{DESCRIPTION}

{Title of Invention}

INFORMATION PROCESSING DEVICE, TOLL COLLECTION SYSTEM, AND TOLL COLLECTION METHOD

{Technical Field}

{0001}

The present invention relates to information processing devices, toll collection systems, and toll collection methods.

{Background Art}

{0002}

In the related art, the so-called global positioning system (GPS) that measures the current position of a vehicle on the basis of a GPS signal received by an antenna in the vehicle from GPS satellites has become widely available. Moreover, a technology for charging a toll to a vehicle traveling in a toll area, which is an area where a toll is charged, on the basis of the position of the vehicle measured by the GPS has been developed.

PTL 1 discusses a technology for comparing the toll area with the current position of the vehicle measured by the GPS and issuing a notification that the vehicle is approaching the toll area when the vehicle is 500 m outside the toll area.

{Citation List}

{Patent Literature}

{0003}

{PTL 1} Japanese Unexamined Patent Application, Publication No. Hei 11-211487

{Summary of Invention}

{Technical Problem}

{0004}

However, in the technology discussed in PTL 1, it is not possible to determine whether or not there is a traffic jam on a road within the toll area, making it impossible to provide a high-convenience service to occupants of vehicles traveling within the toll area.

{0005}

In view of such circumstances, it is an object of the present invention to provide an information processing device, a toll collection system, and a toll collection method that can detect whether or not there is a traffic jam on a road by using measured positions of vehicles.

{Solution to Problem}

{0006}

In order to solve the aforementioned problem, an information processing device, a toll collection system, and a toll collection method of the present invention employ the following solutions.

{0007}

Specifically, an information processing device according to a first aspect of the present invention includes receiving

means for receiving positional information indicating the positions of a plurality of vehicles from the vehicles; storage means for storing road-range information indicating segmented road ranges obtained by virtually segmenting a road on which the vehicles travel in a predetermined area into multiple segments; calculating means for calculating a value indicating traffic conditions of the vehicles traveling on the road corresponding to one of the segmented ranges indicated by the road-range information stored in the storage means on the basis of the positional information received by the receiving means; and detecting means for detecting whether or not a traffic jam has occurred on the road corresponding to the range where the calculation is performed by the calculating means on the basis of the value indicating the traffic conditions calculated by the calculating means and a predetermined threshold value.

{0008}

In the above configuration, the information processing device includes the receiving means for receiving the positional information indicating the positions of the vehicles from the vehicles, and the storage means for storing the road-range information indicating the segmented road ranges obtained by virtually segmenting a road on which the vehicles travel in the predetermined area into multiple segments.

For example, the positional information of each vehicle is generated on the basis of a GPS signal received from GPS satellites and indicates the position of the vehicle based on the latitude and the longitude thereof.

The predetermined area is, for example, an area where a toll is charged to vehicles traveling therein. The segmented road ranges are each defined by, for example, the latitude and the longitude at the start point of the segmented road, the latitude and the longitude at the end point, and the road width.

{0009}

Based on the positional information received by the receiving means, the calculating means calculates the value indicating the traffic conditions of the vehicles traveling on the road corresponding to the segmented range indicated by the road-range information. Based on the value calculated by the calculating means and the threshold value, the detecting means detects whether or not there is a traffic jam on the road corresponding to the range where calculation is performed by the calculating means.

{0010}

Accordingly, the present invention detects whether or not there is a traffic jam on a road corresponding to each segmented range from the value indicating the traffic conditions calculated on the basis of the positional

information received from the vehicles traveling on the road, thereby allowing for traffic-jam detection on the road by using the measured positions of the vehicles.

{0011}

In the first aspect, the value indicating the traffic conditions preferably includes at least one of the density of the vehicles traveling on the road corresponding to the segmented range and the speed of the vehicles, the density and the speed being obtained on the basis of the positional information of the vehicles received by the receiving means.

{0012}

With the above configuration, since the value indicating the traffic conditions used for the traffic-jam detection includes at least one of the density of the vehicles traveling on the road corresponding to the segmented range and the speed of the vehicles, which are obtained on the basis of the received positional information of the vehicles, it can be simply and accurately detected whether or not there is a traffic jam on the road.

