Description

Title of Invention

VEHICLE DATA PROCESSING SYSTEM, VEHICLE DATA PROCESSING METHOD, VEHICLE DATA PROCESSING DEVICE, PROGRAM, AND RECORDING MEDIUM

Technical Field

[0001]

The present invention relates to a vehicle data processing system, a vehicle data processing method, a vehicle data processing device, a program, and a recording medium. In particular, the present invention relates to a vehicle data processing system for processing vehicle data including information of a vehicle running on a road, a vehicle data processing method of processing first vehicle data including information of a vehicle imaged by an imaging device which continuously images a road and second vehicle data including the information of the vehicle received by a wireless device having a communication area overlapping an imaging area of the imaging device from a vehicle-mounted device of the vehicle, a vehicle data processing device, a program for causing a computer to function as the vehicle data processing device, and a recording medium recording the program.

Priority is claimed on Japanese Patent Application No. 2012-082431, filed March 30, 2012, the content of which is incorporated herein by reference.

Background Art

[0002]

On a toll road, a dedicated lane for employing an electronic toll collection system (ETC) which automatically collects tolls is provided. However, there are illegal vehicles on which vehicle-mounted ETC equipment is not mounted that destroy a blocking bar installed on the gate and escape without paying tolls among vehicles using the dedicated lane. Therefore, as technology related to this background, technology for specifying an illegal vehicle by imaging a vehicle using an imaging device when the blocking bar is destroyed so as to monitor such an illegal vehicle is known (for example, see PLT 1).

[0003]

Technology for specifying an illegal vehicle by associating and recording a captured image and a charging result when the charging result in a gate is defective by imaging the vehicle using the imaging device at a point in time at which the entry of a vehicle has been detected by a vehicle detecting device provided in front of the gate is also known.

[0004]

However, the technology disclosed in the above-described PLT 1 has a problem in that it is impossible to monitor a subsequent vehicle passing through the gate after the blocking bar has been destroyed and it is difficult to accurately specify an illegal vehicle because the vehicle is imaged at a point in time at which the blocking bar has been destroyed.

[0005]

In addition, vehicles do not constantly enter the gate in the sequential order in which the vehicles are detected by the vehicle detecting device such as when a vehicle changes places with another vehicle during movement from a position of the vehicle detecting device to a position of the gate because imaging is performed before the gate

and the charging result is fixed in the gate in the above-described other technology. Thus, it is difficult to strictly manage the sequential order of vehicles detected by the vehicle detection device and the sequential order of the vehicles which enter the gate in this technology. As a result, this technology has a problem in that the association between the charging result and the image is difficult and it is difficult to accurately specify an illegal vehicle. As technology related to this background, various technologies are known (for example, see PLT 2).

[0006]

An illegal passage imaging system disclosed in PLT 2 communicates with vehicle-mounted equipment of a vehicle and acquires vehicle-mounted equipment information. Then, the illegal passage imaging system generates imaging data by imaging a vehicle using completion of communication with the vehicle-mounted equipment as a trigger. Then, when the charging result based on the vehicle-mounted equipment information is abnormal, the illegal passage imaging system associates and stores the imaging data after imaging and the vehicle-mounted equipment information. Thus, the illegal passage imaging system can easily associate a captured image of the vehicle and information of the vehicle, and easily and accurately specify an illegal vehicle.

[0007]

However, in a mobile object charging system as disclosed in PLT 2, it is necessary to provide a vehicle sensor for acquiring vehicle information of a vehicle running along a charging zone, or a wireless device for dedicated short range communications (DSRC) communication, in a large-scale structure such as a gantry as represented by an electronic road pricing (ERP) system implemented in Singapore. Thus, because the construction cost necessary to produce this mobile object charging

system is high, there is a strong demand for a reduction in construction cost. As technology related to this background, various technologies are known (for example, see PLT 3).

[0008]

In PLT 3, a mobile object charging method for reducing construction cost is disclosed. In this mobile object charging method, it is recognized that vehicle-mounted equipment mounted on a mobile object and configured to store a charging zone representing a region in which charging is performed and vehicle-mounted equipment identification information allocated to individually identify the vehicle-mounted equipment has entered the charging zone based on position information obtained according to a Global Positioning System (GPS) function. Then, in the mobile object charging method, a local side computer system generates photographing data by capturing a mobile object image within the charging zone. Then, in the mobile object charging method, a center side computer system receives the mobile object image from the local side computer. Then, in the mobile object charging method, information of a number plate is extracted from the mobile image and the extracted information is stored. Then, in the mobile object charging method, the vehicle-mounted equipment transmits transaction information including vehicle-mounted equipment identification information when the vehicle-mounted equipment has entered the charging zone to an authenticating computer on the center side computer system according to wireless communication at a predetermined timing. Then, in the mobile object charging method, the authenticating computer performs authentication for performing charging on the mobile object equipped with the vehicle-mounted equipment based on matching between the vehicle-mounted device identification information received from the vehicle-mounted equipment and pre-registered identification information. Thus, according to the mobile object charging

method, it is possible to reduce the construction cost because the installation of the large-scale structure such as the gantry for providing a roadside device for acquiring vehicle information of a vehicle running along the charging zone is unnecessary.

Citation List

Patent Literature

[0009]

PLT 1: Japanese Patent No. 4385786

PLT 2: Japanese Unexamined Patent Application, First Publication No. 2009-193167

PLT 3: Japanese Unexamined Patent Application, First Publication No. 2007-207220

Summary of Invention

Technical Problem

[0010]

In the mobile object charging system disclosed in PLT 3, only a number plate image acquiring device is provided in a local side system and the center system determines illegality by comparing a charging result with a vehicle number recognition result. In this mobile object charging system, when it is difficult to recognize the vehicle number, an operation of artificially checking the number plate image by transmitting a number plate image from which the vehicle number is not recognizable to the center system is performed.

[0011]

However, because this mobile object charging system has to image number

plates of all vehicles which pass through a road, not only does the load on a network increase, but also the burden on an operator increases when all number plate images from which vehicle numbers are not recognizable are transmitted to the center system.

Solution to Problem

[0012]

In order to solve the above-described problem, according to a first aspect of the present invention, a vehicle data processing system is provided for processing vehicle data including information of a vehicle running on a road, and includes: an imaging device configured to continuously capture an image of a road; a wireless device having a communication area overlapping an imaging area of the imaging device; and a vehicle data processing device configured to process vehicle data I including information of a vehicle captured by the imaging device and vehicle data II including information of vehicles received by the wireless device from vehicle-mounted devices of the vehicles, wherein the vehicle data processing device includes a data associating unit configured to associate (i) vehicle data II including information of a vehicle which has a possibility to be the same as information of a target vehicle of the vehicle data I among the vehicle data II with (ii) the vehicle data I.

[0013]

The vehicle data processing device may further include: a vehicle number search unit configured to retrieve vehicle data II including information of a vehicle number which is the same as information of a vehicle number of the vehicle included in the vehicle data I among the vehicle data II, and the data associating unit may properly associate the vehicle data II retrieved by the vehicle number search unit with the vehicle data I.

[0014]

The vehicle data processing device may further include: an optical character recognition availability determining unit configured to determine whether a character string of a vehicle number, which is a result of optical character recognition on a number plate of the vehicle captured by the imaging device and is represented by the information of the vehicle number of the vehicle included in the vehicle data I, is recognized as characters or not. If the optical character recognition availability determining unit determines that the entire character string of the vehicle number represented by the information of the vehicle number of the vehicle included in the vehicle data I is recognized as characters, the vehicle number search unit may retrieve vehicle data II including information of a vehicle number which is the same as the information of the vehicle number of the vehicle included in the vehicle data I among the vehicle data II.

[0015]

The vehicle data processing device may further include: a vehicle type classification search unit configured to retrieve vehicle data II including information of vehicle type classification different from information of vehicle type classification of the vehicle included in the vehicle data I among the vehicle data II; and a running limitation search unit configured to retrieve vehicle data II including information of a value which is not subject to running limitation of the road among the vehicle data II. If a result of retrieval performed by the vehicle number search unit represents that the vehicle data II including the information of the vehicle number which is the same as the information of the vehicle number of the vehicle included in the vehicle data I is not found, the data associating unit may provisionally associate the vehicle data II retrieved by the vehicle type classification search unit and the vehicle data II retrieved by the running limitation search unit with the vehicle data I.

[0016]

If results of retrieval performed by the vehicle type classification search unit and the running limitation search unit represent that the vehicle data II including the information of the vehicle type classification different from the information of the vehicle type classification of the vehicle included in the vehicle data I and the information of the value which is not subject to the running limitation of the road is not found, the data associating unit may end association of the vehicle data II with the vehicle data I without associating the vehicle data II with the vehicle data I by determining that there is a suspicion of illegality in which a vehicle-mounted device is not mounted on the vehicle on the basis that there is no vehicle data II to be associated with the vehicle data I.

[0017]

The vehicle data processing device may further include: an overlapping range search unit configured to retrieve vehicle data II including information of the wireless device having the communication area overlapping the imaging area of the imaging device represented by information of the imaging device capturing the vehicle included in the vehicle data I among the vehicle data II, the vehicle type classification search unit may retrieve the vehicle data II including the information of the vehicle type classification different from the information of the vehicle type classification of the vehicle included in the vehicle data I among the vehicle data II retrieved by the overlapping range search unit, and the running limitation search unit may retrieve the vehicle data II including the information of the value which is not subject to the running limitation of the road among the vehicle data II retrieved by the overlapping range search unit.

[0018]

If a result of retrieval performed by the overlapping range search unit represents that the vehicle data II including the information of the wireless device having the communication area overlapping the imaging area of the imaging device represented by the information of the imaging device capturing the vehicle included in the vehicle data I is not found, the data associating unit may end association of the vehicle data II with the vehicle data I without associating the vehicle data II with the vehicle data I by determining that there is no vehicle data II to be associated with the vehicle data I.

[0019]

The vehicle data processing device may further include: a character completing unit configured to complete partial characters which are not recognized as characters in the character string of the vehicle number represented by the information of the vehicle number of the vehicle included in the vehicle data I. If the optical character recognition availability determining unit determines that part of the character string of the vehicle number represented by the information of the vehicle number of the vehicle included in the vehicle data I is not recognized as the characters, the vehicle number search unit may retrieve vehicle data II including information of a vehicle number which is the same as the information of the vehicle number of the vehicle, where the characters have been completed by the character completing unit, included in the vehicle data I among the vehicle data II.

[0020]

The vehicle data processing device may further include: a control target search unit configured to retrieve vehicle data II including information of a vehicle of a control target among the vehicle data II. If the result of the retrieval performed by the vehicle number search unit represents that the vehicle data II including the information of the vehicle number which is the same as the information of the vehicle number of the vehicle,

where the characters have been completed by the character completing unit, included in the vehicle data I is not found, the data associating unit may provisionally associate the vehicle data II retrieved by the control target search unit with the vehicle data I.

[0021]

The control target search unit may retrieve the vehicle data II including the information of the vehicle of the control target among the vehicle data II retrieved by the overlapping range search unit.

[0022]

If a result of retrieval performed by the control target search unit represents that the vehicle data II including the information of the vehicle of the control target is not found, the data associating unit may provisionally associate the vehicle data II retrieved by the vehicle type classification search unit and the vehicle data II retrieved by the running limitation search unit with the vehicle data I.

[0023]

If a result of retrieval performed by the control target search unit represents that the vehicle data II including the information of the vehicle of the control target is not found and the results of the retrieval performed by the vehicle type classification search unit and the running limitation search unit represent that the vehicle data II including the information of the vehicle type classification different from the information of the vehicle type classification of the vehicle included in the vehicle data I and the information of the value which is not subject to the running limitation of the road is not found, the data associating unit may end the association of the vehicle data II with the vehicle data I without associating the vehicle data II with the vehicle data I by determining that a possibility of illegality of the target vehicle of the vehicle data I is low.

[0024]

The vehicle data processing device may further include: a control target determining unit configured to determine whether the vehicle is a control target based on the information of the vehicle number of the vehicle included in the vehicle data I. If the vehicle data II retrieved by the running limitation search unit among the vehicle data II retrieved by the vehicle type classification search unit is provisionally associated with the vehicle data I or if association of the vehicle data II with the vehicle data I ends without associating the vehicle data II with the vehicle data I by determining that there is no vehicle data II to be associated with the vehicle data I, the data associating unit may associate information representing a result of determination made by the control target determining unit with the vehicle data I.

[0025]

Upon properly associating the vehicle data II with the vehicle data I, if the vehicle data II is provisionally associated with other vehicle data I, the data associating unit may cancel provisional association of the vehicle data II with the other vehicle data I and properly associate the vehicle data II with the vehicle data I.

[0026]

The vehicle data processing device may further include: a vehicle data transmitting unit configured to transmit vehicle data including information of a vehicle included in at least one of the vehicle data I and the vehicle data II to an external device.

[0027]

If the data associating unit has properly associated the vehicle data II with the vehicle data I, the vehicle data transmitting unit may transmit vehicle data including the information of the vehicle included in the vehicle data I and the vehicle data II to the external device.

[0028]

If the data associating unit has ended association of the vehicle data II with the vehicle data I without associating the vehicle data II with the vehicle data I by determining that there is no vehicle data II to be associated with the vehicle data I, the vehicle data transmitting unit may transmit vehicle data including the information of the vehicle included in the vehicle data I to the external device.

[0029]

If the imaging device having the imaging area overlapping the communication area of the wireless device receiving the vehicle data II captures a predetermined number of vehicles after a reception time of the vehicle data II if the data associating unit has provisionally associated the vehicle data II with the vehicle data I, the vehicle data transmitting unit may transmit vehicle data including the information of the vehicle included in the vehicle data I and the vehicle data II and an image captured by the imaging device represented by information of an image included in the vehicle data I to the external device.

