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## DETERMINING A TRAFFIC ROUTE USING PREDICTED TRAFFIC CONGESTION

### Technical Field

- 5 [001] The present invention generally relates to a method, processing system, system and/or a computer program product for determining a traffic route using predicted traffic congestion.

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### 15 Background

- [003] There are a number of products and services available which allow a commuter to determine an optimal route between a first location and a second location. Generally, a road map database is used to determine a plurality of possible routes between the locations, and a weight analysis is performed to assess which route is considered the optimal route  
20 which is then presented to the user. Different weights can be considered to determine the optimal route, such as the least amount of time to travel between the locations, the least distance travelled, or the least cost between the locations.

- [004] However, traffic congestion varies at different times of the day, week, month, or  
25 year, thus one particular route may be considered favourable over another at one point in time, whereas at another point in time, a different route may be considered favourable.

- [005] Whilst attempts have been made to provide systems which predict traffic congestion based on historical traffic data in order to determine an optimal route between  
30 two locations, these systems are disadvantageous due to assuming that the same traffic conditions are being experienced based on a temporal similarity with the historical data.

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[006] Therefore, there is a need to more accurately determine an optimal route between a first and second location which overcomes, or at least ameliorates, one or more of the above mentioned disadvantages.

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[007] The reference in this specification to any prior publication (or information derived from the prior publication), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that the prior publication (or information derived from the prior publication) or known matter forms part  
10 of the common general knowledge in the field of endeavour to which this specification relates.

### Summary

[008] In one broad is provided a method of determining an optimal route between a first  
15 and second location, wherein the method includes, in a processing system, steps of

- (a) obtaining input data indicative of the first and second location;
- (b) obtaining real time traffic data;
- (c) generating predicted traffic congestion data using the real time traffic data and historical traffic data; and
- 20 (d) determining, from a plurality of potential routes between the first and second location, an optimal route for a commuter travelling between the first and second location based upon the predicted traffic congestion data.

[009] In one form, the method includes:  
25 obtaining the current commuter location;  
repeating steps (b), (c) and (d) wherein the first location is set to be the current commuter location upon performing repetitions of steps (b), (c) and (d) to update the optimal route.

30 [010] In another form, the predicted traffic congestion data is temporally dependent.

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[011] In one embodiment, the method includes:

generating, using the real time traffic data and historical traffic data, the temporally dependent predicted traffic congestion data indicative of predicted traffic congestion for a plurality of potential route portions for a plurality of future time intervals; and

5 determining the optimal route using the temporally dependent predicted traffic congestion data to determine an estimated time which the commuter is expected to travel along a respective route portion to determine the estimated traffic congestion expected to be experienced by the commuter during travel.

10 [012] In another embodiment, the method includes:

determining a weight for each potential route portion in accordance with one or more weight factors;

determining the optimal route using the weight for each potential route portion;

15 [013] In an optional form, the one or more weight factors include an estimated travel time to travel the potential route portion, wherein the estimated travel time is determined using the temporally dependent predicted traffic congestion data.

[014] In another optional form, the one or more weight factors include an estimated fuel  
20 consumption when travelling along the potential route portion, wherein the estimated fuel consumption is determined using the temporally dependent predicted traffic congestion data.

[015] In an optional embodiment, the one or more weight factors include an estimated  
25 travel distance to travel the potential route portion, wherein the estimated travel time is determined using a road network data store.

[016] In another optional embodiment, the one or more weight factors include one or  
more road tolls incurred by travelling along the potential route portion, wherein the one or  
30 more road tolls incurred is determine using a road toll data store.

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[017] Optionally, the method includes determining the optimal route by applying Dijkstra algorithm in relation to the weights for the potential route portions to determine a plurality of connected potential route portions having a total weight favourable for the commuter.

5 [018] In one form, the method includes using the real time traffic data and the historical traffic data in a simulator to generate the predicted traffic congestion data.

[019] In another form, the method includes:

obtaining traffic incident data indicative of a traffic incident; and  
10 generating, using the traffic incident data, the predicted traffic congestion data.

[020] In one embodiment, the method includes transferring optimal route data indicative of the optimal route to a commuter interface device for presenting the optimal route to the commuter.

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[021] In another broad aspect there is provided a processing system for determining an optimal route between a first and second location, wherein the processing system is configured to:

(a) obtain input data indicative of the first and second location;  
20 (b) obtain real time traffic data;  
(c) generate predicted traffic congestion data using the real time traffic data and historical traffic data; and  
(d) determine, from a plurality of potential routes between the first and second location, an optimal route for a commuter travelling between the first and second location  
25 based upon the predicted traffic congestion data.

[022] In one form, the processing system is configured to:

obtain the current commuter location; and  
repeat steps (b), (c) and (d) wherein the first location is set to be the current  
30 commuter location upon performing repetitions of steps (b), (c) and (d) to update the optimal route.

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[023] In another form, the predicted traffic congestion data is temporally dependent.

[024] In one embodiment, the processing system is configured to:

- 5       generate, using the real time traffic data and historical traffic data, the temporally dependent predicted traffic congestion data indicative of predicted traffic congestion for a plurality of potential route portions for a plurality of future time intervals; and
- determine the optimal route using the temporally dependent predicted traffic congestion data to determine an estimated time which the commuter is expected to travel
- 10   along a respective route portion to determine the estimated traffic congestion expected to be experienced by the commuter during travel.

[025] In another embodiment, the processing system is configured to:

- determine a weight for each potential route portion in accordance with one or more
- 15   weight factors;
- determine the optimal route using the weight for each potential route portion;

[026] In an optional form, the one or more weight factors include an estimated travel time to travel the potential route portion, wherein the estimated travel time is determined using

20   the temporally dependent predicted traffic congestion data.

[027] In another optional form, the one or more weight factors include an estimated fuel consumption when travelling along the potential route portion, wherein the estimated fuel consumption is determined using the temporally dependent predicted traffic congestion

25   data.