{0013}

In the first aspect, the threshold value is preferably a value set according to each segmented range.

{0014}

With the above configuration, the threshold value used for the traffic-jam detection is a value set according to each

segmented range, that is, each segmented road. Thus, for example, if the value indicating the traffic conditions corresponds to the number of vehicles, a threshold value for a road corresponding to a range connected to an intersection can be set to be higher than that for a road corresponding to a range not connected to an intersection, so that vehicles waiting for the traffic lights to change at an intersection are less likely to be detected as being in a traffic jam.

Therefore, the present invention can more accurately detect whether or not there is a traffic jam on a road.

{0015}

In the first aspect, it is preferable that the information processing device further include transmitting means for transmitting, to the vehicles, a detection result indicating whether or not a traffic jam has been detected by the detecting means.

{0016}

With the above configuration, since the transmitting means for transmitting the detection result obtained by the detecting means to the vehicles is further provided, the vehicles can process the transmitted traffic-jam information and issue a notification to the vehicle occupants, thereby enhancing the convenience for the occupants of the vehicles.

{0017}

In the first aspect, it is preferable that the

information processing device further include charging means for determining a toll fee for the vehicles traveling in the predetermined area on the basis of whether or not a traffic jam has been detected on the road by the detecting means.

{0018}

With the above configuration, the charging means determines the toll fee for the vehicles traveling in the predetermined area on the basis of whether or not a traffic jam has been detected on the road. Specifically, for example, the charging means can increase or reduce the toll fee for vehicles traveling on a road with a traffic jam.

Therefore, the present invention can charge the vehicles a toll fee according to the traffic conditions.

{0019}

A toll collection system according to a second aspect of the present invention includes an on-board device that is installed in a vehicle and that generates and transmits positional information indicating the position of the vehicle, and the aforementioned information processing device.

{0020}

Since the above configuration includes the on-board device that is installed in a vehicle and that transmits positional information indicating the running position thereof, and the aforementioned information processing device, it can be detected whether or not there is a traffic jam on a

road by using measured positions of vehicles.

{0021}

A toll collection method according to a third aspect of the present invention is implemented by an information processing device including storage means for storing toll-area information indicating an area where a toll is charged to vehicles, and receiving means for receiving positional information indicating the positions of the vehicles from the vehicles. The method includes a first step of virtually segmenting a road on which the vehicles travel in a predetermined area into multiple segments and calculating a value indicating traffic conditions of the vehicles traveling on the segmented road on the basis of the positional information of the vehicles received by the receiving means; a second step of detecting whether or not a traffic jam has occurred on the road corresponding to one of the segments where the calculation is performed in the first step on the basis of the value indicating the traffic conditions calculated in the first step and a predetermined threshold value; and a third step of determining a toll fee for the vehicles traveling in the area indicated by the toll-area information stored in the storage means on the basis of the detection result obtained in the second step.

{0022}

With the above configuration, it is detected whether or

not there is a traffic jam on a road corresponding to each segmented range from the value indicating the traffic conditions calculated on the basis of the positional information received from the vehicles traveling on the road, thereby allowing for traffic-jam detection on the road by using the measured positions of the vehicles. Therefore, the present invention can determine the toll fee for the vehicles traveling in the toll area in accordance with whether or not there is a traffic jam therein.

{Advantageous Effects of Invention}

{0023}

The present invention has a notable advantage in that it is possible to detect whether or not there is a traffic jam on a road by using measured positions of vehicles.

{Brief Description of Drawings}

{0024}

{Fig. 1} Fig. 1 illustrates the overall configuration of a toll collection system according to a first embodiment of the present invention.

{Fig. 2} Fig. 2 is a block diagram schematically illustrating the configuration of an on-board device according to the first embodiment of the present invention.

{Fig. 3} Fig. 3 is a block diagram schematically illustrating the configuration of a central unit according to the first embodiment of the present invention.

{Fig. 4} Fig. 4 schematically illustrates road segments according to the first embodiment of the present invention.