[0030]

If a predetermined time has elapsed from a reception time of the vehicle data II if the data associating unit has provisionally associated the vehicle data II with the vehicle data I, the vehicle data transmitting unit may transmit vehicle data including the information of the vehicle included in the vehicle data I and the vehicle data II and an image captured by the imaging device represented by information of an image included in the vehicle data I to the external device.

[0031]

According to a second aspect of the present invention, a vehicle data processing method of processing vehicle data I including information of a vehicle captured by an imaging device continuously capturing an image of a road and vehicle data II including

information of vehicles received by a wireless device having a communication area overlapping an imaging area of the imaging device from vehicle-mounted devices of the vehicles is provided, and includes: a data associating step of associating (i) vehicle data II including information of a vehicle which has a possibility to be the same as information of a target vehicle of the vehicle data I among the vehicle data II with (ii) the vehicle data I.

[0032]

According to a third aspect of the present invention, a vehicle data processing device is provided for processing vehicle data I including information of a vehicle captured by an imaging device continuously capturing an image of a road and vehicle data II including information of vehicles received by a wireless device having a communication area overlapping an imaging area of the imaging device from vehicle-mounted devices of the vehicles, and includes: a data associating unit configured to associate (i) vehicle data II including information of a vehicle which has a possibility to be the same as information of a target vehicle of the vehicle data I among the vehicle data II with (ii) the vehicle data I.

[0033]

According to a fourth aspect of the present invention, a program is provided for causing a computer to function as a vehicle data processing device for processing vehicle data I including information of a vehicle captured by an imaging device continuously capturing an image of a road and vehicle data II including information of vehicles received by a wireless device having a communication area overlapping an imaging area of the imaging device from vehicle-mounted devices of the vehicles, wherein the program causes the computer to function as a data associating unit configured to associate (i) vehicle data II including information of a vehicle which has a possibility to

be the same as information of a target vehicle of the vehicle data I among the vehicle data II with (ii) the vehicle data I.

[0034]

According to a fifth aspect of the present invention, a recording medium recording a program for causing a computer to function as a vehicle data processing device for processing vehicle data I including information of a vehicle captured by an imaging device continuously capturing an image of a road and vehicle data II including information of vehicles received by a wireless device having a communication area overlapping an imaging area of the imaging device from vehicle-mounted devices of the vehicles is provided, wherein the program causes the computer to function as a data associating unit configured to associate (i) vehicle data II including information of a vehicle which has a possibility to be the same as information of a target vehicle of the vehicle data I among the vehicle data II with (ii) the vehicle data I.

[0035]

The summary of the invention does not necessarily describe all necessary features of the present invention.

The present invention may also be a sub-combination of feature groups described above.

Advantageous Effects of Invention

[0036]

As is apparent from the above description, according to some aspects of the present invention, a charging system using the GPS can decrease a data volume of information connected with specifying of an illegal vehicle to be transmitted to a higher-order server or the like and reduce the load on a network between higher-order

servers or the burden on an operator who performs an artificial process using the higher-order server.

Brief Description of Drawings

[0037]

Fig. 1 is a diagram illustrating an example of a usage environment of a vehicle data processing system 100 according to an embodiment.

Fig. 2 is a diagram illustrating an example of a block configuration of a vehicle data processing device 110.

Fig. 3 is a diagram illustrating an example of information stored in a first vehicle data storage unit 123 in the form of a table.

Fig. 4 is a diagram illustrating an example of information stored in the first vehicle data storage unit 123 in the form of a table.

Fig. 5 is a diagram illustrating an example of information stored in a second vehicle data storage unit 124 in the form of a table.

Fig. 6 is a diagram illustrating an example of information stored in the second vehicle data storage unit 124 in the form of a table.

Fig. 7 is a diagram illustrating an example of information stored in a vehicle data storage unit 125 in the form of a table.

Fig. 8 is a diagram illustrating an example of an operation sequence of the vehicle data processing device 110, a monitoring camera 130, and a first vehicle data generating device 150.

Fig. 9 is a diagram illustrating an example of an operation sequence of the vehicle data processing device 110, a roadside wireless device 140, and a second vehicle data generating device 160.

Fig. 10 is a diagram illustrating an example of an operation flow of the vehicle data processing device 110.

Fig. 11 is a diagram illustrating an example of an operation flow of the vehicle data processing device 110.

Fig. 12 is a diagram illustrating an example of an operation flow of the vehicle data processing device 110.

Fig. 13 is a diagram illustrating an example of an operation flow of the vehicle data processing device 110.

Fig. 14 is a diagram illustrating an example of a hardware configuration of a computer 800 constituting the vehicle data processing device 110 according to this embodiment.

Description of Embodiments

[0038]

An aspect of the invention will now be described based on the preferred embodiments, which are not intended to limit the scope of the present invention, but exemplify the invention. All of the features and the combinations thereof described in the embodiment are not necessarily essential to the invention.

[0039]

Fig. 1 illustrates an example of a usage environment of a vehicle data processing system 100 according to an embodiment. The vehicle data processing system 100 is a system which processes data including information of a vehicle running on a toll road R including a plurality of lanes Ra to Rc. In addition, the toll road R may be an example of a "road" in the present invention.

[0040]

The vehicle data processing system 100 includes a vehicle data processing device 110, a plurality of monitoring cameras 130a to 130c (hereinafter collectively referred to as a monitoring camera 130), a plurality of roadside wireless devices 140a to 140c (hereinafter collectively referred to as a roadside wireless device 140), a first vehicle data generating device 150, a second vehicle data generating device 160, and a server 170. In addition, the monitoring camera 130 may be an example of an "imaging device" in the present invention. In addition, the roadside wireless device 140 may be an example of a "wireless device" in the present invention. In addition, the server 170 may be an example of an "external device" in the present invention.

[0041]

The vehicle data processing device 110 is a device configured to process first vehicle data and second vehicle data. Here, the first vehicle data include information of vehicles imaged by the monitoring camera 130. In addition, the second vehicle data include information of vehicles received by the roadside wireless device 140 from vehicle-mounted equipment of the vehicle. More specifically, the vehicle data processing device 110 is communicably connected to the first vehicle data generating device 150 and the second vehicle data generating device 160. In addition, the vehicle data processing device 110 is communicably connected to the server 170 via a communication circuit N. Then, the vehicle data processing device 110 receives the first vehicle data transmitted from the first vehicle data generating device 150. In addition, the vehicle data processing device 110 receives the second vehicle data transmitted from the second vehicle data generating device 160. Then, the vehicle data processing device 110 associates second vehicle data including information of a vehicle, which is likely to be the same vehicle as a vehicle of a target of the first vehicle data, among the second vehicle data with the first vehicle data. Then, the vehicle data

processing device 110 transmits vehicle data including information of a vehicle included in at least one of the first vehicle data and the second vehicle data to the server 170. In addition, the vehicle-mounted equipment may be an example of a "vehicle-mounted device" in the present invention.

[0042]

The monitoring camera 130 is a device for use in recognition of a vehicle number. More specifically, monitoring cameras 130 are laterally provided in a width direction of a beam Ga such as a gatepost or a cantilever stretched above the toll road R. In addition, the monitoring camera 130 is electrically connected to the first vehicle data generating device 150. Then, the monitoring camera 130 continuously images an obliquely downward imaging area A. In this embodiment, the monitoring camera 130a continuously images an obliquely downward imaging area Aa. In addition, the monitoring camera 130b continuously images an obliquely downward imaging area Ab. In addition, the monitoring camera 130c continuously images an obliquely downward imaging area Ac. Then, the monitoring camera 130 outputs image data obtained by imaging the imaging area A to the first vehicle data generating device 150.

[0043]

The roadside wireless device 140 is a device configured to wirelessly communicate with the vehicle-mounted equipment. More specifically, the roadside wireless devices 140 are laterally provided in a width direction of a beam Gb such as a gatepost or a cantilever stretched above the toll road R. In addition, the roadside wireless device 140 is electrically connected to the second vehicle data generating device 160. Then, the roadside wireless device 140 has a communication area C overlapping the imaging area A of the monitoring camera 130. In this embodiment, the roadside wireless device 140a has a communication area Ca overlapping the imaging area Aa of

the monitoring camera 130a. In addition, the roadside wireless device 140b has a communication area Cb overlapping the imaging area Ab of the monitoring camera 130b. The roadside wireless device 140c has a communication area Cc overlapping the imaging area Ac of the monitoring camera 130c. Then, upon receiving data transmitted from the vehicle-mounted equipment of the vehicle entering the communication area C, the roadside wireless device 140 outputs the data to the second vehicle data generating device 160.

[0044]

The roadside wireless device 140, for example, receives data including information of vehicle type classification, a vehicle-mounted equipment identifier (ID), running limitation (Yes or No), violation content, and a vehicle number from the vehicle-mounted equipment.

[0045]

The information of the vehicle type classification is information representing a type of vehicle to be equipped with the vehicle-mounted equipment. More specifically, the vehicle is equipped with the vehicle-mounted equipment storing information of the vehicle type classification representing a vehicle type of the vehicle. Then, a toll according to a type of vehicle represented by information of vehicle type classification of a vehicle is charged to the vehicle running on the toll road R. That is, when normal vehicle-mounted equipment is mounted on the vehicle, a regular toll according to the type of the vehicle can be charged to the vehicle. However, when vehicle-mounted equipment storing information of vehicle type classification representing a type of vehicle different from the above-described type of vehicle is mounted on the vehicle, it is difficult to charge a legal toll to the vehicle according to the type of vehicle.

[0046]

The information of the vehicle-mounted equipment ID is information representing an identification code for uniquely identifying vehicle-mounted equipment.

[0047]

The information of the running limitation (Yes or No) is information representing whether the vehicle to be equipped with the vehicle-mounted equipment is subject to the running limitation of the toll road R. More specifically, the information of the running limitation (Yes or No) represents whether the vehicle to be equipped with the vehicle-mounted equipment is subject to the running limitation of the toll road R when the running limitation is present on the toll road R. For example, when the running limitation of limiting the passage of the toll road R in a predetermined time zone is performed, information in which a value of the running limitation (Yes or No) is "Yes" becomes "information of a value which is not subject to the running limitation of the toll road R" in the present invention only in a time zone other than the predetermined time zone. On the other hand, when the running limitation of limiting the passage of the toll road R in the predetermined time zone is performed, information in which a value of the running limitation (Yes or No) is "No" becomes "information of a value which is not subject to the running limitation of the toll road R" in the present invention in any time zone.

[0048]

The information of the violation content is information representing the violation content related to charging. More specifically, the information of the violation content, for example, includes information representing that an integrated circuit (IC) card necessary for a charging process is not inserted, information representing that the remainder of electronic money of the IC card is insufficient, or the like when the charging process is performed. For example, when there is such a violation, the

vehicle-mounted equipment stores information representing the violation content.

[0049]

The information of the vehicle number is information representing the vehicle number of a vehicle to be equipped with the vehicle-mounted equipment. More specifically, the vehicle is equipped with the vehicle-mounted equipment storing vehicle number information representing the vehicle number of the vehicle.

[0050]

The first vehicle data generating device 150 is a device configured to generate the first vehicle data. More specifically, the first vehicle data generating device 150 is electrically connected to the monitoring camera 130. In addition, the first vehicle data generating device 150 is communicably connected to the vehicle data processing device 110. Then, the first vehicle data generating device 150 receives an input of image data output from the monitoring camera 130. Then, the first vehicle data generating device 150 generates the first vehicle data. Then, the first vehicle data generating device transmits the first vehicle data to the vehicle data processing device 110.

[0051]

The first vehicle data generating device 150, for example, generates the first vehicle data including information of an image ID, a vehicle number, a vehicle number detection region center position, a vehicle detection region center position, an imaging time (year/month/day/hour:minute:second), a monitoring camera ID, a first imaging time (year/month/day/hour:minute:second), a last imaging time (year/month/day/hour:minute:second), and vehicle type classification. In addition, the information of the image ID may be an example of "information of an image" in the present invention. In addition, the information of the monitoring camera ID may be an example of "information of the imaging device imaging the vehicle" and "information of

the imaging device of the vehicle" in the present invention.

[0052]

The information of the image ID is information representing an identification code for uniquely identifying each image captured by the monitoring camera 130. More specifically, the monitoring camera 130, for example, performs imaging at predetermined time intervals of about 20 (images/sec). Thus, the monitoring camera 130 images the vehicle a plurality of times from when the vehicle running on the road R enters the imaging area A until the vehicle passes through the imaging area A. The first vehicle data generating device 150 saves an image which is most likely to be visibly recognized among a series of captured images obtained by imaging the same vehicle as described above. Here, the image which is most likely to be visibly recognized, for example, is an image in which a number plate of the vehicle is shown to be largest. Information of the image ID is information representing an identification code of the image saved as described above.

[0053]

The information of the vehicle number is information representing the vehicle number of the number plate of the vehicle imaged by the monitoring camera 130. More specifically, when the vehicle is shown in the image represented by image data of an input received from the monitoring camera 130, the vehicle number of the number plate of the vehicle shown in the image is read by performing optical character recognition on the image. The information of the vehicle number is information representing the vehicle number read as described above.

[0054]

The information of the vehicle number detection region center position is information representing the center position of the region occupied by the number plate

of the vehicle shown in the image in the image captured by the monitoring camera 130. More specifically, the first vehicle data generating device 150 recognizes the number plate shown in the image as described above. At this time, the first vehicle data generating device specifies coordinates of the center position of the region in the image recognized as the number plate. These coordinates, for example, are coordinates in an orthogonal coordinate system in which the vertical direction of the image is set as an X axis and the horizontal axis of the image is set as a Y axis. The information of the vehicle number detection region center position is information representing coordinates specified as described above.