[028] In an optional embodiment, the one or more weight factors include an estimated travel distance to travel the potential route portion, wherein the estimated travel time is determined using a road network data store.

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[029] In another optional embodiment, the one or more weight factors include one or more road tolls incurred by travelling along the potential route portion, wherein the one or more road tolls incurred is determine using a road toll data store.

5 [030] Optionally, the processing system is configured to determine the optimal route by applying Dijkstra algorithm in relation to the weights for the potential route portions to determine a plurality of connected potential route portions having a total weight favourable for the commuter.

10 [031] In one form, the processing system is configured to use the real time traffic data and the historical traffic data in a simulator to generate the predicted traffic congestion data.

[032] In another form, the processing system is configured to:

15 obtain traffic incident data indicative of a traffic incident; and  
generate, using the traffic incident data, the predicted traffic congestion data.

[033] In one embodiment, the processing system is configured to transfer optimal route data indicative of the optimal route to a commuter interface device for presenting the optimal route to the commuter.

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[034] In another broad aspect there is provided a computer program product including a computer readable medium having executable instructions which when executed enable a processing system to determine an optimal route between a first and second location, wherein the computer program configures the processing system to:

25 (a) obtain input data indicative of the first and second location;  
(b) obtain real time traffic data;  
(c) generate predicted traffic congestion data using the real time traffic data and historical traffic data; and  
(d) determine, from a plurality of potential routes between the first and second  
30 location, an optimal route for a commuter travelling between the first and second location based upon the predicted traffic congestion data.

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[035] In one form, the computer program product according to claim 27, wherein the computer program product configures the processing system to:

obtain the current commuter location; and

5 repeat steps (b), (c) and (d) wherein the first location is set to be the current commuter location upon performing repetitions of steps (b), (c) and (d) to update the optimal route.

[036] In another form, the predicted traffic congestion data is temporally dependent.

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[037] In one embodiment, the computer program product configures the processing system to:

generate, using the real time traffic data and historical traffic data, the temporally dependent predicted traffic congestion data indicative of predicted traffic congestion for a plurality of potential route portions for a plurality of future time intervals; and

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determine the optimal route using the temporally dependent predicted traffic congestion data to determine an estimated time which the commuter is expected to travel along a respective route portion to determine the estimated traffic congestion expected to be experienced by the commuter during travel.

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[038] In another embodiment, the computer program product configures the processing system to:

determine a weight for each potential route portion in accordance with one or more weight factors;

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determine the optimal route using the weight for each potential route portion;

[039] In an optional form, the one or more weight factors include an estimated travel time to travel the potential route portion, wherein the estimated travel time is determined using the temporally dependent predicted traffic congestion data.

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[040] In another optional form, the one or more weight factors include an estimated fuel consumption when travelling along the potential route portion, wherein the estimated fuel consumption is determined using the temporally dependent predicted traffic congestion data.

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[041] In an optional embodiment, the one or more weight factors include an estimated travel distance to travel the potential route portion, wherein the estimated travel time is determined using a road network data store.

10 [042] In another optional embodiment, the one or more weight factors include one or more road tolls incurred by travelling along the potential route portion, wherein the one or more road tolls incurred is determine using a road toll data store.

15 [043] In one form, the computer program product configures the processing system to determine the optimal route by applying Dijkstra algorithm in relation to the weights for the potential route portions to determine a plurality of connected potential route portions having a total weight favourable for the commuter.

20 [044] In another form, the computer program product configures the processing system to use the real time traffic data and the historical traffic data in a simulator to generate the predicted traffic congestion data.

[045] In one embodiment, the computer program product configures the processing system to:  
25       obtain traffic incident data indicative of a traffic incident; and  
          generate, using the traffic incident data, the predicted traffic congestion data.

[046] In another embodiment, the computer program product configures the processing system to transfer optimal route data indicative of the optimal route to a commuter  
30 interface device for presenting the optimal route to the commuter.

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[047] Other embodiments of the above mentioned broad aspects will be realised throughout the description of the example embodiments.

### **Brief Description of the Figures**

5 [048] Example embodiments should become apparent from the following description, which is given by way of example only, of at least one preferred but non-limiting embodiment, described in connection with the accompanying figures.

[049] Figure 1 illustrates a functional block diagram of an example processing system that  
10 can be utilised to embody or give effect to a particular embodiment;

[050] Figure 2 illustrates a flow chart representing an example method of determining an optimal route between a first and second location;

15 [051] Figure 3 illustrates a functional block diagram of an example system for determining an optimal route between a first and second location;

[052] Figure 4 illustrates a further functional block diagram of an example system for determining an optimal route between a first and second location;

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[053] Figure 5 illustrates a flowchart representing a method for determining an optimal route from a plurality of routes; and

[054] Figure 6 illustrates a flowchart representing another method for determining an  
25 optimal route from a plurality of routes based upon the possible time travelled for the commuter along a plurality of routes.

### **Description of Embodiments**

[055] The following modes, given by way of example only, are described in order to  
30 provide a more precise understanding of the subject matter of a preferred embodiment or

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embodiments. In the figures, incorporated to illustrate features of an example embodiment, like reference numerals are used to identify like parts throughout the figures.

[056] A particular embodiment can be realized using a processing system, an example of which is shown in Fig. 1. In particular, the processing system 100 generally includes at least one processor 102, or processing unit or plurality of processors, memory 104, at least one input device 106 and at least one output device 108, coupled together via a bus or group of buses 110. In certain embodiments, input device 106 and output device 108 could be the same device. An interface 112 also can be provided for coupling the processing system 100 to one or more peripheral devices, for example interface 112 could be a PCI card or PC card. At least one storage device 114 which houses at least one database 116 can also be provided. The memory 104 can be any form of memory device, for example, volatile or non-volatile memory, solid state storage devices, magnetic devices, etc. The processor 102 could include more than one distinct processing device, for example to handle different functions within the processing system 100.

