navigation data between a starting point and a destination point and can transmit the requested navigation data to the cloud and/or on-board means of the vehicle, and/or the mobile terminal. Similarly, the data supplier can receive a request for obtaining pollution forecast data (respectively weather forecast data) between a starting point and a destination point and can transmit the requested data to the cloud and/or on-board means of the vehicle and/or the mobile terminal.

System

Fig. 11 shows a schematic representation of a system according to the invention configured to carry out at least partly any of the first or second way of implementing the method previously described.

The system may or may not be entirely embedded in the user's vehicle. In one option, such system may include the on-board computer of the vehicle and/or the information system source of the vehicle and/or the entertainment system of the vehicle and/or the portable communication device or mobile terminal such as a smartphone.

The system comprises communication means 410, computing or control means 430 and output means 440. Additionally, the system can comprise pollution sensing means 420. The system may also comprise a detection module adapted to detect at least one parameter impacting air quality inside the vehicle cabin.

Referring to both figures 2 and 11, the communication means 410 are configured to acquire or obtain navigation data, a starting point S and destination point D and plurality of routes between the starting point S and destination point D. This may be achieved in a conventional manner known in the art, by means of global positioning system (GPS) integration, optionally coupled with internet connection to navigation services provider. Preferably, the communication means 410 are adapted to provide internet connection for the system, in particular to cloud computing services.

The communication means 410 may include one or more transceiver for transmitting and receiving data. The communication means 410 can be adapted to receive and send wireless signals, such as navigation signals, for example GPS signals or the like.

For example, a navigation module can be embedded in the vehicle. This navigation module may or may not be part of the vehicle's entertainment system. Alternatively, the user can have access to a navigation module through an application on the portable communication device or mobile terminal such as a smartphone. The on-board navigation module or through the application of the smartphone includes a global positioning system.

The vehicle's entertainment system generally comprises a user interface, like a touch screen or touch pad, or the user interface may be the screen of the smartphone, through which the user can input starting point S and destination point D. The communication means 410 are configured to receive information from the user interface. The starting point S can also be determined as the current position of the user or vehicle by the navigation module.

The communication means 410 of the navigation module may send a request for obtaining navigation data representative of geographical position of the vehicle and real-time traffic, from a navigation services provider with communicating the starting point S and destination point D. The communication means 410 of the navigation module can receive such navigation data. In a complementary way, the navigation services provider comprises communication means for receiving the request and for transmitting the navigation data.

All received data by the communication means 410 can be supplied to and from the computing or control means 430 embedded in the vehicle or to cloud computing services. Preferably, the communication means 410 and/or the computing or control means 430 have at least one memory to store the collected data.

- 5 The communication means 410 of the navigation module may send a request to the cloud for obtaining the plurality of routes with communicating the starting point S and destination point D. In this case, cloud computing services can determine the plurality of routes. The communication means 410 of the navigation module may receive the determined plurality of routes and information about the travelling time. In a
10 complementary way, the cloud comprises communication means for receiving the request and possibly for transmitting the determined plurality of routes.

Alternatively, computing or control means 430 embedded in the vehicle, for example part of the on-board computer of the vehicle, or through the application of the smartphone, are configured to determine the plurality of routes based on the
15 navigation data, the starting point S and the destination point D. In that case, the control means 430 are configured to receive data from the communication means 410 and/or from the user interface.

The communication means 410 may be also adapted to communicate with other vehicles comprising a system according to the invention, for example via internet or
20 by other means, so that data can be exchanged.

The communication means 410 are further adapted to acquire or obtain air pollution forecast data and possibly weather forecast data for the plurality of routes. In particular, the communication means 410 may be adapted to obtain air pollution forecast data for example in form of the pollution map data, which is indicative of
25 most current air pollution levels within a specified area and a forecast for air pollution levels in the future, from a data supplier.

It is for example, communication means 410 of the vehicle's on-board computer or of the smartphone. The communication means 410 may send a request for obtaining air pollution forecast data, such as the pollution map, from a data supplier of air pollution
30 forecast data with communicating the specified area. The communication means 410 can receive such air pollution forecast data. In a complementary way, the data

supplier comprises communication means for receiving the request and for transmitting the air pollution forecast data.

Preferably, the system further comprises pollution sensing means 420 adapted to be mounted on a vehicle and to be configured to provide real-time pollution measurement data, indicative of pollution levels within the vehicle cabin and/or outside the vehicle's cabin, in its immediate vicinity. This data may be transmitted using communication means 410 to the data supplier or used internally to supplement available data.