{Fig. 5} Fig. 5 is a flowchart illustrating the flow of a traffic-jam detecting program according to the first embodiment of the present invention.

{Fig. 6} Fig. 6 is a flowchart illustrating the flow of a traffic-jam detecting program according to a second embodiment of the present invention.

{Description of Embodiments}

{0025}

Embodiments of an information processing device, a toll collection system, and a toll collection method according to the present invention will be described below with reference to the drawings.

{0026}

First Embodiment

A first embodiment of the present invention will be described below.

Fig. 1 is an overall schematic view of a toll collection system 10 according to the first embodiment of the present invention.

As shown in Fig. 1, the toll collection system 10 includes a facility 16 having a central unit 14 serving as an information processing device. The central unit 14 charges a toll to a vehicle 12 traveling through a toll area serving as

an area where a toll is charged (road pricing). The facility 16 including the central unit 14 may be provided outside the toll area.

{0027}

Fig. 2 is a block diagram schematically illustrating the configuration of an on-board device 20 installed in the vehicle 12 according to the first embodiment.

As shown in Fig. 2, the on-board device 20 includes a power supply circuit 26 connected with a vehicle power source 22 and an internal battery 24, a wide-area communication unit 28 that transmits/receives various kinds of information to/from the central unit 14, a global-positioning-system (GPS) receiver 30 that receives a GPS signal transmitted from multiple GPS satellites, an on-board storage section 32 that stores various kinds of information, a controller 34, a display section 38, a notification section 40 such as a buzzer or a light-emitting diode (LED), an IC-card insertion section 42 in which an integrated-circuit (IC) card is inserted, an IC-card interface 44 (shown as "IC-card I/F" in Fig. 2) provided in the IC-card insertion section 42, and a communication port 46.

{0028}

In Fig. 2, various components, such as the GPS receiver 30, do not necessarily need to be contained in the on-board device 20. For example, these various components may be

configured in any form so long as they are capable of transmitting/receiving information. As one possible configuration example, a portable terminal having a GPS function may be connected to the on-board device 20 via an external connector, and the GPS function of this portable terminal may be used as the GPS receiver 30.

With the so-called GPS that measures the current position on the basis of the GPS signal received from the multiple GPS satellites, the controller 34 generates positional information indicating the current position of the vehicle 12. Specifically, the positional information indicates the position of the vehicle 12 based on the latitude and the longitude thereof, and additionally includes the time and date when the positional information was generated.

{0029}

The power supply circuit 26 mainly adjusts a voltage supplied from the vehicle power source 22 to a voltage suitable for the on-board device 20, and supplies the voltage to each component in the on-board device 20. The internal battery 24 is provided so as to ensure enough power for performing communication even when the power supply from the vehicle power source 22 is disconnected.

{0030}

The wide-area communication unit 28 performs wireless communication with an external device and can communicate

with, for example, the central unit 14.

{0031}

The on-board storage section 32 stores various kinds of information, such as vehicle information including owner information, vehicle-type information, and a vehicle ID of the vehicle 12; positional information of the vehicle 12; identification information of the on-board device; and balance information and card information read from the IC card.

{0032}

The IC card inserted in the IC-card insertion section 42 is, for example, a contact-type IC card and has a built-in IC chip equipped with a flash memory or a microprocessor unit (MPU). In addition to card information such as a card ID number, the IC card stores the balance, the usage history, and the like. The information stored in the IC card can be read and rewritten by the controller 34 via the IC-card interface 44.

{0033}

In such an on-board device 20, when the IC card is inserted into the IC-card insertion section 42, the controller 34 reads the IC card information and the balance stored in the IC card and writes the information in the on-board storage section 32 via the IC-card interface 44, and also displays the balance on the display section 38 for a certain period of time (e.g., about 10 seconds). Furthermore, when the controller 34

is able to properly read the information from the IC card, the controller 34 activates the notification section 40 so as to notify the user of normal operation. Consequently, for example, the notification section 40 notifies the user of the normal operation by setting off a buzzer sound if the notification section 40 is a buzzer or by turning on an LED if the notification section 40 is an LED.