[057] Input device 106 receives input data 118 and can include, for example, a keyboard, a pointer device such as a pen-like device or a mouse, audio receiving device for voice controlled activation such as a microphone, data receiver or antenna such as a modem or wireless data adaptor, data acquisition card, etc.. Input data 118 could come from different sources, for example keyboard instructions in conjunction with data received via a network. Output device 108 produces or generates output data 120 and can include, for example, a display device or monitor in which case output data 120 is visual, a printer in which case output data 120 is printed, a port for example a USB port, a peripheral component adaptor, a data transmitter or antenna such as a modem or wireless network adaptor, etc.. Output data 120 could be distinct and derived from different output devices, for example a visual display on a monitor in conjunction with data transmitted to a network. A user could view data output, or an interpretation of the data output, on, for example, a monitor or using a printer. The storage device 114 can be any form of data or information storage means, for example, volatile or non-volatile memory, solid state storage devices, magnetic devices, etc..

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[058] In use, the processing system 100 is adapted to allow data or information to be stored in and/or retrieved from, via wired or wireless communication means, the at least one database 116 and/or the memory 104. The interface 112 may allow wired and/or  
5 wireless communication between the processing unit 102 and peripheral components that may serve a specialised purpose. The processor 102 receives instructions as input data 118 via input device 106 and can display processed results or other output to a user by utilising output device 108. More than one input device 106 and/or output device 108 can be provided. It should be appreciated that the processing system 100 may be any form of  
10 terminal, server, specialised hardware, or the like.

[059] Referring to Figure 2 there is shown a flow chart illustrating a method of determining an optimal route between a first and second location.

15 [060] In particular, at step 210, the method includes, in the processing system, obtaining input data indicative of the first and second location. At step 220, the method includes, in the processing system, obtaining real time traffic data. At step 230, the method includes, in the processing system, generating predicted traffic congestion data using the real time traffic data and historical traffic data. At step 240, the method includes, determining, from  
20 a plurality of potential routes between the first and second location, an optimal route for a commuter travelling between the first and second location based upon the predicted traffic congestion data

[061] By calculating the predicted traffic congestion using both real time traffic data and  
25 historical traffic data, a more accurate optimal route can be determined for the commuter.

[062] It will be appreciated from above that a processing system can be provided for determining an optimal route between a first and second location. In particular, the processing system is configured to: obtain input data indicative of the first and second  
30 location; obtain real time traffic data; generate predicted traffic congestion data using the real time traffic data and historical traffic data; and determine, from a plurality of potential

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routes between the first and second location, an optimal route for a commuter travelling between the first and second location based upon the predicted traffic congestion data. It will be appreciated that processing system 100 is suitable for this embodiment.

5 [063] It will also be appreciated from above that a computer program product can be provided which can configure a processing system, such as processing system 100, to determine an optimal route between a first and second location. In particular, the computer program product can include executable instructions which when executed in a processing system configure the processing system to: obtain input data indicative of the first and  
10 second location; obtain real time traffic data; generate predicted traffic congestion data using the real time traffic data and historical traffic data; and determine, from a plurality of potential routes between the first and second location, an optimal route for a commuter travelling between the first and second location based upon the predicted traffic congestion data. It will be appreciated that computer program product may configure a processing  
15 system in accordance with processing system 100 for this embodiment.

[064] The computer program product can be provided in the form of software. The software may be stored in a computer readable medium, and loaded into the computer, from the computer readable medium, to allow execution. A computer readable medium  
20 having such software or computer program recorded on it can be considered a computer program product.

[065] The term "computer readable medium" as used herein refers to any storage or transmission medium that participates in providing instructions and/or data to the computer  
25 system 100 for execution and/or processing. Examples of storage media include floppy disks, magnetic tape, CD-ROM, a hard disk drive, a ROM or integrated circuit, a magneto-optical disk, or a computer readable card such as a PCMCIA card and the like, whether or not such devices are internal or external of the processing system 100. Examples of transmission media include radio or infra-red transmission channels as well as a network  
30 connection to another computer or networked device, and the Internet or Intranets including e-mail transmissions and information recorded on Websites and the like.

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[066] Referring to Figure 3 there is shown a functional block diagram of an example optimal route determination system for determining an optimal route between a first and second location. In particular the system includes a real-time traffic data system 310 in data communication with a traffic congestion prediction system 320 which is in data communication with a route processing system. The route processing system is in data communication with the commuter interface device 370.

[067] More specifically, the real-time traffic data system 310 includes a plurality of traffic sensors 312 for sensing traffic conditions throughout a road network. Whilst the traffic sensors 312 can be traditional traffic sensors that are positioned adjacent roads upon the road network, other forms of sensors can also be used such as video sensors or traffic reports which may be collected via radio of similar means.

[068] The real time traffic conditions 316 sensed by the traffic sensors 312 are transferred to a real time traffic data collector 314 which can be provided in the form of a processing system similar to processing system 100. The real time traffic data collector 314 processes the sensed traffic conditions 316 to generate real time traffic data 318 which is suitable for predicting traffic congestion. The real time traffic data collector 314 may process the sensed measurements by the sensors 312 to determine meaningful values such as traffic volume, travelling speed, or an indication of a traffic jam or incident such as a traffic accident. If alternate forms of sensors 312, such as video cameras are being used to determine real time traffic conditions, then video recognition can be performed by the real time traffic data collector 314 to extract or determine the relevant data.

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[069] As shown in Figure 3, the real time traffic data collector 314 transfers the real time traffic data 318 to the traffic congestion prediction system 320 and optionally the route processing system 340. Whilst the real time traffic data 318 may be forwarded directly to the route processing system 340 by the real time traffic data collector 314, in an alternate form, the traffic congestion prediction system 320 may act as an intermediary and forward the real time traffic data 318 to the route processing system 340.