[0055]

The information of the vehicle detection region center position is information representing the center position of the region in which the vehicle shown in the image appears in the image captured by the monitoring camera 130. More specifically, the first vehicle data generating device 150 recognizes the vehicle shown in the image as described above. At this time, the first vehicle data generating device, for example, specifies coordinates of the center position of the region in the image recognized as the vehicle. These coordinates are coordinates in the same orthogonal coordinate system as coordinates represented by the information of the vehicle number detection region center position. The information of the vehicle detection region center position is information representing the coordinates specified as described above.

[0056]

The information of the imaging time (year/month/day/hour:minute:second) is information representing a time at which an image has been captured. More specifically, the first vehicle data generating device 150 saves an image which is most likely to be visibly recognized as described above. The information of the imaging time

(year/month/day/hour:minute:second) is information representing a time at which the image has been captured.

[0057]

The information of the monitoring camera ID is information representing an identification code for uniquely identifying each monitoring camera 130. More specifically, the first vehicle data generating device 150 saves an image which is most likely to be visibly recognized as described above. The information of the monitoring camera ID is information representing the identification code of the monitoring camera 130 capturing the image.

[0058]

The information of the first imaging time (year/month/day/hour:minute:second) is information representing a time at which a physical object imaged by the monitoring camera 130 has been first detected as the vehicle. In addition, the information of the last imaging time (year/month/day/hour:minute:second) is information representing a time at which the vehicle has last been imaged by the monitoring camera 130.

[0059]

The information of the vehicle type classification is information representing a type of vehicle. More specifically, for example, the first vehicle data generating device 150 specifies the type of vehicle based on a size or type of the number plate of the vehicle. The information of the vehicle type classification is information representing the type of vehicle specified as described above.

[0060]

The second vehicle data generating device 160 is a device configured to generate the second vehicle data. More specifically, the second vehicle data generating device 160 is electrically connected to the roadside wireless device 140. In addition, the

second vehicle data generating device 160 is communicably connected to the vehicle data processing device 110. Then, the second vehicle data generating device 160 receives an input of data output from the roadside wireless device 140. Then, the second vehicle data generating device 160 generates the second vehicle data. Then, the second vehicle data generating device 160 transmits the second vehicle data to the vehicle data processing device 110.

[0061]

The second vehicle data generating device 160, for example, generates the second vehicle data including information of vehicle type classification, a reception time (year/month/day/hour:minute:second), vehicle-mounted equipment ID, a roadside wireless device ID, running limitation (Yes or No), violation content, and a vehicle number. In addition, the information of the roadside wireless device ID may be an example of "information of a reception position of the second vehicle data" in the present invention. In addition, the information of the violation content may be an example of "information of a vehicle of a control target" in the present invention.

[0062]

The information of the vehicle type classification, the vehicle-mounted equipment ID, the running limitation (Yes or No), the violation content, and the vehicle number is information included in data of an input received from the roadside wireless device 140.

[0063]

The information of the reception time (year/month/day/hour:minute:second) is information representing a time at which the roadside wireless device 140 has received data from the vehicle-mounted equipment.

[0064]

The server 170 is a computer configured to collect vehicle data including information of a vehicle running on the toll road R. More specifically, the server 170 receives vehicle data transmitted from the vehicle data processing device 110. Then, the server 170 stores information included in the vehicle data. A provider of the toll road R, for example, specifies an illegal vehicle by referring to the information stored in the server 170 as described above.

[0065]

In addition, in this embodiment, for the purpose of preventing the description from becoming complex, a configuration in which the vehicle data processing system 100 includes the vehicle data processing device 110, the first vehicle data generating device 150, the second vehicle data generating device 160, and the server 170 will be described. However, the vehicle data processing system 100 may include a plurality of vehicle data processing devices 110, a plurality of first vehicle data generating devices 150, a plurality of second vehicle data generating devices 160, and a plurality of servers 170.

[0066]

Fig. 2 illustrates an example of a block configuration of the vehicle data processing device 110. The vehicle data processing device 110 includes a first vehicle data receiving unit 111, a second vehicle data receiving unit 112, an optical character recognition availability determining unit 113, a character completing unit 114, a vehicle number search unit 115, an overlapping range search unit 116, a control target search unit 117, a vehicle type classification search unit 118, a running limitation search unit 119, a control target determining unit 120, a data associating unit 121, a vehicle data transmitting unit 122, a first vehicle data storage unit 123, a second vehicle data storage unit 124, and a vehicle data storage unit 125. In the following description, functions

and operations of the components will be described in detail.

[0067]

The first vehicle data receiving unit 111 receives the first vehicle data transmitted from the first vehicle data generating device 150.

[0068]

The second vehicle data receiving unit 112 receives the second vehicle data transmitted from the second vehicle data generating device 160.

[0069]

The optical character recognition availability determining unit 113 determines whether a character string of the vehicle number represented by the information of the vehicle number included in the first vehicle data is recognized as characters.

[0070]

The character completing unit 114 completes partial characters which are not recognized as characters in the character string of the vehicle number represented by the information of the vehicle number included in the first vehicle data.

[0071]

The vehicle number search unit 115 searches for second vehicle data including information of a vehicle number which is the same as the information of the vehicle number included in the first vehicle data from among the second vehicle data. More specifically, when the optical character recognition availability determining unit 113 determines that the entire character string of the vehicle number represented by information of the vehicle number included in the first vehicle data is recognized as characters, the vehicle number search unit 115 searches for the second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number included in the first vehicle data from among the second vehicle data.

In addition, when the optical character recognition availability determining unit 113 determines that part of the character string of the vehicle number represented by information of the vehicle number included in the first vehicle data is not recognized as the characters, the vehicle number search unit 115 searches for second vehicle data including information of a vehicle number which is the same as information of a vehicle number obtained by the character completing unit 114 completing the characters included in the first vehicle data from among the second vehicle data.

[0072]

The overlapping range search unit 116 searches for second vehicle data including information of a roadside wireless device ID for identifying the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information of a monitoring camera ID included in the first vehicle data from among the second vehicle data.

[0073]

The control target search unit 117 searches for the second vehicle data including information of violation content from among the second vehicle data. More specifically, the control target search unit 117 searches for the second vehicle data including the information of the violation content from among the second vehicle data searched by the overlapping range search unit 116.

[0074]

The vehicle type classification search unit 118 searches for second vehicle data including information of vehicle type classification different from information of vehicle type classification included in the first vehicle data from among the second vehicle data. More specifically, the vehicle type classification search unit 118 searches for the second vehicle data including the information of the vehicle type classification different from the

information of the vehicle type classification included in the first vehicle data from among the second vehicle data searched by the overlapping range search unit 116.

[0075]

The running limitation search unit 119 searches for second vehicle data including information of a value which is not subject to the running limitation of the toll road R from among the second vehicle data. More specifically, the running limitation search unit 119 searches for the second vehicle data including information of the running limitation (Yes or No) of a value which is not subject to the running limitation of the toll road R from among the second vehicle data searched by the overlapping range search unit 116.

[0076]

The control target determining unit 120 determines whether the vehicle is a control target based on information of the vehicle number of the vehicle included in the first vehicle data.

[0077]

The data associating unit 121 associates second vehicle data including information of a vehicle which is likely to be the same vehicle as a vehicle of a target of the first vehicle data among the second vehicle data with the first vehicle data. More specifically, the data associating unit 121 properly associates the second vehicle data searched by the vehicle number search unit 115 with the first vehicle data. In addition, when a result of the search performed by the vehicle number search unit 115 represents that the second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number included in the first vehicle data is not found, the data associating unit 121 provisionally associates the second vehicle data searched by the vehicle type classification search unit 118 and the second vehicle data

searched by the running limitation search unit 119 with the first vehicle data. In addition, when results of the searches performed by the vehicle type classification search unit 118 and the running limitation search unit 119 represent that the second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification included in the first vehicle data and the information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the road are not found, the data associating unit 121 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that there is a suspicion of illegality in which vehicle-mounted equipment is not mounted on the vehicle because there is no second vehicle data to be associated with the first vehicle data. In addition, when a result of the search performed by the overlapping range search unit 116 represents that the second vehicle data including the information of the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by the information of the monitoring camera ID included in the first vehicle data is not found, the data associating unit 121 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data. In addition, when a result of the search performed by the vehicle number search unit 115 represents that the second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number of the vehicle in which the characters have been completed by the character completing unit 114 included in the first vehicle data is not found, the data associating unit 121 provisionally associates the second vehicle data searched by the control target search unit 117 with the first vehicle data. In addition, when a result of the search

performed by the control target search unit 117 represents that the second vehicle data including the information of the violation content is not found, the data associating unit 121 provisionally associates the second vehicle data searched by the vehicle type classification search unit 118 and the second vehicle data searched by the running limitation search unit 119 with the first vehicle data. In addition, when a result of the search performed by the control target search unit 117 represents that the second vehicle data including the information of the violation content is not found and results of the searches performed by the vehicle type classification search unit 118 and the running limitation search unit 119 represent that second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification included in the first vehicle data and the information of the value which is not subject to the running limitation of the toll road R is not found, the data associating unit 121 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that a possibility of illegality of the vehicle of the target of the first vehicle data is low. In addition, when the second vehicle data searched by the running limitation search unit 119 among the second vehicle data searched by the vehicle type classification search unit 118 is provisionally associated with the first vehicle data or when the association of the second vehicle data with the first vehicle data ends without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data, the data associating unit 121 associates information representing a result of the determination made by the control target determining unit 120 with the first vehicle data. In addition, if the second vehicle data is provisionally associated with other first vehicle data when the second vehicle data is properly associated with the first vehicle data, the data associating unit 121 may cancel

provisional association of the second vehicle data with the other first vehicle data and properly associate the second vehicle data with the first vehicle data.

[0078]

The vehicle data transmitting unit 122 transmits vehicle data including information of a vehicle included in at least one of the first vehicle data and the second vehicle data to the server 170. More specifically, when the data associating unit 121 has properly associated the second vehicle data with the first vehicle data, the vehicle data transmitting unit 122 transmits vehicle data including the information of a vehicle included in the first vehicle data and the second vehicle data to the server 170. In addition, when the data associating unit 121 has ended the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data, the vehicle data transmitting unit 122 transmits the vehicle data including the information of a vehicle included in the first vehicle data to the server 170. In addition, if the monitoring camera 130 having the imaging area A overlapping the communication area C of the roadside wireless device 140 receiving the second vehicle data images a predetermined number of vehicles after a reception time of the second vehicle data when the data associating unit 121 has provisionally associated the second vehicle data with the first vehicle data, the vehicle data transmitting unit 122 transmits the information of a vehicle included in the first vehicle data and the second vehicle data and vehicle data including an image represented by information of an image ID included in the first vehicle data to the server 170. In addition, if a predetermined time has elapsed from a reception time of the second vehicle data when the data associating unit 121 has provisionally associated the second vehicle data with the first vehicle data, the vehicle data transmitting unit 122 transmits the information of a vehicle

included in the first vehicle data and the second vehicle data and the vehicle data including the image represented by the information of the image ID included in the first vehicle data to the server 170.

[0079]

Each of Figs. 3 and 4 illustrates an example of information stored in the first vehicle data storage unit 123 in the form of a table. Information of a first vehicle data ID, an image ID, a vehicle number, a vehicle number detection region center position, a vehicle detection region center position, an imaging time (year/month/day/hour:minute:second), a monitoring camera ID, a first imaging time (year/month/day/hour:minute:second), a last imaging time (year/month/day/hour:minute:second), and vehicle type classification is associated and stored in the first vehicle data storage unit 123.

[0080]

The information of the first vehicle data ID is an identification code for uniquely identifying first vehicle data. More specifically, when information included in the first vehicle data is stored in the first vehicle data storage unit 123, the information of the first vehicle data ID is stored in association with the above-described information.

[0081]

The information of the image ID, the vehicle number, the vehicle number detection region center position, the vehicle detection region center position, the imaging time (year/month/day/hour:minute:second), the monitoring camera ID, the first imaging time (year/month/day/hour:minute:second), the last imaging time (year/month/day/hour:minute:second), and the vehicle type classification is information included in the first vehicle data received from the first vehicle data generating device 150.

[0082]

Each of Figs. 5 and 6 illustrates an example of information stored in the second vehicle data storage unit 124 in the form of a table. Information of a second vehicle data ID, vehicle type classification, a reception time (year/month/day/hour:minute:second), a vehicle-mounted equipment ID, a roadside wireless device ID, running limitation (Yes or No), violation content, and a vehicle number is associated and stored in the second vehicle data storage unit 124.

[0083]

The information of the second vehicle data ID is an identification code for uniquely identifying the second vehicle data. More specifically, when information included in the second vehicle data is stored in the second vehicle data storage unit 124, the information of the second vehicle data ID is stored in association with the above-described information.

[0084]

The information of the vehicle type classification, the reception time (year/month/day/hour:minute:second), the vehicle-mounted equipment ID, the roadside wireless device ID, the running limitation (Yes or No), the violation content, and the vehicle number is information included in the second vehicle data received from the second vehicle data generating device 160.

[0085]

Fig. 7 illustrates an example of information stored in the vehicle data storage unit 125 in the form of a table. Information of the first vehicle data ID, the second vehicle data ID, and the control target (Yes or No) is associated and stored in the vehicle data storage unit 125.

[0086]

The information of the first vehicle data ID is information for identifying the first vehicle data for which a process of associating the second vehicle data has ended.

[0087]

The information of the second vehicle data ID is information for identifying the second vehicle data associated with the first vehicle data identified by the information of the first vehicle data ID.

[0088]

The information of the control target (Yes or No) is information representing whether the vehicle identified by the information of the first vehicle data ID is the control target.

[0089]

Fig. 8 illustrates an example of an operation sequence of the vehicle data processing device 110, the monitoring camera 130, and the first vehicle data generating device 150. In the description of this operation sequence, a process from when the monitoring camera 130 captures an image until the vehicle data processing device 110 stores information included in the first vehicle data will be described in detail. In addition, the operation sequence will be described with reference to Figs. 1 to 7 together.