Possibly, the communication means 410 may send a request for obtaining weather forecast data from a data supplier with communicating the specified area. The communication means 410 can receive the weather forecast data. In a complementary way, the data supplier comprises communication means for receiving the request and for transmitting the weather forecast data. Preferably, the communication means 410 are configured to obtain weather forecast data which is at least partly obtained from the vehicle's system information source comprising at least one from the group of: wipers speed, lighting operation, braking efficiency.

The communication means 410 of the vehicle's on-board computer or of the portable communication device or mobile terminal such as the smartphone may transmit the air pollution forecast data received from the data supplier and/or the pollution measurement data from the sensing means 420 and possibly the weather forecast data received from the data supplier and/or from the vehicle's system information source, to the cloud. In a complementary way, the cloud comprises communication means for receiving these data. Thus, the cloud can receive and store from different vehicles, so that those data can be used by different users. The data may also be used internally to supplement available data.

Alternatively, the communication means 410 may transmit the pollution and possibly weather forecast data to the computing or control means 430 embedded in the vehicle, for example part of the on-board computer of the vehicle, or through the application of the smartphone. The control means 430 are configured to receive this data from the communication means 410.

Further, the communication means 410 and/or the control means 430 are adapted to acquire or obtain user preference information from the user. This may be done by integration with any known input means, which might be a part of output means 440, e.g. by means of a touch screen of the vehicle entertainment system or through an application on the smart phone.

More precisely, the user can input preference information through the user interface such as the touch screen of the vehicle's entertainment system or of the smartphone. The communication means 410, for example of the vehicle's entertainment system or through an application on the mobile terminal, are configured to receive information from the user interface.

In one option, the communication means 410 can then transmit the preference information to the computing or control means 430 embedded in the vehicle, for example part of the on-board computer of the vehicle, or through the application of the smartphone. In another option, the communication means 410 are configured to transmit the preference information to cloud computing services.

The control means 430 embedded in the vehicle or the cloud computing services are configured to receive data from the communication means 410, and possibly from pollution sensing means 420 or from data supplier. The control means 430 can comprise memory for storing the obtained data.

The computing or control means 430 embedded in the vehicle or the cloud computing services are further configured to determine route score, in particular a first route score, based on user preference information, for each of the plurality of routes without taking into account the weather forecast data and the air pollution forecast data so that a first group of routes is obtained. For that purpose, the computing or control means 430 embedded in the vehicle or the cloud computing services may be adapted to compare the plurality of routes each other based on the user preference information and advantageously based on real-time information provided by the communication means 410 of the system.

The computing or control means 430 embedded in the vehicle or the cloud computing services may be configured to calculate the average air quality index,

based on air quality indexes received from the communication means 410 of the system.

The computing or control means 430 may be configured to determine the travelling time of each route of the determined first group of routes or possibly receive the travelling time information from the communication means 410, for the whole trip
5 and/or when the vehicle operates in a fresh air mode.

The computing or control means 430 may be configured to calculate exposure factor based on the average air quality index and the travelling time for each of the first group of routes applying the formula (a) or during a fresh air mode applying the
10 formula (b).

The computing or control means 430 are configured to determine route score, based on user preference information, for each of the plurality of routes with taking into account the weather forecast data and the air pollution forecast data so that a second group of routes is obtained.

15 In particular, the computing or control means 430 embedded in the vehicle or the cloud computing services are also configured to determine a second route score, based on user preference information, for each of the first group of routes with taking into account the air pollution forecast data and the calculated exposure factors, and possibly the weather forecast data, so that the second group of routes is obtained.

20 The computing or control means 430 may be configured to compare the calculated exposure factors each other to determine the lowest.

Preferably, the computing or control means 430 are configured to calculate and compare the additional time of each route of the first group of routes to the fastest route.

25 The computing or control means 430 may be configured to compare air quality indexes acquired at the different measuring points along each route to a first threshold for instance 25, and/or to a second threshold for instance 50 or 75.

The computing or control means 430 may be configured to calculate the exposure time while the air quality index is less than or equal to a first threshold, and/or the
30 exposure time while the air quality index is greater than the second threshold.

The computing or control means 430 may be configured to compare the calculated exposure times in order to determine the route with more exposure time with air quality index below or equal to the first threshold, and possibly less exposure time with air quality index above the second threshold.