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[070] The traffic congestion prediction system 320 can be provided in the form of a processing system such as processing system 100. The traffic congestion prediction system 320 is in data communication with a historical traffic database 330 including historical traffic data 332, and a road network database 350 including road network data 352 indicative of the road network. The road network database 350 includes road network data 352 indicative of the geography of the road network, such as the distance of roads in the road network. It will be appreciated that one or more processing systems, such as processing system 100, may be provided to host the historical traffic database 330 and the road network database 350 separately to the traffic congestion prediction system 320, however, this is not essential.

[071] The traffic congestion prediction system 320 uses the real time traffic data 318, historical traffic data 332 from the historical traffic database 330, and road network data 352 from the road network database 350 to calculate predicted traffic congestion data 324. The predicted traffic congestion data 324 calculated by the traffic congestion prediction system 320 can be temporarily stored by the traffic congestion prediction system 320 until requested by the route processing system 340 once an optimal route request 372 is received, as will be explained in more detail below. Once the predicted traffic congestion data 324 has been determined, the real time traffic data 318 can be stored in the historical traffic database 330 to help predict future traffic congestion conditions.

[072] The route processing system 340 can be provided in the form of a processing system, such as processing system 100. The route processing system 340 is in data communication with the historical traffic database 330, the road network database 350, and optionally a road toll database 360 which stores road toll data 362 of a financial cost incurred at road tolls and the roads which these road tolls are incurred upon. As previously discussed, the route processing system 340 may be a separate processing system which communicates with a database server processing system which stores these databases, however, this is not essential.

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[073] As will be discussed in more detail in relation to Figure 4, when an optimal route request 372 is transferred by the commuter interface device 370 and received by the route processing system 340, the route processing system 340 can use the predicted traffic congestion data 324, the road network data 352 from the road network database 350, the  
5 historical traffic data 332 from the historical traffic database 330 and optionally the road toll data 362 from the road toll database 360 to determine a plurality of routes from a first location to a second location in the road network and associated weights for each route. As will be appreciated and also discussed in more detail below, a number of different weights can be used to assess the optimal route, such as the predicted travel time, the predicted  
10 distance travelled, or the predicted fuel consumption consumed for each available route.

[074] The route processing system 340 performs a comparison of the calculated weights for each route to determine the optimal route associated with the most favourable weight. Upon determining the optimal route, the route processing system 340 generates optimal  
15 route data 342 indicative of the optimal route from the first location to the second location. The optimal route data 342 is then transferred to the commuter interface device 370.

[075] The commuter interface device 370 is in data communication with the route processing system 340. The commuter interface device 370 is generally a mobile  
20 processing system, such as a mobile telephone, mobile navigation processing system, PDA, laptop, or similar device which is able to utilise a wireless communication network whilst the commuter travels upon the road network. The commuter interface device has the same functional architecture to that of the processing system 100, however, it will be appreciated that the commuter interface device 370 is generally of a smaller physical size to allow ease  
25 of mobility.

[076] The commuter interface device 370 includes a GPS unit 378 which allows the commuter interface device 370 to determine a current location of the commuter interface device 370, and thus the commuter. As will be discussed in more detail in relation to  
30 Figure 4, when the optimal route request 372 is generated by the commuter interface

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device 370, the GPS unit 378 can determine the current GPS location of the commuter interface device 370 which is then used as an indication of the first location.

[077] The commuter interface device 370 can include a map engine presentation unit 376  
5 which stores map presentation data indicative of the road network. The map engine presentation unit 376 can use the optimal route data 342 in combination with the map presentation data to generate optimal route presentation data which is displayed to the commuter. In a preferable form, the map presentation data is stored in the form of visual  
10 pictures indicative of a road map which can be adjusted with the optimal route data to highlight the optimal route to the commuter. However, as will be appreciated, this is not essential and that textual or audio presentation mediums are also possible by the commuter interface device.

[078] The commuter interface device 370 can additionally include an input device to  
15 allow the user to indicate the second location. The input device of the commuter interface device may include a keyboard, a touch screen, or similar other input devices. However, again it will be appreciated that other forms of input device, such as voice recognition, are possible for the commuter interface device 370 to determine the second location.

[079] It will be appreciated that the optimal route determination system 300 depicted in  
20 Figure 300 can be formed using a distributed processing system architecture, wherein a plurality of processing systems are in communication via one or more networks. However, particular portions of the optimal route determination system 300 may be provided using a single processing system, such as processing system 100. For example, the real time traffic  
25 data collector 314, the traffic congestion prediction system 320, the historical traffic database 330, the road network database 350, the road toll database 360, and/or the route processing system 340 can be provided as a single processing system, such as processing system 100. However, it is preferable that multiple computer processing systems, such as processing system 100, are used to form the optimal route determination system 300 so as  
30 to increase processing performance of each portion of the system.

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[080] Referring to Figure 4 there is shown a flow chart illustrating a more detailed example of a method of determining an optimal route between a first and second location.

[081] In particular at step 405, the method 400 includes the real time traffic sensors 312  
5 sensing real time traffic conditions 316 upon the road network. As discussed, the measurements collected by the traffic sensors 312 may not be in a discernable form for use in predicting traffic congestion and therefore may require analysis.

[082] At step 410, the real time traffic sensors 312 forward the real time traffic conditions  
10 316 to the real time traffic data collector 314.

[083] At step 415, the traffic data collector 314 analyses the real time traffic conditions 316 in order to extract real time traffic data 318. For example, this may include analysing the time intervals between two sensed cars travelling over a weight sensor to determine a  
15 speed of the traffic. Additionally or alternatively, analysis of the video data may be performed in order to determine the traffic speed, traffic volume, or an indication of an accident or incident upon a particular portion of the road network. As the system 300 includes a plurality of traffic sensors 312, the real time traffic data collector 314 collects multiple traffic conditions over a road network. Therefore, the data 316 collected can  
20 include identification data indicative of the location upon the road network of the sensed traffic conditions 316.