[0090]

The monitoring camera 130 continuously images an obliquely downward imaging area A (S101). Then, the monitoring camera 130 outputs image data obtained by imaging the imaging area A to the first vehicle data generating device 150 (S102).

[0091]

Upon receiving an input of the image data output from the monitoring camera 130, the first vehicle data generating device 150 generates the first vehicle data (S103). More specifically, the first vehicle data generating device 150, for example, generates the

first vehicle data including information of an image ID, a vehicle number, a vehicle number detection region center position, a vehicle detection region center position, an imaging time (year/month/day/hour:minute:second), a monitoring camera ID, a first imaging time (year/month/day/hour:minute:second), a last imaging time (year/month/day/hour:minute:second), and vehicle type classification. Then, the first vehicle data generating device transmits the first vehicle data to the vehicle data processing device 110 (S104).

[0092]

Upon receiving the first vehicle data transmitted from the first vehicle data generating device 150, the first vehicle data receiving unit 111 of the vehicle data processing device 110 associates the information of the first vehicle data ID with the information included in the first vehicle data and stores an association result in the first vehicle data storage unit 123 (S105).

[0093]

Thus, information as illustrated in Figs. 3 and 4 is stored in the first vehicle data storage unit 123 of the vehicle data processing device 110.

[0094]

Fig. 9 illustrates an example of an operation sequence of the vehicle data processing device 110, the roadside wireless device 140, and the second vehicle data generating device 160. In the description of this operation sequence, a process from when the roadside wireless device 140 receives the data from the vehicle-mounted equipment until the vehicle data processing device 110 stores information included in the second vehicle data will be described in detail. In addition, the operation sequence will be described with reference to Figs. 1 to 8 together.

[0095]

Upon receiving data transmitted from the vehicle-mounted equipment of the vehicle entering the communication area C (S201), the roadside wireless device 140 outputs the data to the second vehicle data generating device 160 (S202).

[0096]

When receiving an input of the data output from the roadside wireless device 140, the second vehicle data generating device 160 generates the second vehicle data (S203). More specifically, the second vehicle data generating device 160, for example, generates the second vehicle data including information of vehicle type classification, a reception time (year/month/day/hour:minute:second), a vehicle-mounted equipment ID, a roadside wireless device ID, running limitation (Yes or No), violation content, and a vehicle number. Then, the second vehicle data generating device 160 transmits the second vehicle data to the vehicle data processing device 110 (S204).

[0097]

Upon receiving the second vehicle data transmitted from the second vehicle data generating device 160, the second vehicle data receiving unit 112 of the vehicle data processing device 110 associates the information of the second vehicle data ID with the information included in the second vehicle data and stores an association result in the second vehicle data storage unit 124 (S205).

[0098]

Thus, information as illustrated in Figs. 5 and 6 is stored in the second vehicle data storage unit 124 of the vehicle data processing device 110.

[0099]

Each of Figs. 10 to 13 illustrates an example of an operation flow of the vehicle data processing device 110. In the description of this operation flow, a process of associating the second vehicle data with the first vehicle data will be described in detail.

In addition, the operation flow will be described with reference to Figs. 1 to 9 together.

[0100]

First, the optical character recognition availability determining unit 113 of the vehicle data processing device 110 determines whether a character string of a vehicle number represented by information of the vehicle number included in the first vehicle data is recognized as characters (S301 and S311). More specifically, the optical character recognition availability determining unit 113 selects first vehicle data serving as a target to be associated with the second vehicle data among the first vehicle data in which information is stored in the first vehicle data storage unit 123. Then, the optical character recognition availability determining unit 113 reads information of the vehicle number of the first vehicle data from the first vehicle data storage unit 123. Then, the optical character recognition availability determining unit 113 determines whether the character string of the vehicle number represented by the information of the vehicle number is recognized as characters. For example, when a character such as "?" representing that character recognition has not been performed is included in the character string of the vehicle number, the optical character recognition availability determining unit 113 determines that its part is not recognized as the character. When the result represents that the entire character string of the vehicle number is determined to be recognized as the characters (S301: Yes), the optical character recognition availability determining unit 113 transmits information of the first vehicle data ID for identifying the above-described first vehicle data to the vehicle number search unit 115.

[0101]

Upon receiving the information of the first vehicle data ID sent from the optical character recognition availability determining unit 113, the vehicle number search unit 115 of the vehicle data processing device 110 searches for second vehicle data including

information of a vehicle number which is the same as information of a vehicle number included in the above-described first vehicle data identified by the information of the first vehicle data ID (S302). More specifically, the vehicle number search unit 115 reads the information of the vehicle number associated with the information of the first vehicle data ID received from the optical character recognition availability determining unit 113 from the first vehicle data storage unit 123. Then, the vehicle number search unit 115 searches for information of the vehicle number of the character string which is the same as the character string of the vehicle number represented by the information of the vehicle number from the second vehicle data storage unit 124.

When the result represents that the information of the same vehicle number has been found (S303: Yes), the vehicle number search unit 115 reads information of the second vehicle data ID associated with the information of the vehicle number. Then, the vehicle number search unit 115 sends the information of the second vehicle data ID and the information of the first vehicle data ID for identifying the above-described first vehicle data to the data associating unit 121.

[0102]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the vehicle number search unit 115, the data associating unit 121 of the vehicle data processing device 110 properly associates the second vehicle data identified by the information of the second vehicle data ID with the above-described first vehicle data identified by the information of the first vehicle data ID. More specifically, the data associating unit 121 associates the information of the first vehicle data ID and the information of the second vehicle data ID received from the vehicle number search unit 115 and stores an association result in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the information of the first vehicle

data ID and the information associated therewith from the first vehicle data storage unit 123. In addition, the data associating unit 121 deletes the information of the second vehicle data ID and the information associated therewith from the second vehicle data storage unit 124.

[0103]

In this manner, when there is second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number of the first vehicle data, the vehicle data processing device 110 properly associates the second vehicle data with the first vehicle data. This is because the data is regarded to certainly be data of the same vehicle when the vehicle number of the number plate of the vehicle imaged by the monitoring camera 130 matches the vehicle number included in the data received from the vehicle-mounted equipment of the vehicle.

[0104]

On the other hand, when a search result of the above-described step S302 represents that the information of the same vehicle number is not found (S303: No), the vehicle number search unit 115 sends the information of the first vehicle data ID for identifying the above-described first vehicle data to the overlapping range search unit 116.

[0105]

Upon receiving the information of the first vehicle data ID sent from the vehicle number search unit 115, the overlapping range search unit 116 of the vehicle data processing device 110 searches for second vehicle data including information of a roadside wireless device ID, which is included in the above-described first vehicle data identified by information of the first vehicle data ID, for identifying the roadside wireless device 140 having the communication area C overlapping the imaging area A of the

monitoring camera 130 represented by information of the monitoring camera ID (S306). More specifically, the overlapping range search unit 116 reads the information of the monitoring camera ID associated with the information of the first vehicle data ID received from the vehicle number search unit 115 from the first vehicle data storage unit 123. Then, the overlapping range search unit 116 searches for the information of the roadside wireless device ID for identifying the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 identified by the information of the monitoring camera ID from the second vehicle data storage unit 124. When the result represents that the information of the corresponding roadside wireless device ID has been found (S307: Yes), the overlapping range search unit 116 reads the information of the second vehicle data ID associated with the information of the roadside wireless device ID. Then, the vehicle number search unit 115 sends the information of the second vehicle data ID and the information of the first vehicle data ID for identifying the above-described first vehicle data to the vehicle type classification search unit 118 and the running limitation search unit 119.

[0106]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the overlapping range search unit 116, the vehicle type classification search unit 118 of the vehicle data processing device 110 searches for second vehicle data including information of vehicle type classification different from information of vehicle type classification included in the first vehicle data identified by the information of the first vehicle data ID from among the second vehicle data identified by the information of the second vehicle data ID (S308). More specifically, the vehicle type classification search unit 118 reads information of vehicle type classification associated with the information of the first vehicle data ID received from the overlapping

range search unit 116 from the first vehicle data storage unit 123. Then, the vehicle type classification search unit 118 searches for the information of the vehicle type classification different from the information of the vehicle type classification read from the first vehicle data storage unit 123 in association with the information of the second vehicle data ID received from the overlapping range search unit 116. For example, when the information of the vehicle type classification read from the first vehicle data storage unit 123 is a "standard vehicle," the vehicle type classification search unit 118 searches for the information of the vehicle type classification other than the "standard vehicle." When the result represents that the information of corresponding vehicle type classification has been found (S309: Yes), the vehicle type classification search unit 118 reads the information of the second vehicle data ID associated with the information of the vehicle type classification. Then, the vehicle type classification search unit 118 sends the information of the second vehicle data ID and the information of the first vehicle data ID for identifying the above-described first vehicle data to the data associating unit 121.

[0107]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the overlapping range search unit 116, the running limitation search unit 119 of the vehicle data processing device 110 searches for second vehicle data including information of running limitation (Yes or No) of a value which is not subject to the running limitation of the toll road R from among the second vehicle data identified by the information of the second vehicle data ID (S308). More specifically, the running limitation search unit 119 searches for the information of the value which is not subject to the running limitation of the toll road R from among the information of the running limitation (Yes or No) associated with the information of the second vehicle data ID received from the overlapping range search unit 116. For

example, when the running limitation of limiting the passage of the toll road R in a predetermined time is performed and the current time is within the predetermined time, the running limitation search unit 119 searches for the information of the running limitation (Yes or No) of the value of "No." When the result represents that the information of the corresponding running limitation (Yes or No) has been found (S309: Yes), the running limitation search unit 119 reads the information of the second vehicle data ID associated with the information of the running limitation (Yes or No). Then, the running limitation search unit 119 sends the information of the second vehicle data ID and the information of the first vehicle data ID for identifying the above-described first vehicle data to the data associating unit 121. In addition, the running limitation search unit 119 sends the information of the first vehicle data ID for identifying the above-described first vehicle data to the control target determining unit 120.

[0108]

On the other hand, upon receiving the information of the first vehicle data ID sent from the running limitation search unit 119, the control target determining unit 120 of the vehicle data processing device 110 determines whether the vehicle is a control target based on the information of the vehicle number of the vehicle included in the first vehicle data identified by the information of the first vehicle data ID (S310). More specifically, the control target determining unit 120 reads the information of the vehicle number of the vehicle associated with the information of the first vehicle data ID received from the running limitation search unit 119 from the first vehicle data storage unit 123.

Then, the control target determining unit 120 determines whether the vehicle is the control target based on the information of the vehicle number of the vehicle. For example, the control target determining unit 120 determines whether the vehicle is the

control target by referring to a list of vehicle numbers of vehicles of the control target. Then, the control target determining unit 120 sends information of a determination result to the data associating unit 121.

[0109]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the vehicle type classification search unit 118 and the running limitation search unit 119 and the information of the determination result sent from the control target determining unit 120, the data associating unit 121 provisionally associates the second vehicle data identified by the information of the second vehicle data ID with the first vehicle data identified by the information of the first vehicle data ID (S304). At this time, the data associating unit 121 associates the information of the determination result received from the control target determining unit 120 together. More specifically, the data associating unit 121 associates the information of the first vehicle data ID and the information of the second vehicle data ID received from the vehicle type classification search unit 118 and the running limitation search unit 119 and stores an association result in the vehicle data storage unit 125. In addition, the data associating unit 121 further associates the information of the determination result received from the control target determining unit 120 and stores an association result in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the above-described information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123. In addition, in this case, the data associating unit 121 does not delete the above-described information of the second vehicle data ID and the information associated therewith from the second vehicle data storage unit 124.

[0110]

In this manner, when there is no second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number of the first vehicle data, the vehicle data processing device 110 provisionally associates second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification of the first vehicle data and including the information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the toll road R with the first vehicle data.

This is because, when vehicle-mounted equipment other than normal vehicle-mounted equipment is mounted on the vehicle, vehicle-mounted equipment for a vehicle of vehicle type classification having a cheaper toll than vehicle type classification of an own vehicle is considered to be likely to be mounted or vehicle-mounted equipment including a setting which is not subject to the running limitation of the toll road R is considered to be likely to be mounted.

[0111]

On the other hand, when a result of the search of the above-described step S306 represents that information of a corresponding roadside wireless device ID is not found (S307: No), the overlapping range search unit 116 sends the information of the first vehicle data ID for identifying the above-described first vehicle data to the control target determining unit 120 and the data associating unit 121.

[0112]

Upon receiving the information of the first vehicle data ID sent from the overlapping range search unit 116, the control target determining unit 120 determines whether the vehicle is the control target based on the information of the vehicle number of the vehicle included in the first vehicle data identified by the information of the first vehicle data ID (S310). Then, the control target determining unit 120 sends information

of a determination result to the data associating unit 121.

[0113]

Upon receiving the information of the first vehicle data ID sent from the overlapping range search unit 116 and the information of the determination result sent from the control target determining unit 120, the data associating unit 121 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data identified by the information of the first vehicle data ID (S304). At this time, the data associating unit 121 associates the information of the determination result received from the control target determining unit 120 with the first vehicle data. More specifically, the data associating unit 121 associates the information of the first vehicle data ID received from the overlapping range search unit 116 and the information of the determination result received from the control target determining unit 120 and stores an association result in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the above-described information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123.

[0114]

In this manner, when there is no second vehicle data including information of a roadside wireless device ID for identifying the roadside wireless device 140 having the communication area C overlapping the imaging area A in which a target vehicle of the first vehicle data has been imaged, the data associating unit ends the association of the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data.

This is because, if no data has been received by the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring

camera 130 from the vehicle-mounted equipment when the vehicle has been imaged by the monitoring camera 130, the reception of data from the vehicle-mounted equipment is considered to have failed or the vehicle-mounted equipment is considered not to be mounted.