On the other hand, if the controller 34 is not able to read the information from the IC card, the controller 34 displays an error message on the display section 38, activates the notification section 40 so as to notify the user of the error, and prompts the user to reinsert the IC card. The notification mode of the notification section 40 differs between normal operation and abnormal operation.

{0034}

When the controller 34 acquires a request signal from the central unit 14 via the wide-area communication unit 28, the controller 34 reads information, such as the identification information of the on-board device 20, the positional information of the vehicle 12, and the card information, stored in the on-board storage section 32, and outputs the read information to the central unit 14 as a response signal to the request signal.

{0035}

The communication port 46 is an interface for performing

communication with an external device and is, for example, connectable with a wireless or wired communication medium.

{0036}

Fig. 3 is a block diagram schematically illustrating the configuration of the central unit 14 according to the first embodiment.

The central unit 14 includes a wide-area communication unit 50 that performs wireless communication with the on-board device 20 installed in the vehicle 12, a central processing unit (CPU) 52 that controls the entire central unit 14, a toll-area-information storage section 54 that stores toll-area information indicating the location of the toll area based on the latitude and the longitude thereof, a road-map storage section 56 that stores road-map information indicating roads within the toll area and in the vicinity of the toll area, and a vehicle-position storage section 58 that successively stores the positional information of the vehicle 12 received by the wide-area communication unit 50.

Moreover, the central unit 14 also includes a traveled-distance calculator 60 that calculates the route and the distance traveled by the vehicle 12, a traffic-jam detecting section 62 that detects whether or not there is a traffic jam on the roads, and a vehicle-speed measuring section 64 that measures the speed of the vehicle 12.

The central unit 14 further includes a toll-fee

determining section 66 that determines a toll fee for the vehicle 12 traveling in the toll area, a toll-table storage section 68 that stores the toll fee for the vehicle 12 as toll-table information, and a communication section 70 that transmitting/receiving information to/from other information processing devices.

{0037}

The CPU 52 controls the entire central unit 14 and executes various programs. In addition, the CPU 52 causes the wide-area communication unit 50 to transmit a request signal to the vehicle 12, receives a response signal from the on-board device 20 via the wide-area communication unit 50, and makes the vehicle-position storage section 58 store the positional information of the vehicle 12 included in the response signal.

{0038}

The traveled-distance calculator 60 calculates the route traveled by the vehicle 12 within the toll area on the basis of the positional information of the vehicle 12, and calculates the distance traveled by the vehicle 12 from the calculated traveled route.

{0039}

Then, the CPU 52 detects whether the vehicle 12 has entered or exited the toll area on the basis of the position of the vehicle 12 based on the traveled route calculated by

the traveled-distance calculator 60 and the toll-area information stored in the toll-area-information storage section 54. Subsequently, information indicating the distance traveled by the vehicle 12 detected as having entered or exited the toll area and the times of entry and exit into and from the toll area is output as entry/exit information from the CPU 52 to the toll-fee determining section 66.

{0040}

The toll-fee determining section 66 determines a toll fee for the vehicle 12 on the basis of the input entry/exit information of the vehicle 12 and the toll-table information stored in the toll-table storage section 68. The toll-table information includes a toll fee to be charged to the vehicle 12 when entering the toll area and a toll fee according to the distance traveled by the vehicle 12 within the toll area. The toll-fee determining section 66 outputs the response signal and toll-fee information indicating the determined toll fee to the wide-area communication unit 50 and the communication section 70.

{0041}

The toll-area information stored in the toll-area-information storage section 54 is appropriately updated when the toll area is changed due to road maintenance or a traffic jam of vehicles 12. Furthermore, the toll-table information also indicates, for example, toll fees set according to

whether or not there is a traffic jam on each of the roads that correspond to road segments, to be described later.

{0042}

The wide-area communication unit 50 transmits the toll-fee information to the on-board device 20 identified on the basis of the identification information of the on-board device 20 included in the response signal. When the on-board device 20 receives the toll-fee information, the on-board device 20 issues a notification of the toll fee indicated by the toll-fee information.