[084] At step 420, the traffic data collector 314 forwards the real time traffic data 318 to the traffic congestion predict server 320 and optionally the route processing system 340. In  
25 the event that the real time traffic data collector 314 does not forward the real time traffic data 318 to the route processing system 340, an intermediary processing system, such as the traffic congestion prediction system 320, may predict real time traffic data 318 for later use in determining an optimal route between the first and second location.

30 [085] At step 425, the traffic congestion predict server 320 calculates the predicted traffic congestion data 324 using the real time traffic data 318, historical traffic data 332 stored in

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the historical traffic database 330, and road network data 350 stored in the road network database 350.

[086] In a preferable form, the traffic congestion prediction system 320 may determine a series of predicted traffic congestion datum 320 for discrete time intervals. In this manner, the series of predicted traffic congestion data 324 is temporally dependent. The traffic congestion prediction system 320 may calculate the predicted traffic congestion which is expected in predetermined time intervals, such as ten minutes, for at least some of the road network, wherein the temporally dependent predicted traffic congestion data 324 is generated for a plurality of potential route portions. For example, the traffic congestion prediction system 320 may calculate that an estimate of two minutes of traffic congestion can be experienced travelling between a first point and a second point upon a road network in ten minutes into the future, and that ten minutes of traffic congestion can be experienced travelling between the same first and second point in twenty minutes in the future. In this form, the estimated future traffic data 324 which is generated by the traffic congestion prediction system 320 may be generated in the form of a series of predicted traffic congestion datum 324 for particular time frames in the future. The length of the discrete time intervals can be adjusted according to how accurate an estimation is required. Once the predicted traffic congestion data 324 has been determined, the real time data 318 can be stored in the historical traffic database 330.

[087] Step 405 through to steps 425 continue to loop over time as further real time traffic conditions are sensed, collected and processed by the system 300.

[088] At step 430, a commuter interface device 370 generates a optimal route request 372 indicative of a first location and a second location. The commuter interface device 372 may automatically generate the optimal route request 372 whilst the commuter is travelling along the road network. Alternatively, the commuter may use the input device of the commuter interface device 370 to indicate at least one of the first and second locations. In one form, the GPS unit 378 of the commuter interface device 370 can be queried to

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determine a current location of the commuter to indicate the first location in the optimal route request 372.

[089] At step 435, the commuter interface device 370 transfers the optimal route request 5 372 indicative of the first location and second location to the route processing system 340. The commuter interface device 370 preferably transfers the optimal route request via a wireless network, such as a telecommunications network or the like.

[090] At step 440, the route processing system 340 determines possible routes through a 10 road network whilst applying weights based upon the real time traffic data 318, the predicted traffic congestion data 324, the distance of each possible route as indicated by the road network database 350 and optionally road toll data 362 indicated by the road toll database 360. The route processing system thereby determines a plurality of possible routes through the road network between the first and second location, wherein each 15 determined route has an associated weight thereby indicating the favourability of the respective route compared to other possible routes between the first and second location.

[091] At step 445, the route processing system 340 compares the associated weights of the plurality of routes to determine the most favourable route based on the associated 20 respective weight. As has been discussed, numerous weight factors can be used. For example, in one form, the weight may be in terms of expected travel time. In this form, the route having the lowest weight indicative of the least travel time is selected as the most favoured. In an alternate example, the weight may be indicative of financial cost, wherein the cost incurred is weighted according to fuel consumed whilst travelling and optionally 25 one or more road tolls incurred along the respective route. Again, in this instance, the route having the least associated financial weight is determined to be the most favoured route. In a further form, the weight may be in terms of distance travelled, wherein the route with the lowest distance travelled is selected as the most favoured.

30 [092] At step 450, the route processing system 340 transfers optimal route data 342 indicative of the optimal route to the commuter interface device 370 via a communications

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network, which is preferably a wireless network. In a preferable form, the optimal route data is transferred via the wireless network such as a mobile telecommunications network. In a specific form, the optimal route data 370 may be disseminated using various services such as SMS, GPRS, GIS or 3G in various formats such as text, static or animated graphics  
5 and/or audio.

[093] At step 455, the commuter interface device 370 interprets the optimal route data 342 and presents the optimal route data 342 to the commuter. The commuter interface device 370 may use the optimal route data 342 in association with the map engine  
10 presentation unit 376 to generate map presentation data for presentation to the commuter via the commuter interface device 370. In particular, a section of a road map stored by the map engine presentation unit 376 may be modified with the optimal route data to highlight the optimal route in a visual form. However, it will be appreciated that other forms of presentation, other than visual, are possible. Optionally, the map engine presentation unit  
15 376 may receive a current location of the commuter interface device 370 from the GPS unit 378 which can be presented simultaneously.

[094] In one optional form, a number of subsequent optimal route requests 372 may be transferred from the commuter interface device 370 to the route processing system 340  
20 whilst the commuter travels along the road network. In this manner, when a subsequent optimal route request 372 is transferred to the route processing system 340, the GPS unit 378 may be queried to determine the new current location of the commuter interface device 370. In one particular form, subsequent optimal route requests 372 may be transferred upon receipt of a detected change in the current position from the GPS unit 378  
25 of the commuter interface device 370. In an alternative form, subsequent optimal route requests 372 may be generated upon regular time intervals.

[095] Referring to Figure 5 there is shown a flowchart representing a method of determining an optimal route based upon weights for a plurality of available paths between  
30 a first and second location. In particular, the method is based upon the Dijkstra algorithm to solve the shortest path between two points on a map. Specifically, the road network can

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be represented as a graph with road junctions as vertices (also referred to as nodes) and road segments between the junctions being edges. The example flowchart determines the most favourable path between the first location, that being the source node, and the second location, that being the target node.