[0115]

On the other hand, when a result of the search of the above-described step S308 represents that neither information of corresponding vehicle type classification nor information of corresponding running limitation (Yes or No) has been found (S309: No), the vehicle type classification search unit 118 or the running limitation search unit 119 sends the information of the first vehicle data ID for identifying the above-described first vehicle data to the control target determining unit 120 and the data associating unit 121.

[0116]

Upon receiving the information of the first vehicle data ID sent from the vehicle type classification search unit 118, the control target determining unit 120 determines whether the vehicle is the control target based on the information of the vehicle number of the vehicle included in the first vehicle data identified by the information of the first vehicle data ID (S310). Then, the control target determining unit 120 sends information of a determination result to the data associating unit 121.

[0117]

Upon receiving the information of the first vehicle data ID sent from the vehicle type classification search unit 118 and the information of the determination result sent from the control target determining unit 120, the data associating unit 121 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data identified by the information of the first vehicle data ID (S304). At this time, the data associating unit 121 associates the

information of the determination result received from the control target determining unit 120 with the first vehicle data. More specifically, the data associating unit 121 associates the information of the first vehicle data ID received from the vehicle type classification search unit 118 and the information of the determination result received from the control target determining unit 120 and stores an association result in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the above-described information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123.

[0118]

In this manner, if there is no second vehicle data including information of vehicle type classification different from information of vehicle type classification of the first vehicle data when there is no second vehicle data including information of a vehicle number which is the same as information of the vehicle number of the first vehicle data, the vehicle data processing device 110 ends the association of the second vehicle data with the first vehicle data by determining that there is a suspicion of illegality in which vehicle-mounted equipment is not mounted on the vehicle because there is no second vehicle data to be associated with the first vehicle data.

[0119]

Upon receiving the information of the first vehicle data ID sent from the running limitation search unit 119, the control target determining unit 120 determines whether the vehicle is the control target based on the information of the vehicle number of the vehicle included in the first vehicle data identified by the information of the first vehicle data ID (S310). Then, the control target determining unit 120 sends information of a determination result to the data associating unit 121.

[0120]

Upon receiving the information of the first vehicle data ID sent from the running limitation search unit 119 and the information of the determination result sent from the control target determining unit 120, the data associating unit 121 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data identified by the information of the first vehicle data ID (S304). At this time, the data associating unit 121 associates the information of the determination result received from the control target determining unit 120 with the first vehicle data. More specifically, the data associating unit 121 associates the information of the first vehicle data ID received from the running limitation search unit 119 and the information of the determination result received from the control target determining unit 120 and stores an association result in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the above-described information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123.

[0121]

In this manner, if there is no second vehicle data including information of running limitation (Yes or No) of a value which is not subject to the running limitation of the toll road R when there is no second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number of the first vehicle data, the vehicle data processing device 110 ends the association of the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data. This is because, when vehicle-mounted equipment of the vehicle is illegally exchanged, vehicle-mounted equipment for a vehicle of vehicle type classification having a cheaper toll than vehicle type classification of an own vehicle is considered to be likely to be mounted.

[0122]

On the other hand, when it is determined that part of a character string of the above-described vehicle number is not recognized as characters in a determination of whether the character string of the vehicle number is recognized as the characters (S301: No → S311: Yes), the optical character recognition availability determining unit 113 sends the information of the first vehicle data ID for identifying the above-described first vehicle data to the character completing unit 114.

[0123]

Upon receiving the information of the first vehicle data ID sent from the optical character recognition availability determining unit 113, the character completing unit 114 of the vehicle data processing device 110 completes partial characters which are not recognized as the characters in the character string of the vehicle number represented by the information of the vehicle number included in the first vehicle data identified by the information of the vehicle data ID (S312). More specifically, the character completing unit 114 reads the information of the vehicle number associated with the information of the first vehicle data ID received from the optical character recognition availability determining unit 113 from the first vehicle data storage unit 123. Then, the character completing unit 114 completes the partial characters which are not recognized as the characters in the character string of the vehicle number represented by the information of the vehicle number. For example, the character completing unit 114 compares the character string of the vehicle number to the information of the vehicle number stored in the second vehicle data storage unit 124 and calculates a degree to which the character strings match. Then, when the calculated matching degree is greater than or equal to a predetermined threshold value, the character completing unit 114 completes the characters by replacing a character of a part of "?" representing that the character recognition has not been performed with the character of the vehicle number stored in the

second vehicle data storage unit 124. Then, the character completing unit 114 stores the information of the vehicle number representing the character string of the vehicle number in which characters of unrecognized parts are completed in the first vehicle data storage unit 123. Then, the character completing unit 114 reads the information of the first vehicle data ID associated with the information of the vehicle number. Then, the character completing unit 114 sends the information of the first vehicle data ID to the vehicle number search unit 115.

[0124]

Upon receiving the information of the vehicle data ID sent from the character completing unit 114, the vehicle number search unit 115 searches for second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number obtained by the character completing unit 114 completing the characters and included in the above-described first vehicle data identified by the information of the first vehicle data ID (S313). More specifically, the vehicle number search unit 115 reads the information of the vehicle number associated with the information of the first vehicle data ID received from the character completing unit 114 from the first vehicle data storage unit 123. Then, the vehicle number search unit 115 searches for the information of the vehicle number of the character string which is the same as the character string of the vehicle number represented by the information of the vehicle number from the second vehicle data storage unit 124. When the result represents that the information of the same vehicle number has been found (S314: Yes), the vehicle number search unit 115 reads the information of the second vehicle data ID associated with the information of the vehicle number. Then, the vehicle number search unit 115 sends the information of the second vehicle data ID and the information of the first vehicle data ID for identifying the above-described first vehicle data to the data

associating unit 121.

[0125]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the vehicle number search unit 115, the data associating unit 121 of the vehicle data processing device 110 properly associates the second vehicle data identified by the information of the second vehicle data ID with the above-described first vehicle data identified by the information of the first vehicle data ID. More specifically, the data associating unit 121 associates the information of the first vehicle data ID and the information of the second vehicle data ID received from the vehicle number search unit 115 and stores an association result in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123. In addition, the data associating unit 121 deletes the information of the second vehicle data ID and the information associated therewith from the second vehicle data storage unit 124.

[0126]

In this manner, after characters on which optical character recognition has failed have been completed in the character string represented by the information of the vehicle number of the first vehicle data, the vehicle data processing device 110 properly associates the second vehicle data with the first vehicle data when there is second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number. This is because the data is regarded to certainly be data of the same vehicle when the information of the vehicle number matches after characters on which optical character recognition has failed have been completed.

[0127]

On the other hand, when it is determined that none of the character string of the vehicle number is recognized as the characters in the determination of whether the character string of the above-described vehicle number is recognized as the characters (S301: No → S311: No), the optical character recognition availability determining unit 113 sends the information of the first vehicle data ID for identifying the above-described first vehicle data to the overlapping range search unit 116.

[0128]

On the other hand, when a result of the search of the above-described step S313 represents that the information of the same vehicle number is not found (S314: No), the vehicle number search unit 115 sends the information of the first vehicle data ID for identifying the above-described first vehicle data to the overlapping range search unit 116.

[0129]

Upon receiving the information of the first vehicle data ID sent from the optical character recognition availability determining unit 113 or the vehicle number search unit 115, the overlapping range search unit 116 searches for second vehicle data including information of a roadside wireless device ID, which is included in the above-described first vehicle data identified by the information of the first vehicle data ID, for identifying the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information of the monitoring camera ID (S315). More specifically, the overlapping range search unit 116 reads the information of the monitoring camera ID associated with the information of the first vehicle data ID received from the optical character recognition availability determining unit 113 or the vehicle number search unit 115 from the first vehicle data storage unit 123. Then, the overlapping range search unit 116 searches for the

information of the roadside wireless device ID for identifying the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 identified by the information of the monitoring camera ID from the second vehicle data storage unit 124. When the result represents that the information of the corresponding roadside wireless device ID has been found (S316: Yes), the overlapping range search unit 116 reads the information of the second vehicle data ID associated with the information of the roadside wireless device ID. Then, the vehicle number search unit 115 sends the information of the second vehicle data ID and the information of the first vehicle data ID for identifying the above-described first vehicle data to the control target search unit 117.

[0130]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the overlapping range search unit 116, the control target search unit 117 of the vehicle data processing device 110 searches for second vehicle data including information of violation content from among the second vehicle data identified by the information of the second vehicle data ID (S317). More specifically, the control target search unit 117 searches for information in which a value representing violation content is stored from among information of violation content associated with the information of the second vehicle data ID received from the overlapping range search unit 116. When the result represents that the information of the violation content in which a value representing the violation content has been stored is not found (S318: No), the control target search unit 117 sends the information of the first vehicle data ID and the information of the second vehicle data ID received from the overlapping range search unit 116 to the vehicle type classification search unit 118 and the running limitation search unit 119.

[0131]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the control target search unit 117, the vehicle type classification search unit 118 searches for second vehicle data including information of vehicle type classification different from information of vehicle type classification included in the first vehicle data identified by the information of the first vehicle data ID from among the second vehicle data identified by the information of the second vehicle data ID (S319). More specifically, the vehicle type classification search unit 118 reads information of vehicle type classification associated with the information of the first vehicle data ID received from the control target search unit 117 from the first vehicle data storage unit 123. Then, the vehicle type classification search unit 118 searches for the information of the vehicle type classification different from the information of the vehicle type classification read from the first vehicle data storage unit 123 in association with the information of the second vehicle data ID received from the control target search unit 117. When the result represents that the information of corresponding vehicle type classification has been found (S320: Yes), the vehicle type classification search unit 118 reads the information of the second vehicle data ID associated with the information of the vehicle type classification. Then, the vehicle type classification search unit 118 sends the information of the second vehicle data ID and the information of the first vehicle data ID for identifying the above-described first vehicle data to the data associating unit 123.

[0132]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the control target search unit 117, the running limitation search unit 119 searches for second vehicle data including information of running limitation (Yes or No) of a value which is not subject to the running limitation of

the toll road R from among the second vehicle data identified by the information of the second vehicle data ID (S319).

More specifically, the running limitation search unit 119 searches for the information of the value which is not subject to the running limitation of the toll road R from among the information of the running limitation (Yes or No) associated with the information of the second vehicle data ID received from the control target search unit 117. When the result represents that the information of the corresponding running limitation (Yes or No) has been found (S320: Yes), the running limitation search unit 119 reads the information of the second vehicle data ID associated with the information of the running limitation (Yes or No). Then, the running limitation search unit 119 sends the information of the second vehicle data ID and the information of the first vehicle data ID for identifying the above-described first vehicle data to the data associating unit 121.

[0133]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the vehicle type classification search unit 118 and the running limitation search unit 119, the data associating unit 121 provisionally associates the second vehicle data identified by the information of the second vehicle data ID with the first vehicle data identified by the information of the first vehicle data ID (S304). More specifically, the data associating unit 121 associates the information of the first vehicle data ID and the information of the second vehicle data ID received from the vehicle type classification search unit 118 and the running limitation search unit 119 and stores an association result in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the above-described information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123. In addition, in this case, the data associating unit 121 does not delete the above-described

information of the second vehicle data ID and the information associated therewith from the second vehicle data storage unit 124.

[0134]

In this manner, when there is no second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number of the first vehicle data after characters on which optical character recognition has failed have been completed in the character string represented by the information of the vehicle number of the first vehicle data, the vehicle data processing device 110 associates second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification of the first vehicle data and including the information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the toll road R with the first vehicle data. This is because, when vehicle-mounted equipment other than normal vehicle-mounted equipment is mounted on the vehicle, vehicle-mounted equipment for a vehicle of vehicle type classification having a cheaper toll than vehicle type classification of an own vehicle is considered to be likely to be mounted or vehicle-mounted equipment including a setting which is not subject to the running limitation of the toll road R is considered to be likely to be mounted.

[0135]

On the other hand, when a result of the search of the above-described step S315 represents that information of a corresponding roadside wireless device ID is not found (S316: No), the overlapping range search unit 116 sends the information of the first vehicle data ID for identifying the above-described first vehicle data to the data associating unit 121.

[0136]

Upon receiving the information of the first vehicle data ID sent from the overlapping range search unit 116, the data associating unit 121 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data identified by the information of the first vehicle data ID (S304). More specifically, the data associating unit 121 stores the information of the first vehicle data ID received from the overlapping range search unit 116 in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the above-described information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123.

[0137]

In this manner, when there is no second vehicle data including information of a roadside wireless device ID for identifying the roadside wireless device 140 having the communication area C overlapping the imaging area A in which a target vehicle of the first vehicle data has been imaged, the data associating unit ends the association of the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data.

This is because, if no data has been received by the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 from the vehicle-mounted equipment when the vehicle has been imaged by the monitoring camera 130, the reception of data from the vehicle-mounted equipment is considered to have failed or the vehicle-mounted equipment is considered not to be mounted.

[0138]

On the other hand, when a result of the search of the above-described step S317 represents that the information of the violation content in which a value representing the

violation content has been stored has been found (S318: Yes), the control target search unit 117 sends the information of the second vehicle data ID associated with the information of the violation content and the information of the first vehicle data ID for identifying the above-described first vehicle data to the data associating unit 121.

[0139]

Upon receiving the information of the first vehicle data ID and the information of the second vehicle data ID sent from the control target search unit 117, the data associating unit 121 provisionally associates the second vehicle data identified by the information of the second vehicle data ID with the first vehicle data identified by the information of the first vehicle data ID (S304). More specifically, the data associating unit 121 associates the information of the first vehicle data ID and the information of the second vehicle data ID received from the control target search unit 117 and stores an association result in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the above-described information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123. In addition, in this case, the data associating unit 121 does not delete the above-described information of the second vehicle data ID and the information associated therewith from the second vehicle data storage unit 124.