- 5 Additionally, the control means 430 may be adapted to acquire vehicle parameters data for instance relating to vehicle air quality system components. The vehicle air quality system parameters may be selected from a group comprising: air mass flow through said installation, recirculation rate of air mass flow, filter parameters, separation of the cabin. The filter parameters may comprise filter separation
10 efficiency and/or active area of the filter.

The control means 430 may also be configured to determine locations along the routes where the air outside is less polluted and forecast opening areas of the recycling flap. The detection module when provided can detect at least one
15 parameter inside the car such as the temperature, carbon dioxide concentration CO₂ level, humidity level, and the number of passengers, and can be adapted to transmit data relating to the at least one parameter to the control means 430 of the system. Then, the control means 430 of the system may be adapted to receive inputs from the detection module and to calculate the level of carbon dioxide concentration CO₂ level or humidity level, inside the vehicle cabin at any time based on the initial value
20 and to compare the obtained value to the at least one threshold limit, for defining where the recycling flap has to switch between open or close position.

The control means 430 may also be adapted to estimate weight of the filter using the obtained data and to match the estimated weight with a predefined clogging level. The control means 430 can comprise memory for storing the obtained data, as well
25 as the estimate function data and predefined clogging levels associated with estimated weight. The memory can also store calibration parameters and instructions, as well as information about the last filter replacement or first installation.

The computing or control means 430 embedded in the vehicle or the cloud
30 computing services may further be configured to compare the different routes based on the parameters or criteria previously described and to select a first route

candidate R1 with optimal route score from the first group of routes and a second route candidate R2 with optimal route score from the second group of routes.

The computing or control means 430 embedded in the vehicle or the cloud computing services may then be configured to send an output command to the output means 440, with communicating information about the first route candidate R1 and the second route candidate R2.

The output means 440 are configured to receive such information.

Further, the output means 440 are configured to output a first route candidate R1 and a second route candidate R2, wherein the first route candidate R1 is the candidate with optimal route score from the first group of routes and the second candidate R2 is the candidate with optimal route score from the second group of routes.

The output means 440 can be carried out in form of visual output device like the touch screen of the vehicle's on-board computer and/or of the smartphone. In this case, the output means 440 and the input means can be the same.

Thanks to an anticipation model using weather, industrial pollution and traffic forecast based on machine learning model, the data could be adjusted for the coming kilometers in real time thanks to on-board sensor.

In another option the system can be considered as the whole set including the on-board means of the vehicle and/or the mobile terminal as well as the cloud and/or the navigation data provider or data supplier or a remote server.

It is understood that embodiments of the present invention can be carried out in form of hardware, software or a combination of both. Any such software can be stored in the form of a volatile or non-volatile storage, for example a storage like a ROM, whether erasable or rewritable or not, or in the form of memory such as, for example RAM, memory chips, device or integrated circuits or an optically or magnetically readable medium such as, for example, a CD, DVD, magnetic disk or magnetic tape. It is understood that the storage devices and storage media are embodiments of machine-readable storage that are suitable for storing program or programs that, when executed, implement embodiments of the present invention. Accordingly, embodiments provide a program comprising code for implementing a system or

method as described and a machine readable storage storing such a program. Further, embodiments of the present invention may be conveyed electronically via any medium such as a communication signal carried over a wired or wireless connection and embodiments suitably encompass the same.

- 5 Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of drawings, the disclosure, and the appended claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to the advantage.
- 10 In conclusion, thanks to the use of pollution map and traffic estimation, the method as previously described allows to propose a clean route on demand of the user or automatically. Further, the data can be adjusted for the coming miles in real time thanks to on-board sensor or to the updated information coming from pollution map.

Claims

1. A computer-implemented method for determining a route, in particular for a vehicle, comprising:

- obtaining navigation data, a starting point (S) and a destination point (D) and
5 determining (110) a plurality of routes between the starting point (S) and the destination (D);
- obtaining (130) air pollution forecast data for the plurality of routes;
- obtaining (140) user preference information;
- determining (150) route score, based on user preference information, for each of
10 the plurality of routes without taking into account the air pollution forecast data, so that a first group of routes is obtained;
- determining (160) route score, based on user preference information, for each of the plurality of routes with taking into account the air pollution forecast data, so that a second group of routes is obtained;
- 15 - outputting (170) a first route candidate (R1) and a second route candidate (R2), wherein the first route candidate (R1) is the candidate with optimal route score from the first group of routes and the second route candidate (R2) is the candidate with optimal route score from the second group of routes.