5

[096] It will be appreciated that the method 500 depicted in Figure 5 is a form of method performed by the route processing system 340 to determine the optimal route for the commuter.

10 [097] The method 500 utilises a number of variables for determining the optimal route. In particular:

- Node u is the current node being analysed in the network;
- Node v is one of the neighbouring nodes to node u in the network
- Sum[u] is the weight for travelling to node u from the source node;
- 15 • Time[u] is the travel time for travelling to node u from the source node;
- Prev[u] is a node previously travelled in order to reach node u;
- sum[u, v] is the weight for travelling from node u to node v;
- time[u, v] is the travel time for travelling from node u to node v;
- Sum[v] is the travel time for travelling to node v from the source node;
- 20 • Alternative Sum[v] is a temporary variable to store the travel time for travelling between node v from the source node.

[098] Referring to the method 500 depicted in Figure 5, at step 505, the method includes initialising Sum[u] and Time[u] and Prev[u] to equal null for each node in the network to  
 25 equal infinity. It will be appreciated by those skilled in the art that infinity can generally not be mathematically represented using a processing system. However, a large number or the largest possible number available which can be represented by processing system can be used as an equivalent to represent such a value.

30 [099] At step 510, the method includes setting Sum[source] and Time[source] to 0. This step essentially sets where the first location, or the source node, is in the network.

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[0100] At step 515, the method includes placing all nodes into a queue. The queue may be represented in the form of an array or similar type data structure in the processing system.

5 [0101] At step 520, the method includes sorting the queue by Sum[]. Thus, upon a first iteration the source node will have the smallest Sum[u] due to being set to zero whilst the remaining nodes being set infinity or similar.

[0102] At step 525, the method includes removing node u from the queue with the smallest  
10 Sum[u]. Upon the first iteration, the source node is removed from the queue.

[0103] At step 530, the method determines whether node u is the target node. If node u is the target node (ie. the second location), the method proceeds to step 565. Otherwise, if node u is not the target node, the method proceeds to step 535. Step 530 ensures that once  
15 the target node is reached upon execution of the method 600, the optimal path has been found such that analysis of any other available paths is not required to be performed.

[0104] At step 535, the method includes determining a neighbouring node v which neighbours node u which has not been analysed. As will be appreciated from steps 535 and  
20 560, steps 540 to 555 are repeated for all neighbouring nodes.

[0105] At step 540, the method includes reading the reading sum[u, v] and time[u, v] based upon Time[u]. This step allows for the weight between node u and v to be determined at the time, Time[u], which the commuter is expected to arrive at node u.

25

[0106] As shown in Figure 5, a concurrent set of steps, that being steps 575, 580, and 585 are performed whilst the method is being performed. As discussed above, real time data 318 is continually sensed, collected, processed, and stored over time. At step 575, real time traffic data is collected. At step 580, the method includes determining the predicted traffic  
30 congestion data 324 using the real time data 318 and historical data. At step 585, the method includes storing in a database, sum[u,v] and time[u, v] for every pair of

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neighbouring nodes  $u$  and  $v$  in the network for the future. Therefore, at step 540, the database is queried to return the values of  $\text{sum}[u, v]$  and  $\text{time}[u, v]$  based upon  $\text{Time}[u]$ .

[0107] At step 545, the method includes calculating Alternate Sum[ $v$ ] by summing Sum[ $u$ ] and  $\text{sum}[u, v]$ . At step 550, the method determines whether Alternate Sum[ $v$ ] is less than Sum[ $v$ ]. If this condition is satisfied, a new portion of an optimal path has been determined such that the method proceeds to step 555 where Sum[ $v$ ] is set to Alternate Sum[ $v$ ], the Time[ $v$ ] is set to the summation of Time[ $u$ ] and  $\text{time}[u, v]$ , and Prev[ $v$ ] is set to node  $u$ . However, in the event that Alternate Sum[ $v$ ] is not less than Sum[ $v$ ], then node  $v$  is not part of the optimal route and is ignored.

[0108] Once the method reaches step 560, the method determines whether all neighbouring nodes, node  $v$ , have been analysed. If there are more neighbouring nodes, node  $v$ , to be analysed for the current node, node  $u$ , then the method returns back to step 540 where the next neighbouring node, node  $v$ , is analysed through steps 540 to 560. However, in the event that all neighbouring nodes of node  $u$  have been analysed, the method proceeds back to step 520, such that a new current node can be analysed in the network, wherein the method continues to execute steps 520 and 525.

[0109] As previously discussed, at step 530, the method determines whether the current node being analysed, node  $u$ , is the target node, wherein upon a successful determination, the method proceeds to step 565. At step 565, the method includes generating the optimal path by traversing through Prev[] to determine Prev[ $u$ ] at each node of the optimal path such as to determine a list of nodes which form the optimal path.

[0110] At step 570, the method includes determining the optimal path including the list of nodes and the weight, Sum[ $u$ ].

[0111] It will be appreciated that the method 500 can be used for weights such as total distance travelled or fuel consumption of the commuter through the network.

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[0112] Referring to Figure 6, there is shown a further flowchart representing an example method of determining an optimal route. In particular, the method calculates the optimal path based on a temporal weight. Therefore, a number of the steps throughout method 600 have been modified to only measure time compared to Figure 5 which measured the time and either the distance travelled or the fuel consumed to determine the optimal path.

[0113] The traffic congestion prediction system 320 may use a number of methods to determine the predicted traffic congestion data 324.