[0140]

In this manner, after characters on which optical character recognition has failed have been completed in the character string represented by the information of the vehicle number of the first vehicle data, the second vehicle data is associated with the first vehicle data if there is second vehicle data including the information representing content of a traffic violation when there is no second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number of the

first vehicle data. This is because, although there is no matching vehicle-mounted equipment information in a character recognition result, one or more pieces of vehicle-mounted equipment information determined to be illegal at that time and in that vicinity are present, any one of the one or more pieces of vehicle-mounted equipment information is likely to match the vehicle data, and the vehicle is considered likely to be an illegal vehicle.

[0141]

On the other hand, when a result of the search of the above-described step S319 represents that neither information of corresponding vehicle type classification nor information of a corresponding running limitation (Yes or No) has been found (S320: No), the vehicle type classification search unit 118 or the running limitation search unit 119 sends the information of the first vehicle data ID for identifying the above-described first vehicle data to the data associating unit 121.

[0142]

Upon receiving the information of the first vehicle data ID sent from the vehicle type classification search unit 118, the data associating unit 121 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data identified by the information of the first vehicle data ID (S304). More specifically, the data associating unit 121 stores the information of the above-described first vehicle data ID received from the vehicle type classification search unit 118 in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the above-described information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123.

[0143]

In this manner, if there is no second vehicle data including information of

vehicle type classification different from information of vehicle type classification of the first vehicle data when there is no second vehicle data including information of a vehicle number which is the same as information of the vehicle number of the first vehicle data after characters on which optical character recognition has failed have been completed in the character string represented by the information of the vehicle number of the first vehicle data, the vehicle data processing device 110 ends the association of the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data. This is because the possibility of the vehicle being a standard vehicle is considered to be high.

[0144]

Upon receiving the information of the first vehicle data ID sent from the running limitation search unit 119, the data associating unit 121 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data identified by the information of the first vehicle data ID (S304). More specifically, the data associating unit 121 stores the information of the first vehicle data ID received from the running limitation search unit 119 in the vehicle data storage unit 125. Then, the data associating unit 121 deletes the above-described information of the first vehicle data ID and the information associated therewith from the first vehicle data storage unit 123.

[0145]

In this manner, if there is no second vehicle data including information of the running limitation (Yes or No) of a value which is not subject to the running limitation of the toll road R when there is no second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number of the first vehicle data after characters on which optical character recognition has failed have been

completed in the character string represented by the information of the vehicle number of the first vehicle data, the vehicle data processing device 110 ends the association of the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data. This is because the possibility of the vehicle being a standard vehicle is considered to be high.

[0146]

In addition, if the second vehicle data is provisionally associated with other first vehicle data when the second vehicle data is properly associated with the first vehicle data, the data associating unit 121 cancels provisional association of the second vehicle data with the other first vehicle data and properly associates the second vehicle data with the first vehicle data.

[0147]

The vehicle data transmitting unit 122 of the vehicle data processing device 110 transmits vehicle data including information of a vehicle included in at least one of the first vehicle data and the second vehicle data to the server 170 (S305). More specifically, when the data associating unit 121 has properly associated the second vehicle data with the first vehicle data, the vehicle data transmitting unit 122 transmits vehicle data including the information of the vehicle included in the first vehicle data and the second vehicle data to the server 170. In addition, when the data associating unit 121 has ended the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data, the vehicle data transmitting unit 122 transmits the vehicle data including the information of the vehicle included in the first vehicle data to the server 170. In addition, if the monitoring camera 130 having the imaging area A overlapping the communication area C of the

roadside wireless device 140 receiving the second vehicle data images a predetermined number of vehicles after a reception time of the second vehicle data when the data associating unit 121 has provisionally associated the second vehicle data with the first vehicle data, the vehicle data transmitting unit 122 transmits vehicle data including the information of the vehicle included in the first vehicle data and the second vehicle data and an image represented by information of an image ID included in the first vehicle data to the server 170. In addition, if a predetermined time has elapsed from a reception time of the second vehicle data when the data associating unit 121 has provisionally associated the second vehicle data with the first vehicle data, the vehicle data transmitting unit 122 transmits vehicle data including the information of the vehicle included in the first vehicle data and the second vehicle data and an image represented by the information of the image ID included in the first vehicle data to the server 170.

[0148]

As described above, the monitoring camera 130 continuously images the toll road R. In addition, the roadside wireless device 140 has the communication area C overlapping the imaging area A of the monitoring camera 130. Then, the vehicle data processing device 110 associates second vehicle data including information of a vehicle which is likely to be the same vehicle as a vehicle of a target of the first vehicle data among the second vehicle data with the first vehicle data.

[0149]

Thus, according to the vehicle data processing system 100, a charging system using the GPS can decrease a data volume of information associated with specifying an illegal vehicle to be transmitted to a higher-order server or the like and reduce a load on a network between higher-order servers or a burden on an operator who performs an artificial process using the higher-order server. In addition, because each monitoring

camera 130 and each roadside wireless device 140 are arranged so that the imaging area A of one monitoring camera 130 and the communication area C of one roadside wireless device 140 overlap in the vehicle data processing system 100, a target of the second vehicle data to be associated with the first vehicle data including information of a vehicle imaged by the one monitoring camera 130, for example, can be limited to that including the information of the vehicle received by the roadside wireless device 140 corresponding to the one monitoring camera 130 or the roadside wireless devices 140 of both sides thereof from the vehicle-mounted equipment of the vehicle.

[0150]

In addition, as described above, the vehicle data processing device 110 searches for second vehicle data including information of a vehicle number which is the same as information of a vehicle number of a vehicle included in the first vehicle data from among the second vehicle data. Then, the vehicle data processing device 110 properly associates the searched second vehicle data with the first vehicle data.

[0151]

Thus, the vehicle data processing system 100 can associate the first vehicle data and the second vehicle data when there is second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number of the vehicle included in the first vehicle data.

[0152]

In addition, as described above, the vehicle data processing device 110 determines whether a character string of a vehicle number represented by information of the vehicle number of the vehicle included in the first vehicle data is recognized as characters. Then, upon determining that the entire character string of the vehicle number represented by the information of the vehicle number of the vehicle included in

the first vehicle data is recognized as characters, the vehicle data processing device 110 searches for second vehicle data including information of a vehicle number which is the same as the information of the vehicle number of the vehicle included in the first vehicle data from among the second vehicle data.

[0153]

Thus, the vehicle data processing system 100 can associate the second vehicle data with the first vehicle data including the information of the vehicle number after checking that the entire character string of the vehicle number has been recognized by optical character recognition.

[0154]

In addition, as described above, the vehicle data processing device 110 searches for second vehicle data including information of vehicle type classification different from information of vehicle type classification included in the first vehicle data from among the second vehicle data. In addition, the vehicle data processing device 110 searches for second vehicle data including information of running limitation (Yes or No) of a value which is not subject to the running limitation of the toll road R from among the second vehicle data. Then, when the second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number included in the first vehicle data is not found, the vehicle data processing device 110 provisionally associates the second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification of the vehicle included in the first vehicle data and the second vehicle data including information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the toll road R with the first vehicle data.

[0155]

Thus, the vehicle data processing system 100 can associate the first vehicle data including information of the vehicle on which vehicle-mounted equipment which is not normal vehicle-mounted equipment to be mounted on the vehicle is likely to be mounted and the second vehicle data.

[0156]

In addition, as described above, when the second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification included in the first vehicle data and the information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the toll road R is not found, the vehicle data processing device 110 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that there is a suspicion of illegality in which a vehicle-mounted device is not mounted on the vehicle because there is no second vehicle data to be associated with the first vehicle data.

[0157]

Thus, the vehicle data processing system 100 can prevent the second vehicle data from being associated with the first vehicle data including the information of the vehicle when it is difficult to receive data from the vehicle-mounted equipment, when the vehicle-mounted equipment is not mounted on the vehicle, or the like.

[0158]

In addition, as described above, the vehicle data processing device 110 searches for second vehicle data including information of the roadside wireless device ID of the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information of the monitoring camera ID included in the first vehicle data from among the second vehicle data. Then,

the vehicle data processing device 110 searches for the second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification included in the first vehicle data from among the searched second vehicle data, and searches for the second vehicle data including the information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the toll road R from among the searched second vehicle data.

[0159]

Thus, according to the vehicle data processing system 100, only second vehicle data including information of the roadside wireless device ID of the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information of the monitoring camera ID included in the first vehicle data can serve as a target to be associated with the first vehicle data.

[0160]

In addition, as described above, when the second vehicle data including information of the roadside wireless device ID of the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information of the monitoring camera ID included in the first vehicle data is not found, the vehicle data processing device 110 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data.

[0161]

Thus, when the second vehicle data including information of the roadside wireless device ID of the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information

of the monitoring camera ID included in the first vehicle data is not found, the vehicle data processing system 100 can prevent the association of the second vehicle data with the first vehicle data from being performed.

[0162]

In addition, as described above, the vehicle data processing device 110 completes partial characters which are not recognized as characters in a character string of a vehicle number represented by the information of the vehicle number included in the first vehicle data. Then, upon determining that part of the character string of the vehicle number represented by the information of the vehicle number included in the first vehicle data is not recognized as the characters, the vehicle data processing device 110 searches for second vehicle data including information of a vehicle number which is the same as the information of the vehicle number in which the characters included in the first vehicle data have been completed from among the second vehicle data.

[0163]

Thus, even when part of the character string of the vehicle number represented by the information of the vehicle number included in the first vehicle data is not recognized as the characters, the vehicle data processing system 100 can associate the second vehicle data with the first vehicle data.

[0164]

In addition, as described above, the vehicle data processing device 110 searches for the second vehicle data including information of violation content from among the second vehicle data. Then, when the second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number in which the characters included in the first vehicle data have been completed is not found, the vehicle data processing device 110 provisionally associates the searched second vehicle

data including information of the violation content with the first vehicle data.

[0165]

Thus, when the second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number in which the characters included in the first vehicle data have been completed is not found, the vehicle data processing system 100 can suppress an amount of data to be transmitted to the server 170 by setting only second vehicle data including information of a vehicle that has committed a traffic violation or the like to be likely to be associated with the first vehicle data.

[0166]

In addition, as described above, the vehicle data processing device 110 searches for the second vehicle data including information of violation content from among the second vehicle data including information of the roadside wireless device ID of the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information of the monitoring camera ID included in the first vehicle data.

[0167]

Thus, the vehicle data processing system 100 can set only the second vehicle data including the information of the roadside wireless device ID of the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information of the monitoring camera ID included in the first vehicle data as a target to be associated with the first vehicle data.

[0168]

In addition, as described above, when the second vehicle data including information of violation content is not found, the vehicle data processing device 110

provisionally associates the second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification of the vehicle included in the first vehicle data and the second vehicle data including information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the toll road R with the first vehicle data.

[0169]

Thus, the vehicle data processing system 100 can associate the first vehicle data including information of the vehicle on which vehicle-mounted equipment which is not normal vehicle-mounted equipment to be mounted on the vehicle is likely to be mounted and the second vehicle data.

[0170]

In addition, as described above, when the second vehicle data including information of violation content is not found and the second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification included in the first vehicle data and information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the toll road R is not found, the vehicle data processing device 110 ends the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that a possibility of illegality of the vehicle of the target of the first vehicle data is low.

[0171]

Thus, the vehicle data processing system 100 can end the association of the second vehicle data with the first vehicle data when there is no suspicion of illegality in a target vehicle of the first vehicle data even when there is no second vehicle data to be associated with the first vehicle data.

[0172]

In addition, as described above, the vehicle data processing device 110 determines whether the vehicle is a control target based on the information of the vehicle number included in the first vehicle data. Then, when the second vehicle data including information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the toll road R among the second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification of the vehicle included in the first vehicle data is provisionally associated with the first vehicle data or when the association of the second vehicle data with the first vehicle data ends without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data, information representing a result of determining whether the vehicle is a control target is associated with the first vehicle data.

[0173]

Thus, by clearly determining whether the target vehicle of the first vehicle data is a control target when it is difficult to properly associate the second vehicle data with the first vehicle data, the vehicle data processing system 100 can use the determination as information for determining whether the vehicle is performing an illegal action.

[0174]

In addition, as described above, if the second vehicle data is provisionally associated with other first vehicle data when the second vehicle data is properly associated with the first vehicle data, the vehicle data processing device 110 cancels provisional association of the second vehicle data with the other first vehicle data and properly associates the second vehicle data with the first vehicle data.

[0175]

Thus, because data is set to be associated again if the first vehicle data to be properly associated is obvious thereafter even when the second vehicle data is associated with data different from the first vehicle data to be properly associated, the vehicle data processing system 100 can suppress the amount of provisionally associated data and reduce a load on a network between the servers 170 or a burden on an operator for artificially processing data integrated on the server 170.

[0176]

In addition, as described above, the vehicle data processing device 110 transmits vehicle data including information of a vehicle included in at least one of the first vehicle data and the second vehicle data to the server 170.

[0177]

Thus, the vehicle data processing system 100 can integrate information connected to specifying of an illegal vehicle in a plurality of toll roads R on the server 170.

[0178]

In addition, when the second vehicle data is properly associated with the first vehicle data as described above, the vehicle data processing device 110 transmits vehicle data including information of a vehicle included in the first vehicle data and the second vehicle data to the server 170.

[0179]

Thus, the vehicle data processing system 100 can integrate information included in the associated first and second vehicle data on the server 170 as information related to the same vehicle.

[0180]

In addition, as described above, when the association of the second vehicle data

with the first vehicle data has ended without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data, the vehicle data processing device 110 transmits the vehicle data including the information of the vehicle included in the first vehicle data to the server 170.

[0181]

Thus, the vehicle data processing system 100 can integrate information included in the first vehicle data on the server 170 as information related to the target vehicle when there is no second vehicle data to be associated with the first vehicle data.

[0182]

In addition, as described above, if the monitoring camera 130 having the imaging area A overlapping the communication area C of the roadside wireless device 140 receiving the second vehicle data images a predetermined number of vehicles after a reception time of the second vehicle data when the second vehicle data has been provisionally associated with the first vehicle data, the vehicle data processing device 110 transmits vehicle data including the information of the vehicle included in the first vehicle data and the second vehicle data and an image represented by information of an image ID included in the first vehicle data to the server 170.