The communication section 70 transmits information indicating the toll fee and an account number of a financial institution designated by the card information included in the response signal to another information processing device (i.e., an information processing device of the financial institution) so that the toll fee indicated by the toll-fee information is debited from the account corresponding to the account number.

{0043}

The central unit 14 according to the first embodiment is capable of performing a traffic-jam detecting process for detecting whether or not there is a traffic jam by using the traffic-jam detecting section 62.

{0044}

The road-map storage section 56 according to the first

embodiment stores road-range information as the road-map information. Specifically, the road-range information indicates segmented road ranges (referred to as "road segments" hereinafter) obtained by virtually segmenting each of the roads on which the vehicle 12 travels in the toll area into multiple segments.

{0045}

As schematically shown in Fig. 4, regarding each of the road segments according to the first embodiment, for example, the segmented road range thereof is defined by the latitude and the longitude at the start point of the segmented road, the latitude and the longitude at the end point, and the road width. Alternatively, the segmented road range corresponding to each road segment may be defined based on other reference points, such as the latitudes and the longitudes at the four corners of the segmented range.

Furthermore, although the segmented road range corresponding to each road segment has, for example, a start point at one intersection and an end point at another intersection, if the road extends for a predetermined length or more or is curved, the segmented road range may be segmented into multiple segments regardless of the positions of the intersections.

{0046}

Furthermore, although the traffic-jam detecting process

according to the first embodiment involves detection of whether or not there is a traffic jam in each road segment, it is not necessarily required to detect whether or not there is a traffic jam on all of the road segments in the toll area. Instead, it may be detected whether or not there is a traffic jam on predetermined road segments. The aforementioned predetermined road segments include, for example, a road segment that corresponds to a road where a traffic jam frequently occurs and a road segment that corresponds to a road that is adjacent to a major building or facility.

The time band for executing the traffic-jam detecting process may be set to 24 hours or to a predetermined time band (e.g., 7 o'clock to 20 o'clock), and the execution of the process may vary depending on the day of the week.

{0047}

Fig. 5 is a flowchart illustrating the flow of a traffic-jam detecting program executed by the CPU 52 when the central unit 14 according to the first embodiment performs the traffic-jam detecting process. The traffic-jam detecting program is stored in advance in a predetermined region of a read-only memory (ROM) (not shown). The traffic-jam detecting program may commence when the central unit 14 starts its operation and may end when the central unit 14 ends its operation, or may be executed in a predetermined time band, as described above.

{0048}

First, in step 100, the program is on standby until a predetermined time (e.g., five seconds) elapses, and proceeds to step 102 after the predetermined time elapses. Specifically, a process from step 102 to step 106 (i.e., traffic-jam detecting process) is performed at predetermined time intervals.

{0049}

In step 102, the area of the road segment where traffic-jam detection is performed and the number of vehicles 12 traveling in the road segment are output to the traffic-jam detecting section 62.

The area of each road segment is obtained from the start point, the end point, and the road width of the road segment. Furthermore, the area of each road segment may be obtained in advance and stored in the road-map storage section 56 in association with the road segment, or may be calculated by the CPU 52 every time step 102 is performed.

{0050}

The number of vehicles 12 traveling in the road segment is obtained from the positional information of each vehicle 12 stored in the vehicle-position storage section 58.

In detail, for example, the CPU 52 compares the position of each vehicle 12 indicated by the corresponding positional information with the range of each road segment so as to

obtain the number of vehicles 12 located in the road segment where traffic-jam detection is performed. Alternatively, the vehicle-position storage section 58 may store the positional information of each vehicle 12 in correspondence with each road segment, and the CPU 52 may read, from the vehicle-position storage section 58, the number of vehicles 12 located in the road segment where traffic-jam detection is performed.

{0051}

When the area of the road segment where traffic-jam detection is performed and the number of vehicles 12 traveling on the road corresponding to that road segment are input to the CPU 52, the traffic-jam detecting section 62 calculates a value that indicates the traffic conditions of the vehicles 12 corresponding to the road segment where traffic-jam detection is performed.