[0114] In a preferable form, the traffic congestion prediction system 320 can generate and run a traffic simulator in order to determine the predicted traffic congestion data 324. The traffic simulator can use the historical data and the real-time data to determine the predicted traffic congestion data 324. Using a traffic simulation engine, the traffic conditions along the road networks can be simulated (and thus, predicted) for different times of a day, and for different days of the week, year etc. It has additional advantage in that if there are changes to the road network such as lane closure, traffic signal time changes, or signage changes indicated along the roads, these effects can be incorporated into the simulation engine and thus dynamically generate predicted traffic congestion data 324 for a period into the future. The simulation engine can also use historical traffic data 332 in combination with the real time traffic data to provide an accurate view of the road condition in the near future in the form of a simulation. The traffic simulation can respond to varying traffic flow, as well as responding to abnormal occurrences such as traffic accidents, and road works, which is not possible using other prediction methods. Thus, a more accurate prediction of an optimal route is possible using a traffic simulation to determine the predicted congestion data for the road network compared to other prediction methods which do not necessarily take into consideration both the historical and real time data 318.

[0115] In another form, a historical statistical method may be used to determine similar historical traffic conditions to that being currently indicated by the real time traffic data.

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The historical and real time traffic data may be weighted accordingly in order to determine the predicted congestion traffic data.

[0116] In another form, network analysis may be performed by the traffic congestion prediction system 320. In particular, the traffic congestion prediction system 320 may analyse the current traffic conditions at the road network together with historical traffic build-up patterns. This information can be fed into a learning system, such as neural network, in order that the learning system learns the behavior of traffic patterns, and can provide a predict of future traffic congestion given some amount of current and past traffic data. This can be build into a self-learning system where its results are constantly calibrated by comparing its predicted result with the actual result.

[0117] The above embodiments may take the form of an entirely hardware embodiment, an entirely software embodiment, firmware, or an embodiment combining software and hardware aspects.

[0118] Optional embodiments of the present invention may also be said to broadly consist in the parts, elements and features referred to or indicated herein, individually or collectively, in any or all combinations of two or more of the parts, elements or features, and wherein specific integers are mentioned herein which have known equivalents in the art to which the invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

[0119] Although a preferred embodiment has been described in detail, it should be understood that various changes, substitutions, and alterations can be made by one of ordinary skill in the art without departing from the scope of the present invention.

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## Claims

1. A method of determining an optimal route between a first and second location, wherein the method includes, in a processing system, steps of:
  - 5 (a) obtaining input data indicative of the first and second location;
  - (b) obtaining real time traffic data;
  - (c) generating predicted traffic congestion data using the real time traffic data and historical traffic data; and
  - (d) determining, from a plurality of potential routes between the first and
- 10 second location, an optimal route for a commuter travelling between the first and second location based upon the predicted traffic congestion data.
2. The method according to claim 1, wherein the method includes:
  - obtaining the current commuter location;
- 15 repeating steps (b), (c) and (d) wherein the first location is set to be the current commuter location upon performing repetitions of steps (b), (c) and (d) to update the optimal route.
3. The method according to claims 1 or 2, wherein the predicted traffic congestion
- 20 data is temporally dependent.
4. The method according to claim 3, wherein the method includes:
  - generating, using the real time traffic data and historical traffic data, the temporally
  - dependent predicted traffic congestion data indicative of predicted traffic congestion for a
  - 25 plurality of potential route portions for a plurality of future time intervals; and
  - determining the optimal route using the temporally dependent predicted traffic
  - congestion data to determine an estimated time which the commuter is expected to travel
  - along a respective route portion to determine the estimated traffic congestion expected to
  - be experienced by the commuter during travel.
- 30 5. The method according to claim 4, wherein the method includes:

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determining a weight for each potential route portion in accordance with one or more weight factors;

determining the optimal route using the weight for each potential route portion;

5 6. The method according to claim 5, wherein the one or more weight factors include an estimated travel time to travel the potential route portion, wherein the estimated travel time is determined using the temporally dependent predicted traffic congestion data.

7. The method according to claim 5 or 6, wherein the one or more weight factors  
10 include an estimated fuel consumption when travelling along the potential route portion, wherein the estimated fuel consumption is determined using the temporally dependent predicted traffic congestion data.

8. The method according to any one of claims 5 to 7, wherein the one or more weight  
15 factors include an estimated travel distance to travel the potential route portion, wherein the estimated travel time is determined using a road network data store.

9. The method according to any one of claims 5 to 8, wherein the one or more weight factors include one or more road tolls incurred by travelling along the potential route  
20 portion, wherein the one or more road tolls incurred is determine using a road toll data store.

10. The method according to any one of claims 5 to 9, wherein the method includes determining the optimal route by applying Dijkstra algorithm in relation to the weights for  
25 the potential route portions to determine a plurality of connected potential route portions having a total weight favourable for the commuter.

11. The method according to any one of claims 1 to 10, wherein the method includes using the real time traffic data and the historical traffic data in a simulator to generate the  
30 predicted traffic congestion data.

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12. The method according to any one of claims 1 to 11, wherein the method includes:  
obtaining traffic incident data indicative of a traffic incident; and  
generating, using the traffic incident data, the predicted traffic congestion data.
- 5 13. The method according to any one of claims 1 to 12, wherein the method includes  
transferring optimal route data indicative of the optimal route to a commuter interface  
device for presenting the optimal route to the commuter.
14. A processing system for determining an optimal route between a first and second  
10 location, wherein the processing system is configured to:  
(a) obtain input data indicative of the first and second location;  
(b) obtain real time traffic data;  
(c) generate predicted traffic congestion data using the real time traffic data and  
historical traffic data; and  
15 (d) determine, from a plurality of potential routes between the first and second  
location, an optimal route for a commuter travelling between the first and second location  
based upon the predicted traffic congestion data.
15. The processing system according to claim 14, wherein the processing system is  
20 configured to:  
obtain the current commuter location; and  
repeat steps (b), (c) and (d) wherein the first location is set to be the current  
commuter location upon performing repetitions of steps (b), (c) and (d) to update the  
optimal route.  
25
16. The processing system according to claims 14 or 15, wherein the predicted traffic  
congestion data is temporally dependent.
17. The processing system according to claim 16, wherein the processing system is  
30 configured to:

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generate, using the real time traffic data and historical traffic data, the temporally dependent predicted traffic congestion data indicative of predicted traffic congestion for a plurality of potential route portions for a plurality of future time intervals; and

5 determine the optimal route using the temporally dependent predicted traffic congestion data to determine an estimated time which the commuter is expected to travel along a respective route portion to determine the estimated traffic congestion expected to be experienced by the commuter during travel.