2. A method according to claim 1, further comprising obtaining (120) weather
20 forecast data for the plurality of routes, and wherein

- determining (150) route score, based on user preference information, for each of the plurality of routes is implemented without taking into account the weather forecast data; and
- determining (160) route score, based on user preference information, for each of
25 the plurality of routes is implemented with taking into account the weather forecast data.

3. A method according to claim 1 or 2, further comprising steps of:

- determining (110), from navigation data, the travelling time (dT; dT_FA) for each of the plurality of routes;

- acquiring (130) air pollution forecast data including air quality indexes for the plurality of routes;

5 - determining (150) a first route score, based on user preference information, for each of the plurality of routes without taking into account the air pollution forecast data including air quality indexes, so that a first ranked group of routes is obtained;

- calculating (160a) exposure factor (E; E_FA) based on the average air quality index (AQI; AQI_FA) and the travelling time (dT; dT_FA) for each route of said first group of routes;

- determining (160) a second route score, based on user preference information, for each route of said first group of routes with taking into account the air pollution forecast data including air quality indexes and the calculated exposure factor (E; E_FA), so that a second ranked group of routes is obtained.

15 **4.** A method according to claim 3, wherein the second route candidate (R2) with optimal second route score is the candidate route with the minimal exposure factor (E; E_FA) from the second group of routes.

5. A method according to claim 3,

20 - comprising the step of calculating (160b) exposure time with average air quality index (AQI; AQI_FA) less than or equal to a first threshold for each of the first group of routes; and

- wherein the step of determining (160) a second route score for each of the first group of routes is implemented with taking into account the exposure time with average air quality index (AQI; AQI_FA) less than or equal to the first threshold calculated, so that said second group of routes is obtained.

25 **6.** A method according to claim 5, wherein the second route candidate (R2) with optimal second route score is the candidate route with the longest exposure time (dT_AQI≤25) with average air quality index (AQI; AQI_FA) less than or equal to the first threshold from said second group of routes.

7. A method according to claim 5, comprising steps of:

- calculating (160c) exposure time with average air quality index (AQI; AQI_FA) greater than a second threshold for each of the plurality of routes and/or
- calculating (160d) exposure time with average air quality index (AQI; AQI_FA) greater than the first threshold and less than or equal to the second threshold for each of the plurality of routes; and

wherein the step of determining (160) a second route score for each of said first group of routes is implemented with taking into account the exposure time ($dT_{AQI>50}$) with average air quality index (AQI; AQI_FA) greater than the second threshold and/or the exposure time ($dT_{25 < AQI \leq 50}$) with average air quality index (AQI; AQI_FA) greater than the first threshold and less than or equal to the second threshold calculated, so that said second group of routes is obtained.

8. A method according to any of claims 3 to 7, wherein the vehicle comprises a heating and/or ventilating and/or air conditioning installation able to operate in a fresh air mode, wherein:

- calculating (160a) exposure factor (E_FA) is implemented based on the average air quality index and the travelling time (dT_{FA}) when said installation operates in the fresh air mode for each of said first group of routes, applying the formula (b):

$$(b) E_{FA} = AQI_{FA} * dT_{FA}$$

with

AQI_FA being the average air quality index when said installation operates in the fresh air mode,

dT_{FA} being the traveling time when said installation operates in the fresh air mode in minutes.

9. A method according to any preceding claim, wherein the vehicle comprises a heating and/or ventilating and/or air conditioning installation including a filter, said method:

- comprising the step of estimating (160e) the filter clogging (C_{filter}) level, and wherein

- the step of determining (160) a second route score for each of said first group of routes is implemented with taking into account the estimated filter clogging (C_{filter}) level.

10. A method according to any preceding claim, wherein the air pollution forecast data is at least partly obtained from a pollution map from a data supplier and/or from the vehicle's onboard pollution sensors.

11. A method according to any preceding claim combined with claim 1 or 2, wherein the air pollution forecast data and/or weather forecast data is at least partly obtained from the vehicle's system information source comprising at least one from the group of: wipers speed, lighting operation, braking efficiency.