The value indicating the traffic conditions in the first embodiment corresponds to the density of vehicles 12 traveling on the road corresponding to the road segment.

{0052}

For each input road segment, the traffic-jam detecting section 62 divides the number of vehicles 12 traveling on the road corresponding to the road segment by the area of the road segment so as to calculate the density of vehicles 12 in the road segment.

Then, if the density of vehicles 12 in the road segment

where traffic-jam detection is performed exceeds a predetermined threshold value stored in the traffic-jam detecting section 62, the traffic-jam detecting section 62 detects a traffic jam on the road corresponding to the road segment.

For example, if there is at least one vehicle 12 per 10 m^2 range (= 2 m in the vehicle-width direction × 5 m in the vehicle traveling direction) of a road segment (i.e., the density of vehicles 12 is 0.1 (vehicles/m^2), that is, the threshold value is 0.1 (vehicles/m^2)), the traffic-jam detecting section 62 detects a traffic jam on the road corresponding to the road segment.

{0053}

The aforementioned threshold value may be a value set according to each road segment, that is, a value set according to each segmented road. Accordingly, for example, in the first embodiment in which the value indicating the traffic conditions corresponds to the number of vehicles 12, a threshold value for a road segment that corresponds to a road range connected to an intersection may be set to be higher than that for a road range not connected to an intersection, so that vehicles 12 waiting for the traffic lights to change at an intersection are less likely to be detected as being in a traffic jam.

{0054}

When the detecting process for each road segment where traffic-jam detection is performed is completed, the traffic-jam detecting section 62 outputs, to the CPU 52, a detection result indicating whether or not there is a traffic jam in each road segment.

{0055}

In step 104, the program is on standby until the traffic-jam detection result is input from the traffic-jam detecting section 62. When the traffic-jam detection result is input, the program proceeds to step 106.

{0056}

In step 106, the traffic-jam detection result is output, and the program returns to step 100. In detail, the traffic-jam detection result is output to the wide-area communication unit 50 and the toll-fee determining section 66.

{0057}

When the traffic-jam detection result is input to the wide-area communication unit 50, the wide-area communication unit 50 transmits the traffic-jam detection result to each vehicle 12 equipped with the on-board device 20.

The on-board device 20 having received the traffic-jam detection result makes the display section 38 display roads with a traffic jam on the basis of the received traffic-jam detection result.

{0058}

On the other hand, when the traffic-jam detection result is input to the toll-fee determining section 66, the toll-fee determining section 66 determines a toll fee for vehicles 12 traveling in the toll area on the basis of the detection result.

In detail, the toll-fee determining section 66 reads a toll fee of a traffic-jammed road indicated by the toll-table information stored in the toll-table storage section 68, and sets the read toll fee as the toll fee for the vehicles 12.

Specifically, if the toll fee of a road with a traffic jam is set to be higher than the toll fee of a road without a traffic jam on the basis of the toll-table information, the toll-fee determining section 66 increases the toll fee for the vehicles 12 traveling on the road with the traffic jam in accordance with the fee indicated by the toll-table information. Setting a higher toll fee for a road with a traffic jam in this manner is expected to ease the traffic jam.

{0059}

If the toll fee of a road with a traffic jam is set to be lower than the toll fee of a road without a traffic jam on the basis of the toll-table information, the toll-fee determining section 66 reduces the toll fee for the vehicles 12 traveling on the road with the traffic jam in accordance with the fee indicated by the toll-table information. Setting a lower toll

fee for a road with a traffic jam in this manner is expected to ease the level of frustration that occupants of the vehicles 12 feel towards the traffic jam.

{0060}

As described above, the central unit 14 according to the first embodiment calculates a value indicating the traffic conditions of vehicles 12 traveling on a road that corresponds to a road segment indicated by the road-map information stored in the road-map storage section 56 on the basis of the positional information of each vehicle 12 received by the wide-area communication unit 50, and detects whether or not there is a traffic jam on the road corresponding to the road segment on the basis of the calculated value and the threshold value.

Therefore, the central unit 14 according to the first embodiment can detect whether or not there is a traffic jam on a road by using the measured positions of vehicles 12.