[0183]

Thus, the vehicle data processing system 100 can integrate information included in the first vehicle data which is not likely to be properly associated with the second vehicle data and information included in the second vehicle data which has been provisionally associated on the server 170 along with an image of a target vehicle.

[0184]

In addition, as described above, if a predetermined time has elapsed from a

reception time of the second vehicle data when the second vehicle data has been provisionally associated with the first vehicle data, the vehicle data processing device 110 transmits vehicle data including the information of the vehicle included in the first vehicle data and the second vehicle data and an image represented by the information of the image ID included in the first vehicle data to the server 170.

[0185]

Thus, the vehicle data processing system 100 can integrate information included in the first vehicle data which is not likely to be properly associated with the second vehicle data and information included in the second vehicle data which has been provisionally associated on the server 170 along with an image of a target vehicle.

[0186]

In addition, as described above, if the monitoring camera 130 having the imaging area A overlapping the communication area C of the roadside wireless device 140 receiving the second vehicle data images a predetermined number of vehicles after a reception time of the second vehicle data when the second vehicle data including information of violation content is not associated with any first vehicle data, the vehicle data processing device 110 transmits the vehicle data including the information of the vehicle included in the second vehicle data to the server 170.

[0187]

Thus, the vehicle data processing system 100 can transmit information included in the second vehicle data which is not likely to be associated with the first vehicle data to the server 170.

[0188]

In addition, as described above, if a predetermined time has elapsed from a reception time of the second vehicle data when the second vehicle data including

information of violation content is not associated with any first vehicle data, the vehicle data processing device 110 transmits vehicle data including information of a vehicle included in the second vehicle data to the server 170.

[0189]

Thus, the vehicle data processing system 100 can transmit information included in the second vehicle data which is not likely to be associated with the first vehicle data to the server 170.

[0190]

In addition, in the above-described embodiment, an example in which the overlapping range search unit 116 searches for second vehicle data including information of a roadside wireless device ID for identifying the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information of a monitoring camera ID included in the first vehicle data from among the second vehicle data has been described. In place of this method, the overlapping range search unit 116, for example, may be configured to specify the roadside wireless device ID for a detection position of the vehicle in an x-axis coordinate by referring to a table in which a range in the x-axis coordinate of the communication area C of each roadside wireless device 140 corresponds to the roadside wireless device ID using a width direction of the toll road R as the x-axis coordinate.

[0191]

In addition, if the monitoring camera 130 having the imaging area A overlapping the communication area C of the roadside wireless device 140 receiving the second vehicle data images a predetermined number of vehicles after a reception time of the second vehicle data when the second vehicle data including information of violation content is not associated with any first vehicle data, the vehicle data transmitting unit 122

may be configured to transmit the vehicle data including the information of the vehicle included in the second vehicle data to the server 170. In addition, if a predetermined time has elapsed from a reception time of the second vehicle data when the second vehicle data including information of violation content is not associated with any first vehicle data, the vehicle data transmitting unit 122 may be configured to transmit vehicle data including information of a vehicle included in the second vehicle data to the server 170.

[0192]

Fig. 14 illustrates an example of a hardware configuration of a computer 800 constituting the vehicle data processing device 110 according to this embodiment. The computer 800 according to this embodiment includes a central processing unit (CPU) peripheral unit which includes a CPU 802, a random access memory (RAM) 803, a graphic controller 804, and a display 805 mutually connected via a host controller 801, an input/output (I/O) unit which includes a communication interface 807, a hard disk drive (HDD) 808, and a compact disc read only memory (CD-ROM) drive 809 mutually connected via an I/O controller 806, and a legacy I/O unit which includes a read only memory (ROM) 810, a flexible disk drive 811, and an I/O chip 812 connected to the I/O controller 806.

[0193]

The host controller 801 connects the RAM 803 to the CPU 802 and the graphic controller 804 which access the RAM 803 at high transfer rates. The CPU 802 operates based on programs stored in the ROM 810 and the RAM 803 to control each part. The graphic controller 804 acquires image data generated by the CPU 802 or the like in a frame buffer provided in the RAM 803 and displays the image data on the display 805. In place of this, the graphic controller 804 may internally include a frame buffer which

stores image data generated by the CPU 802 or the like.

[0194]

The I/O controller 806 connects the host controller 801 to the communication interface 807, the HDD 808, and the CD-ROM drive 809 which are relatively high-speed I/O devices. The HDD 808 stores programs and data used by the CPU 802 within the computer 800. The CD-ROM drive 809 reads programs or data from a CD-ROM 892 and provides the programs or the data to the HDD 808 via the RAM 803.

[0195]

In addition, the I/O controller 806 is connected to the ROM 810, the flexible disk drive 811, and the I/O chip 812 which are relatively low-speed I/O devices. The ROM 810 stores a boot program to be executed when the computer 800 is activated and/or programs, etc. depending on hardware of the computer 800. The flexible disk drive 811 reads programs or data from a flexible disk 893 and provides the programs or the data to the HDD 808 via the RAM 803. The I/O chip 812 connects the flexible disk drive 811 to the I/O controller 806 and also connects various I/O devices to the I/O controller 806 via, for example, a parallel port, a serial port, a keyboard port, a mouse port, etc.

[0196]

The programs provided to the HDD 808 via the RAM 803 are stored on a recording medium, such as the flexible disk 893, the CD-ROM 892, or an integrated circuit (IC) card, and are provided by a user. The programs are read from the recording medium, installed on the HDD 808 within the computer 800 via the RAM 803, and executed in the CPU 802.

[0197]

A program, which is installed in the computer 800 and causes the computer 800

to function as the vehicle data processing device 110, causes the computer 800 to function as the data associating unit 121 configured to associate second vehicle data including information of a vehicle which is likely to be the same vehicle as a vehicle of a target of the first vehicle data among the second vehicle data with the first vehicle data in step S304.

[0198]

Further, the program may cause the computer 800 to function as the vehicle number search unit 115 configured to search for second vehicle data including information of a vehicle number which is the same as information of a vehicle number of a vehicle included in the first vehicle data from among the second vehicle data in step S302 and the data associating unit 121 configured to properly associate second vehicle data searched by the vehicle number search unit 115 with the first vehicle data in step S304.

[0199]

Further, the program may cause the computer 800 to function as the optical character recognition availability determining unit 113 configured to determine whether a character string of a vehicle number represented by information of a vehicle number included in the first vehicle data is recognized as characters in step S301 and the vehicle number search unit 115 configured to search for second vehicle data including information of a vehicle number which is the same as the information of the vehicle number included in the first vehicle data from among the second vehicle data in step S302 when the optical character recognition availability determining unit 113 determines that the entire character string of the vehicle number represented by the information of the vehicle number included in the first vehicle data is recognized as characters.

[0200]

Further, the program may cause the computer 800 to function as the vehicle type classification search unit 118 configured to search for second vehicle data including information of vehicle type classification different from information of vehicle type classification included in the first vehicle data from among the second vehicle data in step S308, a running limitation search unit 119 configured to search for second vehicle data including information of running limitation (Yes or No) of a value which is not subject to running limitation of the toll road R from among the second vehicle data in step S308, and the data associating unit 121 configured to provisionally associate the second vehicle data searched by the vehicle type classification search unit 118 and the second vehicle data searched by the running limitation search unit 119 with the first vehicle data in step S304 when a result of the search performed by the vehicle number search unit 115 represents that the second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number included in the first vehicle data is not found.

[0201]

Further, the program may cause the computer 800 to function as the data associating unit 121 configured to end the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that there is a suspicion of illegality in which a vehicle-mounted device is not mounted on the vehicle because there is no second vehicle data to be associated with the first vehicle data in step S304 when results of the searches performed by the vehicle type classification search unit 118 and the running limitation search unit 119 represent that the second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification included in the first vehicle data and the information of the running limitation (Yes or No) of the value which

is not subject to the running limitation of the toll road R is not found.

[0202]

Further, the program may cause the computer 800 to function as the overlapping range search unit 116 configured to search for second vehicle data including information of the roadside wireless device ID of the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information of the monitoring camera ID included in the first vehicle data from among the second vehicle data in step S306, the vehicle type classification search unit 118 configured to search for the second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification included in the first vehicle data, in step S308, from among the second vehicle data searched by the overlapping range search unit 116, and the running limitation search unit 119 configured to search for the second vehicle data including the information of the running limitation (Yes or No) of the value which is not subject to the running limitation of the toll road R, in step S308, from among the second vehicle data searched by the overlapping range search unit 116.

[0203]

Further, the program may cause the computer 800 to function as the data associating unit 121 configured to end the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data in step S304 when a result of the search performed by the overlapping range search unit 116 represents that the second vehicle data including the information of the roadside wireless device ID of the roadside wireless device 140 having the communication area C overlapping the imaging area A of the monitoring camera 130 represented by information

of the monitoring camera ID in the first vehicle data is not found.

[0204]

Further, the program may cause the computer 800 to function as the character completing unit 114 configured to complete partial characters which are not recognized as characters in a character string of a vehicle number represented by the information of the vehicle number of the vehicle included in the first vehicle data in step S312 and the vehicle number search unit 115 configured to search for second vehicle data including information of a vehicle number which is the same as the information of the vehicle number in which the characters have been completed by the character completing unit 114 included in the first vehicle data from among the second vehicle data in step S313 when the optical character recognition availability determining unit 113 determines that part of the character string of the vehicle number represented by the information of the vehicle number included in the first vehicle data is not recognized as the characters.

[0205]

Further, the program may cause the computer 800 to function as the control target search unit 177 configured to search for the second vehicle data including information of violation content from among the second vehicle data in step S317 and the data associating unit 121 configured to provisionally associate the second vehicle data searched by the control target search unit 117 with the first vehicle data in step S304 when a result of the search performed by the vehicle number search unit 115 represents that the second vehicle data including the information of the vehicle number which is the same as the information of the vehicle number in which the characters have been completed by the character completing unit 114 included in the first vehicle data is not found.

[0206]

Further, the program may cause the computer 800 to function as the control target search unit 117 configured to search for the second vehicle data including the information of violation content, in step S317, from among the second vehicle data searched by the overlapping range search unit 116.

[0207]

Further, the program may cause the computer 800 to function as the data associating unit 121 configured to provisionally associate the second vehicle data searched by the vehicle type classification search unit 118 and the second vehicle data searched by the running limitation search unit 119 with the first vehicle data in step S304 when a result of the search performed by the control target search unit 117 represents that the second vehicle data including the information of the violation content is not found.

[0208]

Further, the program may cause the computer 800 to function as the data associating unit 121 configured to end the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that a possibility of illegality of the vehicle of the target of the first vehicle data is low in step S304 when a result of the search performed by the control target search unit 117 represents that the second vehicle data including the information of the violation content is not found and results of the searches performed by the vehicle type classification search unit 118 and the running limitation search unit 119 represent that second vehicle data including the information of the vehicle type classification different from the information of the vehicle type classification included in the first vehicle data and the information of the value of the running limitation (Yes or No) which is not subject to the running limitation of the toll road R is not found.

[0209]

Further, the program may cause the computer 800 to function as the control target determining unit 120 configured to determine whether the vehicle is a control target based on the information of the vehicle number included in the first vehicle data in step S310 and the data associating unit 121 configured to associate information representing a result of the determination made by the control target determining unit 120 with the first vehicle data in step S304 when the second vehicle data searched by the running limitation search unit 119 among the second vehicle data searched by the vehicle type classification search unit 118 is provisionally associated with the first vehicle data or when the association of the second vehicle data with the first vehicle data ends without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data.

[0210]

Further, the program may cause the computer 800 to function as the data associating unit 121 configured to cancel provisional association of the second vehicle data with other first vehicle data and properly associate the second vehicle data with the first vehicle data if the second vehicle data is provisionally associated with the other first vehicle data when the second vehicle data is properly associated with the first vehicle data in step S304.

[0211]

Further, the program may cause the computer 800 to function as the vehicle data transmitting unit 122 configured to transmit vehicle data including information of a vehicle included in at least one of the first vehicle data and the second vehicle data to the server 170 in step S305.

[0212]

Further, the program may cause the computer 800 to function as the vehicle data

transmitting unit 122 configured to transmit vehicle data including the information of the vehicle included in the first vehicle data and the second vehicle data to the server 170 in step S305 when the data associating unit 121 has properly associated the second vehicle data with the first vehicle data.

[0213]

Further, the program may cause the computer 800 to function as the vehicle data transmitting unit 122 configured to transmit the vehicle data including the information of a vehicle included in the first vehicle data to the server 170 in step S305 when the data associating unit 121 has ended the association of the second vehicle data with the first vehicle data without associating the second vehicle data with the first vehicle data by determining that there is no second vehicle data to be associated with the first vehicle data.

[0214]

Further, the program may cause the computer 800 to function as the vehicle data transmitting unit 122 configured to transmit vehicle data including the information of a vehicle included in the first vehicle data and the second vehicle data and an image represented by information of an image ID included in the first vehicle data to the server 170 if the monitoring camera 130 having the imaging area A overlapping the communication area C of the roadside wireless device 140 receiving the second vehicle data images a predetermined number of vehicles after a reception time of the second vehicle data in step S305 when the data associating unit 121 has provisionally associated the second vehicle data with the first vehicle data.

[0215]

Further, the program may cause the computer 800 to function as the vehicle data transmitting unit 122 configured to transmit the information of a vehicle included in the

first vehicle data and the second vehicle data and vehicle data including an image represented by the information of the image ID included in the first vehicle data to the server 170 if a predetermined time has elapsed from a reception time of the second vehicle data in step S305 when the data associating unit 121 has provisionally associated the second vehicle data with the first vehicle data.