12. A method according to any preceding claim combined with claim 1 or 2, wherein the air pollution forecast data and/or weather forecast data is at least partly obtained from at least one from the group of: meteorological stations, pollution stations with a fixed location, a personal mobile pollution sensors, other vehicles, a satellite, a weather map.

13. A method according to any preceding claim, wherein the method is iterated based on elapsed time or based on a travelled distance.

14. A method according to any preceding claim, wherein the method is iterated for each update of air pollution forecast data.

15. A system comprising:

- communication means (410) and/or control means (430) configured to

obtain navigation data, starting point (S) and destination point (D) and plurality of routes between the starting point (S) and destination point (D), air pollution forecast data for the plurality of routes, user preference information;

determine route score, based on user preference information, for each of the plurality of routes without taking into account the air pollution forecast data so that a first group of routes is obtained; and to determine route score, based on user preference information, for each of the plurality of routes with taking into

account the air pollution forecast data so that a second group of routes is obtained;

- output means (440) configured to output a first route candidate (R1) and a second route candidate (R2), wherein the first route candidate is the candidate with optimal route score from the first group of routes and the second candidate is the candidate with optimal route score from the second group of routes.

16. A computer readable storage medium storing a program of instructions executable by a machine to perform a method according to any of claims 1 to 14.

Fig.1

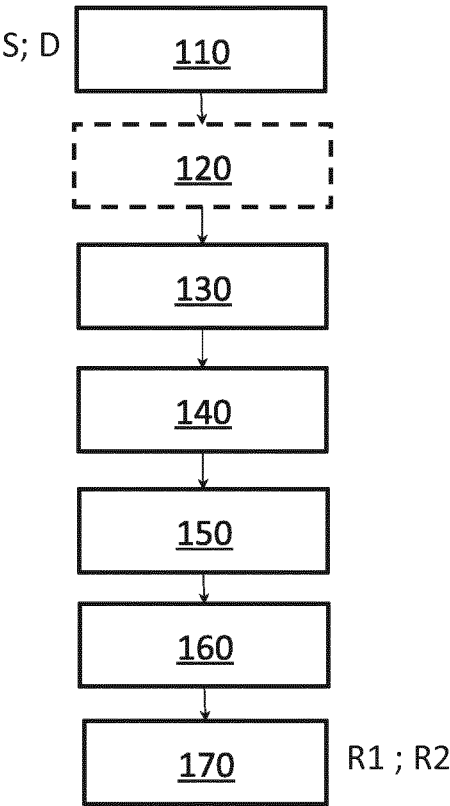
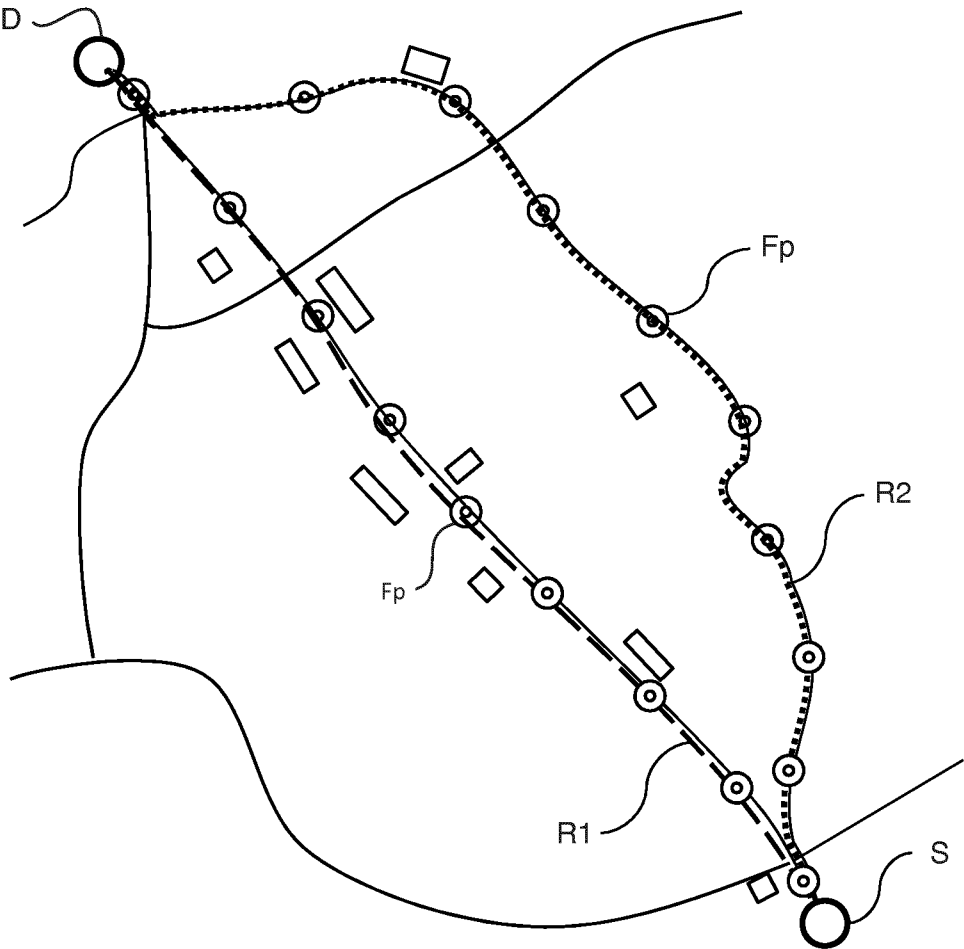