{0061}

Furthermore, in the central unit 14 according to the first embodiment, since the value indicating the traffic conditions to be used for the traffic-jam detection corresponds to the density of vehicles 12, which is based on the received positional information of each vehicle 12, traveling on the road corresponding to the road segment, it can be simply and accurately detected whether or not there is

a traffic jam on the road.

{0062}

Furthermore, in the central unit 14 according to the first embodiment, since the threshold value used for the traffic-jam detection is set according to each road segment, it can be more simply and accurately detected whether or not there is a traffic jam on the road.

{0063}

Furthermore, since the central unit 14 according to the first embodiment transmits the traffic-jam detection result to each vehicle 12, the convenience for the occupants of the vehicles 12 can be enhanced.

{0064}

Furthermore, since the central unit 14 according to the first embodiment determines a toll fee for the vehicles 12 traveling in the toll area on the basis of the traffic-jam detection result, a toll fee according to the traffic conditions can be charged to the vehicles 12.

{0065}

Second Embodiment

A second embodiment of the present invention will be described below.

{0066}

Because the configurations of a toll collection system 10, an on-board device 20, and a central unit 14 according to

the second embodiment are similar to the configurations of the toll collection system 10, the on-board device 20, and the central unit 14 according to the first embodiment shown in Figs. 1, 2, and 3, descriptions thereof will be omitted.

{0067}

Fig. 6 is a flowchart illustrating the flow of a traffic-jam detecting program according to the second embodiment. Steps in Fig. 6 that are the same as those in Fig. 5 are given the same reference numerals as in Fig. 5, and descriptions thereof will be omitted.

{0068}

Step 200 is a step that the program proceeds to after the predetermined time has elapsed in step 100. In step 200, vehicle trajectory data of vehicles 12 traveling in a road segment where traffic-jam detection is performed is read from the vehicle-position storage section 58, and the read vehicle trajectory data and the length (referred to as "road length" hereinafter) of the road segment where traffic-jam detection is performed are output to the vehicle-speed measuring section 64. The vehicle trajectory data is a set of positional information (latitude and longitude) of each vehicle 12 obtained at predetermined time intervals (e.g., one second).

{0069}

Based on the input vehicle trajectory data of multiple vehicles 12 in the road segment where traffic-jam detection is

performed, the vehicle-speed measuring section 64 calculates an average speed of the vehicles 12 traveling on the road corresponding to the road segment and outputs the calculated average speed to the CPU 52.

{0070}

In detail, based on the input vehicle trajectory data, the vehicle-speed measuring section 64 obtains, for example, a difference between the time of entry of each vehicle 12 into the road corresponding to the road segment and the time of exit from the road, and divides the road length of the road segment by the difference so as to calculate the speed of the vehicle 12.

Then, the vehicle-speed measuring section 64 averages out the speeds of multiple vehicles 12 in the same road segment so as to calculate an average speed of the vehicles 12 in the road segment where traffic-jam detection is performed.

{0071}

Subsequently, in step 202, the program is on standby until the average speed of the vehicles 12 in each road segment is input from the vehicle-speed measuring section 64. When the average speed is input, the program proceeds to step 204.

{0072}

In step 204, the input average speed in each road segment is output to the traffic-jam detecting section 62, and the

program proceeds to step 104.

{0073}

When the average speed in each road segment is input to the traffic-jam detecting section 62, the traffic-jam detecting section 62 detects a traffic jam on the road corresponding to the road segment where traffic-jam detection is performed if the average speed is below a predetermined threshold value.

Accordingly, in the second embodiment, since the value indicating the traffic conditions of vehicles 12 traveling on the road corresponds to the average speed of the vehicles 12, it can be simply and accurately detected whether or not there is a traffic jam on the road.

{0074}

In the second embodiment, the aforementioned threshold value may be set according to each road segment, i.e., according to each segmented road. Accordingly, for example, in the second embodiment in which the value indicating the traffic conditions corresponds to the average speed of the vehicles 12, it can be more accurately detected whether or not there is a traffic jam on each road by setting the threshold value on the basis of the speed limit of the road.