18. The processing system according to claim 17, wherein the processing system is  
10 configured to:

determine a weight for each potential route portion in accordance with one or more weight factors;

determine the optimal route using the weight for each potential route portion;

15 19. The processing system according to claim 18, wherein the one or more weight factors include an estimated travel time to travel the potential route portion, wherein the estimated travel time is determined using the temporally dependent predicted traffic congestion data.

20 20. The processing system according to claim 18 or 19, wherein the one or more weight factors include an estimated fuel consumption when travelling along the potential route portion, wherein the estimated fuel consumption is determined using the temporally dependent predicted traffic congestion data.

25 21. The processing system according to any one of claims 18 to 20, wherein the one or more weight factors include an estimated travel distance to travel the potential route portion, wherein the estimated travel time is determined using a road network data store.

22. The processing system according to any one or claims 18 to 21, wherein the one or  
30 more weight factors include one or more road tolls incurred by travelling along the

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potential route portion, wherein the one or more road tolls incurred is determine using a road toll data store.

23. The processing system according to any one of claims 18 to 22, wherein the  
5 processing system is configured to determine the optimal route by applying Dijkstra algorithm in relation to the weights for the potential route portions to determine a plurality of connected potential route portions having a total weight favourable for the commuter.

24. The processing system according to any one of claims 14 to 23, wherein the  
10 processing system is configured to use the real time traffic data and the historical traffic data in a simulator to generate the predicted traffic congestion data.

25. The processing system according to any one of claims 14 to 24, wherein the processing system is configured to:  
15 obtain traffic incident data indicative of a traffic incident; and  
generate, using the traffic incident data, the predicted traffic congestion data.

26. The processing system according to any one of claims 14 to 25, wherein the processing system is configured to transfer optimal route data indicative of the optimal  
20 route to a commuter interface device for presenting the optimal route to the commuter.

27. A computer program product including a computer readable medium having executable instructions which when executed enable a processing system to determine an optimal route between a first and second location, wherein the computer program  
25 configures the processing system to:

- (a) obtain input data indicative of the first and second location;
- (b) obtain real time traffic data;
- (c) generate predicted traffic congestion data using the real time traffic data and historical traffic data; and

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(d) determine, from a plurality of potential routes between the first and second location, an optimal route for a commuter travelling between the first and second location based upon the predicted traffic congestion data.

5 28. The computer program product according to claim 27, wherein the computer program product configures the processing system to:

obtain the current commuter location; and

repeat steps (b), (c) and (d) wherein the first location is set to be the current  
commuter location upon performing repetitions of steps (b), (c) and (d) to update the  
10 optimal route.

29. The computer program product according to claims 27 or 28, wherein the predicted traffic congestion data is temporally dependent.

15 30. The computer program product according to claim 29, wherein the computer program product configures the processing system to:

generate, using the real time traffic data and historical traffic data, the temporally dependent predicted traffic congestion data indicative of predicted traffic congestion for a plurality of potential route portions for a plurality of future time intervals; and

20 determine the optimal route using the temporally dependent predicted traffic congestion data to determine an estimated time which the commuter is expected to travel along a respective route portion to determine the estimated traffic congestion expected to be experienced by the commuter during travel.

25 31. The computer program product according to claim 30, wherein the computer program product configures the processing system to:

determine a weight for each potential route portion in accordance with one or more weight factors;

determine the optimal route using the weight for each potential route portion;

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32. The computer program product according to claim 31, wherein the one or more weight factors include an estimated travel time to travel the potential route portion, wherein the estimated travel time is determined using the temporally dependent predicted traffic congestion data.

5

33. The computer program product according to claim 31 or 32, wherein the one or more weight factors include an estimated fuel consumption when travelling along the potential route portion, wherein the estimated fuel consumption is determined using the temporally dependent predicted traffic congestion data.

10

34. The computer program product according to any one of claims 31 to 33, wherein the one or more weight factors include an estimated travel distance to travel the potential route portion, wherein the estimated travel time is determined using a road network data store.

15

35. The computer program product according to any one or claims 31 to 34, wherein the one or more weight factors include one or more road tolls incurred by travelling along the potential route portion, wherein the one or more road tolls incurred is determine using a road toll data store.

20

36. The computer program product according to any one of claims 31 to 35, wherein the computer program product configures the processing system to determine the optimal route by applying Dijkstra algorithm in relation to the weights for the potential route portions to determine a plurality of connected potential route portions having a total weight  
25 favourable for the commuter.

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37. The computer program product according to any one of claims 27 to 36, wherein the computer program product configures the processing system to use the real time traffic data and the historical traffic data in a simulator to generate the predicted traffic congestion  
30 data.

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38. The computer program product according to any one of claims 27 to 37, wherein the computer program product configures the processing system to:

obtain traffic incident data indicative of a traffic incident; and

generate, using the traffic incident data, the predicted traffic congestion data.

5

39. The computer program product according to any one of claims 27 to 38, wherein the computer program product configures the processing system to transfer optimal route data indicative of the optimal route to a commuter interface device for presenting the optimal route to the commuter.

10

40. A system, a method, a processing system, and/or a computer program product for determining an optimal route between a first and second location for a commuter, being substantially hereinbefore described with reference to the accompanying drawings.

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