Fig.2



2/6

Fig.3

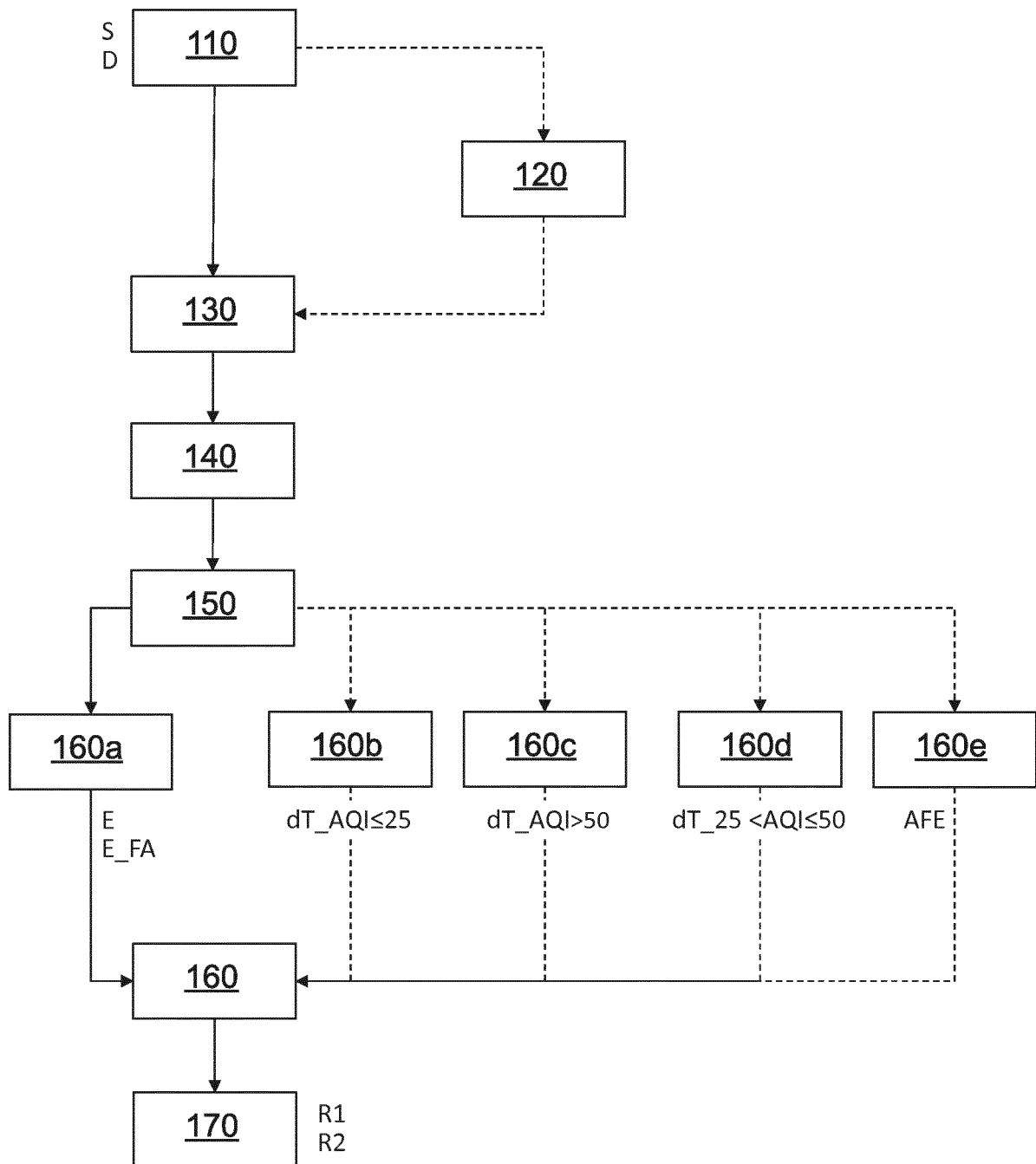


Fig.4

	Ra	Rb	Rc
AQI	45	30	40
dT	60	80	70
E	2700	2400	2800

Fig.5

	Ra	Rb	Rc
AQI	45	45	39
dT	60	60	70
E	2700	2700	2710
dT_AQI≤25	36	0	17.5
dT_AQI>50	24	0	0
dT_25 <AQI≤50	0	45	52,5

Fig.6

	Ra	Rb	Rc
AQI	30	50	50