{0075}

When the detecting process for each road segment where traffic-jam detection is performed is completed, the traffic-

jam detecting section 62 outputs, to the CPU 52, a detection result indicating whether or not there is a traffic jam in each road segment.

{0076}

Although the present invention has been described above with reference to the above embodiments, the technical scope of the invention is not limited to the scope discussed in the embodiments. Various modifications and alterations to the above embodiments are permissible so long as they do not depart from the spirit of the invention, and embodiments in which such modifications and alterations are additionally made are also encompassed within the technical scope of the invention.

{0077}

For example, although a configuration in which the current position of each vehicle 12 is detected by using radio waves from GPS satellites is described in the above embodiments, the present invention is not limited to this configuration. Alternatively, the current position of each vehicle 12 may be detected by using radio waves transmitted from wireless local-area-network (LAN) access points that are set mainly for internet connection and that use a wireless LAN called wireless fidelity (Wi-Fi).

{0078}

Furthermore, when the number of vehicles 12 traveling on

a road corresponding to a road segment where traffic-jam detection is performed exceeds a threshold value set according to the number of vehicles 12, and the average speed of the vehicles 12 is below a threshold value set according to the average speed, the traffic-jam detecting section 62 may detect that there is a traffic jam on the road corresponding to the road segment where traffic-jam detection is performed.

{Reference Signs List}

10 toll collection system

12 vehicle

14 central unit

20 on-board device

50 wide-area communication unit

52 CPU

56 map-information storage section

62 traffic-jam detecting section

64 vehicle-speed measuring section

68 toll-table storage section

{CLAIMS}

{Claim 1}

An information processing device comprising:

receiving means for receiving positional information indicating the positions of a plurality of vehicles from the vehicles;

storage means for storing road-range information indicating segmented road ranges obtained by virtually segmenting a road on which the vehicles travel in a predetermined area into multiple segments;

calculating means for calculating a value indicating traffic conditions of the vehicles traveling on the road corresponding to one of the segmented ranges indicated by the road-range information stored in the storage means on the basis of the positional information received by the receiving means; and

detecting means for detecting whether or not a traffic jam has occurred on the road corresponding to the range where the calculation is performed by the calculating means on the basis of the value indicating the traffic conditions calculated by the calculating means and a predetermined threshold value.

{Claim 2}

The information processing device according to Claim 1, wherein the value indicating the traffic conditions includes

at least one of the density of the vehicles traveling on the road corresponding to the segmented range and the speed of the vehicles, the density and the speed being obtained on the basis of the positional information of the vehicles received by the receiving means.

{Claim 3}

The information processing device according to Claim 1 or 2, wherein the threshold value is a value set according to each segmented range.

{Claim 4}

The information processing device according to any one of Claims 1 to 3, further comprising transmitting means for transmitting, to the vehicles, a detection result indicating whether or not a traffic jam has been detected by the detecting means.

{Claim 5}

The information processing device according to any one of Claims 1 to 4, further comprising charging means for determining a toll fee for the vehicles traveling in the predetermined area on the basis of whether or not a traffic jam has been detected on the road by the detecting means.

{Claim 6}

A toll collection system comprising:

an on-board device that is installed in a vehicle and that generates and transmits positional information indicating

the position of the vehicle; and

the information processing device according to any one of Claims 1 to 5.

{Claim 7}

A toll collection method of an information processing device including storage means for storing toll-area information indicating an area where a toll is charged to vehicles, and receiving means for receiving positional information indicating the positions of the vehicles from the vehicles, the method comprising:

a first step of virtually segmenting a road on which the vehicles travel in a predetermined area into multiple segments and calculating a value indicating traffic conditions of the vehicles traveling on the segmented road on the basis of the positional information of the vehicles received by the receiving means;

a second step of detecting whether or not a traffic jam has occurred on the road corresponding to one of the segments where the calculation is performed in the first step on the basis of the value indicating the traffic conditions calculated in the first step and a predetermined threshold value; and

a third step of determining a toll fee for the vehicles traveling in the area indicated by the toll-area information stored in the storage means on the basis of the detection

result obtained in the second step.