dT	60	55	60
E	1800	2750	3000
AQI_FA	30	50	25
dT_FA	30	20	30
E_FA	900	1000	750

Fig.7

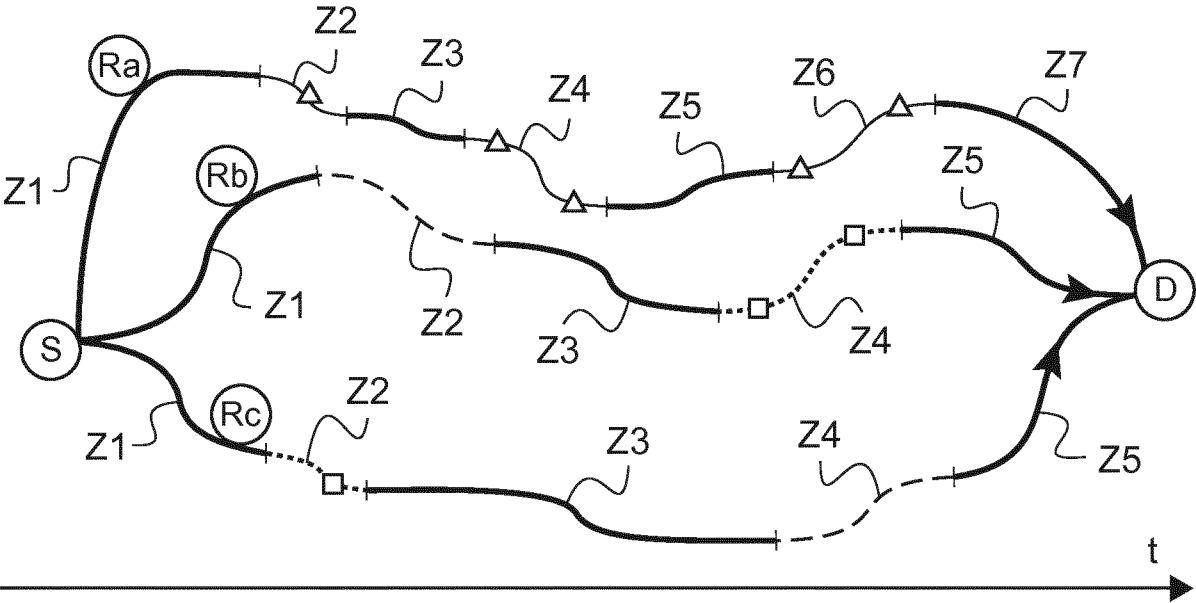


Fig.8

Ra	Z1	Z2	Z3	Z4	Z5	Z6	Z7
AFE	100 %	96 %	95%	91%	90%	86%	85%
C_{filter}	0g	4g	5g	9g	10g	14g	15g
dT	10	10	10	10	10	10	10
AQI_FA	-	50	-	50	-	50	-

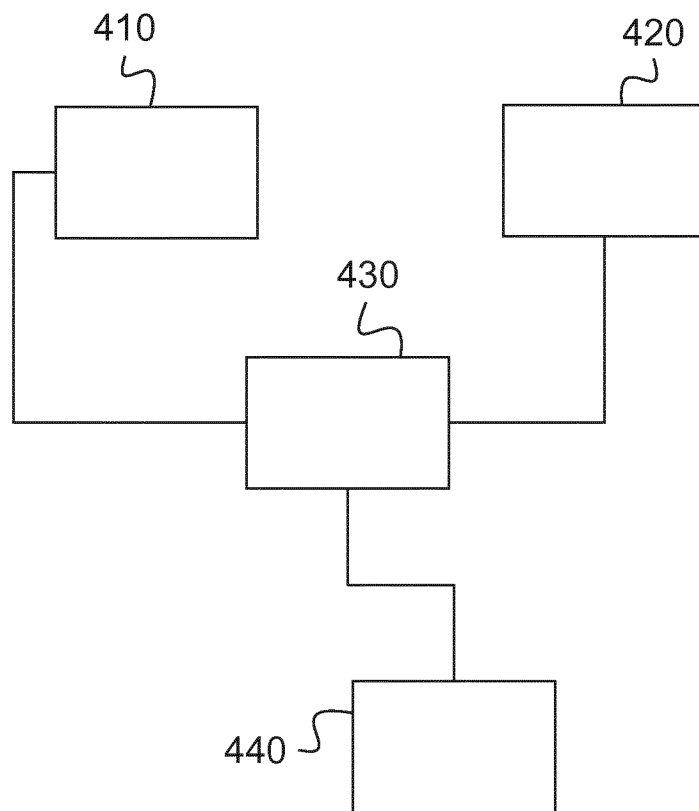
Fig.9

Rb	Z1	Z2	Z3	Z4	Z5
AFE	100%	98 %	98%	92%	90%
C_{filter}	0g	2g	2g	8g	10g
dT	10	10	10	10	10
AQI_FA	-	25	-	75	-

Fig.10

Rc	Z1	Z2	Z3	Z4	Z5
AFE	100%	94 %	92%	90%	90%
C_{filter}	0g	6g	8g	10g	10g
dT	10	10	20	10	10
AQI_FA	-	75	-	25	-

Fig.11



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/075572

A. CLASSIFICATION OF SUBJECT MATTER INV. G01C21/34 G01C21/36 G01N33/00 G06Q10/00 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) G01C G06Q G01N		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/080053 A1 (RAKSHIT SARBAJIT K [IN]) 28 March 2013 (2013-03-28)	1,3,4, 10,11, 13-16
A	figures 3,4 paragraphs [0014], [0020], [0024], [0025], [0028] - [0031], [0033] -----	5-7
X	DE 10 2015 211776 A1 (BAYERISCHE MOTOREN WERKE AG [DE]) 29 December 2016 (2016-12-29)	1,2,10, 11,13-16
A	figures 2,5 paragraphs [0044], [0045], [0051] -----	5-7
X	DE 10 2015 013596 A1 (DAIMLER AG [DE]) 28 April 2016 (2016-04-28) figure 2 paragraphs [0005], [0006], [0007], [0023], [0025] -----	1,2, 10-16
-/-		
☒ 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	Date of mailing of the international search report	
15 November 2019	28/01/2020	
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 Berbil Bautista, L	

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2019/075572

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009/082917 A1 (ADACHI AKITO [JP]) 26 March 2009 (2009-03-26) paragraph [0065] -----	1-7, 10-16
A	US 2015/330807 A1 (UNO SATOSHI [JP] ET AL) 19 November 2015 (2015-11-19) paragraph [0032] - paragraph [0034] -----	1-7, 10-16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2019/075572

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-7, 10-16

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-7, 10-16

claims 1-7 and 10-16 deal with comparing the air quality index to a threshold

2. claim: 8

claim 8 deals with a fresh air mode along the route

3. claim: 9

claim 9 deals with filter clogging along the route

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/075572

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013080053 A1	28-03-2013	NONE	
DE 102015211776 A1	29-12-2016	NONE	
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US 2009082917 A1	26-03-2009	CN 101297335 A EP 1960982 A1 JP 4367431 B2 JP 2007149054 A US 2009082917 A1 WO 2007049110 A1	29-10-2008 27-08-2008 18-11-2009 14-06-2007 26-03-2009 03-05-2007
US 2015330807 A1	19-11-2015	CN 104813381 A EP 2927891 A1 JP 5949940 B2 JP WO2014083708 A1 US 2015330807 A1 WO 2014083708 A1	29-07-2015 07-10-2015 13-07-2016 05-01-2017 19-11-2015 05-06-2014