[0216]

Information processing described in the program is loaded to the computer 800, which thereby functions as the first vehicle data receiving unit 111, the second vehicle data receiving unit 112, the optical character recognition availability determining unit 113, the character completing unit 114, the vehicle number search unit 115, the overlapping range search unit 116, the control target search unit 117, the vehicle type classification search unit 118, the running limitation search unit 119, the control target determining unit 120, the data associating unit 121, the vehicle data transmitting unit 122, the first vehicle data storage unit 123, the second vehicle data storage unit 124, and the vehicle data storage unit 125 which are concrete means resulting from cooperation of software and various hardware resources described above. These concrete means implement calculation or processing of information according to the usage of the computer 800 in this embodiment, whereby the specific vehicle data processing device 110 according to the usage is constructed.

[0217]

For example, when the computer 800 performs communication with an external device or the like, the CPU 802 executes a communication program loaded to the RAM 803 and instructs the communication interface 807 to perform communication processing based on processing content written in the communication program. Under control of the CPU 802, the communication interface 807 reads transmission data stored in a

transmission buffer region or the like provided on a storage device, such as the RAM 803, the HDD 808, the flexible disk 893, or the CD-ROM 892 to transmit the transmission data to the network, or the communication interface 807 writes reception data received from the network to a reception buffer region or the like provided on the storage device. In this manner, the communication interface 807 may transfer transmission/reception data from and to the storage device using a direct memory access method. In place of this, the CPU 802 reads data from a storage device or the communication interface 807 at a transfer source, and writes the data to the communication interface 807 or a storage device at a transfer destination, whereby transmission/reception data may be transferred.

[0218]

Moreover, the CPU 802 loads all or a necessary part of a file or a database stored in an external storage device such as the HDD 808, the CD-ROM 892, or the flexible disk 893 to the RAM 803 using the direct memory access transfer or the like. Then, the CPU 802 performs various types of processing on the data in the RAM 803. Then, the CPU 802 writes the processed data back to the external storage device using the direct memory access transfer or the like.

[0219]

In such processing, because the RAM 803 is considered to provisionally store the content of the external storage device, the RAM 803, the external storage device, and the like are collectively referred to as a memory, a storage unit, or a storage device in the embodiment. Various types of information such as various programs, data, tables, and databases in the embodiment are stored in such a storage device and serve as information processing targets. In addition, the CPU 802 can also hold part of the RAM 803 in a cache memory and perform read and write operations on the cache memory. Even in such a form, because the cache memory undertakes some of the functions of the RAM

803, it is assumed in the embodiment that the cache memory is included in the RAM 803, a memory, and/or a storage device, unless otherwise noted.

[0220]

Moreover, the CPU 802 performs various types of processing specified by an instruction sequence in a program on data read from the RAM 803. The various types of processing include various types of calculation, processing of information, condition determination, and search and replacement of information described in the embodiment. Then, the CPU 802 writes the processed data back to the RAM 803. For example, when the CPU 802 performs condition determination, the CPU 802 compares each of the various variables shown in the embodiment with another variable or a constant and determines whether a condition is satisfied. The condition includes, for example, whether the variable is greater than the other variable or the constant, whether the variable is less than the other variable or the constant, whether the variable is equal to or greater than the other variable or the constant, whether the variable is equal to or less than the other variable or the constant, and whether the variable is equal to the other variable or the constant. When the condition is satisfied or is not satisfied, the process branches to a different instruction sequence, or a subroutine is called.

[0221]

Additionally, the CPU 802 can search for information stored in files or databases stored in storage devices. For example, when a plurality of entries, in each of which an attribute value of a second attribute is associated with an attribute value of a first attribute, are stored in a storage device, the CPU 802 searches for an entry whose attribute value of the first attribute satisfies a specified condition from the plurality of entries stored in the storage device and reads the attribute value of the second attribute stored in the entry, thereby obtaining the attribute value of the second attribute associated with the first

attribute satisfying the predetermined condition.

[0222]

The above-described programs or modules may be stored on an external storage medium. In addition to the flexible disk 893 and the CD-ROM 892, for example, an optical recording medium such as a digital versatile disk (DVD) or a compact disk (CD), a magneto-optical recording medium such as a magneto-optical disk (MO), a tape medium, or a semiconductor memory such as an IC card can be used as the storage medium. Moreover, a storage device such as a hard disk or a RAM provided in a server system connected to a dedicated communication network or the Internet may be used as the recording medium, and the programs may be provided to the computer 800 via the network.

[0223]

While the present invention has been described above using the embodiment, the technical scope of the present invention is not limited to the scope of the description of the aforementioned embodiment. It is obvious to persons skilled in the art that various changes or improvements can be made in the aforementioned embodiment. It is obvious from the description of the claims that such changes or improvements are also included in the technical scope of the present invention.

[0224]

It should be noted that the execution order of processes such as operations, procedures, steps, and stages in the system, the method, the device, the program, and the recording medium described in the claims, the specification, and the drawings can be implemented in any order unless expressions such as “before” and “prior to” are explicitly given or the output of a preceding process is used by a following process. Even when operation flows in the claims, the specification, and the drawings are

described using expressions such as “first” and “next” for convenience, this does not mean that such order is required.

Industrial Applicability

[0225]

According to some aspects of the present invention, it is possible to process vehicle data including information of a vehicle running on a road.

Reference Signs List

[0226]

100	Vehicle data processing system
110	Vehicle data processing device
111	First vehicle data receiving unit
112	Second vehicle data receiving unit
113	Optical character recognition availability determining unit
114	Character completing unit
115	Vehicle number search unit
116	Overlapping range search unit
117	Control target search unit
118	Vehicle type classification search unit
119	Running limitation search unit
120	Control target determining unit
121	Data associating unit
122	Vehicle data transmitting unit
123	First vehicle data storage unit

124	Second vehicle data storage unit
125	Vehicle data storage unit
130	Monitoring camera
140	Roadside wireless device
150	First vehicle data generating device
160	Second vehicle data generating device
170	Server
800	Computer
801	Host controller
802	CPU
803	RAM
804	Graphic controller
805	Display
806	I/O controllers
807	Communication interface
808	HDD
809	CD-ROM drive
810	ROM
811	Flexible disk drive
812	I/O chip
891	Network communication device
892	CD-ROM
893	Flexible disk
Aa	Imaging area of monitoring camera 130a
Ab	Imaging area of monitoring camera 130b

Ac	Imaging area of monitoring camera 130c
Ca	Communication area of roadside wireless device 140a
Cb	Communication area of roadside wireless device 140b
Cc	Communication area of roadside wireless device 140c
Ga	Beam
Gb	Beam
N	Communication circuit
R	Toll road
Ra	Lane
Rb	Lane
Rc	Lane

Claims

1. A vehicle data processing system for processing vehicle data including information of a vehicle running on a road, the vehicle data processing system comprising:

an imaging device configured to continuously capture an image of a road;

a wireless device having a communication area overlapping an imaging area of the imaging device; and

a vehicle data processing device configured to process vehicle data I including information of a vehicle captured by the imaging device and vehicle data II including information of vehicles received by the wireless device from vehicle-mounted devices of the vehicles,

wherein the vehicle data processing device includes a data associating unit configured to associate (i) vehicle data II including information of a vehicle which has a possibility to be the same as information of a target vehicle of the vehicle data I among the vehicle data II with (ii) the vehicle data I.

2. The vehicle data processing system according to claim 1,

wherein the vehicle data processing device further includes:

a vehicle number search unit configured to retrieve vehicle data II including information of a vehicle number which is the same as information of a vehicle number of the vehicle included in the vehicle data I among the vehicle data II, and

wherein the data associating unit properly associates the vehicle data II retrieved by the vehicle number search unit with the vehicle data I.

3. The vehicle data processing system according to claim 2,

wherein the vehicle data processing device further includes:

an optical character recognition availability determining unit configured to determine whether a character string of a vehicle number, which is a result of optical character recognition on a number plate of the vehicle captured by the imaging device and is represented by the information of the vehicle number of the vehicle included in the vehicle data I, is recognized as characters or not; and

wherein, if the optical character recognition availability determining unit determines that the entire character string of the vehicle number represented by the information of the vehicle number of the vehicle included in the vehicle data I is recognized as characters, the vehicle number search unit retrieves vehicle data II including information of a vehicle number which is the same as the information of the vehicle number of the vehicle included in the vehicle data I among the vehicle data II.

4. The vehicle data processing system according to claim 3,

wherein the vehicle data processing device further includes:

a vehicle type classification search unit configured to retrieve vehicle data II including information of vehicle type classification different from information of vehicle type classification of the vehicle included in the vehicle data I among the vehicle data II; and

a running limitation search unit configured to retrieve vehicle data II including information of a value which is not subject to running limitation of the road among the vehicle data II, and

wherein, if a result of retrieval performed by the vehicle number search unit represents that the vehicle data II including the information of the vehicle number which

is the same as the information of the vehicle number of the vehicle included in the vehicle data I is not found, the data associating unit provisionally associates the vehicle data II retrieved by the vehicle type classification search unit and the vehicle data II retrieved by the running limitation search unit with the vehicle data I.

5. The vehicle data processing system according to claim 4, wherein, if results of retrieval performed by the vehicle type classification search unit and the running limitation search unit represent that the vehicle data II including the information of the vehicle type classification different from the information of the vehicle type classification of the vehicle included in the vehicle data I and the information of the value which is not subject to the running limitation of the road is not found, the data associating unit ends association of the vehicle data II with the vehicle data I without associating the vehicle data II with the vehicle data I by determining that there is a suspicion of illegality in which a vehicle-mounted device is not mounted on the vehicle on the basis that there is no vehicle data II to be associated with the vehicle data I.

6. The vehicle data processing system according to claim 4 or 5,

wherein the vehicle data processing device further includes:

an overlapping range search unit configured to retrieve vehicle data II including information of the wireless device having the communication area overlapping the imaging area of the imaging device represented by information of the imaging device capturing the vehicle included in the vehicle data I among the vehicle data II,

wherein the vehicle type classification search unit retrieves the vehicle data II including the information of the vehicle type classification different from the information of the vehicle type classification of the vehicle included in the vehicle data I among the

vehicle data II retrieved by the overlapping range search unit, and

wherein the running limitation search unit retrieves the vehicle data II including the information of the value which is not subject to the running limitation of the road among the vehicle data II retrieved by the overlapping range search unit.

7. The vehicle data processing system according to claim 6, wherein, if a result of retrieval performed by the overlapping range search unit represents that the vehicle data II including the information of the wireless device having the communication area overlapping the imaging area of the imaging device represented by the information of the imaging device capturing the vehicle included in the vehicle data I is not found, the data associating unit ends association of the vehicle data II with the vehicle data I without associating the vehicle data II with the vehicle data I by determining that there is no vehicle data II to be associated with the vehicle data I.

8. The vehicle data processing system according to claim 7,

wherein the vehicle data processing device further includes:

a character completing unit configured to complete partial characters which are not recognized as characters in the character string of the vehicle number represented by the information of the vehicle number of the vehicle included in the vehicle data I; and

wherein, if the optical character recognition availability determining unit determines that part of the character string of the vehicle number represented by the information of the vehicle number of the vehicle included in the vehicle data I is not recognized as the characters, the vehicle number search unit retrieves vehicle data II including information of a vehicle number which is the same as the information of the vehicle number of the vehicle, where the characters have been completed by the

character completing unit, included in the vehicle data I among the vehicle data II.

9. The vehicle data processing system according to claim 8,

wherein the vehicle data processing device further includes:

a control target search unit configured to retrieve vehicle data II including information of a vehicle of a control target among the vehicle data II, and

wherein, if the result of the retrieval performed by the vehicle number search unit represents that the vehicle data II including the information of the vehicle number which is the same as the information of the vehicle number of the vehicle, where the characters have been completed by the character completing unit, included in the vehicle data I is not found, the data associating unit provisionally associates the vehicle data II retrieved by the control target search unit with the vehicle data I.

10. The vehicle data processing system according to claim 9, wherein the control target search unit retrieves the vehicle data II including the information of the vehicle of the control target among the vehicle data II retrieved by the overlapping range search unit.

11. The vehicle data processing system according to claim 9 or 10, wherein, if a result of retrieval performed by the control target search unit represents that the vehicle data II including the information of the vehicle of the control target is not found, the data associating unit provisionally associates the vehicle data II retrieved by the vehicle type classification search unit and the vehicle data II retrieved by the running limitation search unit with the vehicle data I.

12. The vehicle data processing system according to any one of claims 9 to 11, wherein, if a result of retrieval performed by the control target search unit represents that the vehicle data II including the information of the vehicle of the control target is not found and the results of the retrieval performed by the vehicle type classification search unit and the running limitation search unit represent that the vehicle data II including the information of the vehicle type classification different from the information of the vehicle type classification of the vehicle included in the vehicle data I and the information of the value which is not subject to the running limitation of the road is not found, the data associating unit ends the association of the vehicle data II with the vehicle data I without associating the vehicle data II with the vehicle data I by determining that a possibility of illegality of the target vehicle of the vehicle data I is low.

13. The vehicle data processing system according to any one of claims 4 to 7, wherein the vehicle data processing device further includes:

a control target determining unit configured to determine whether the vehicle is a control target based on the information of the vehicle number of the vehicle included in the vehicle data I, and

wherein, if the vehicle data II retrieved by the running limitation search unit among the vehicle data II retrieved by the vehicle type classification search unit is provisionally associated with the vehicle data I or if association of the vehicle data II with the vehicle data I ends without associating the vehicle data II with the vehicle data I by determining that there is no vehicle data II to be associated with the vehicle data I, the data associating unit associates information representing a result of determination made by the control target determining unit with the vehicle data I.

14. The vehicle data processing system according to any one of claims 1 to 13, wherein, upon properly associating the vehicle data II with the vehicle data I, if the vehicle data II is provisionally associated with other vehicle data I, the data associating unit cancels provisional association of the vehicle data II with the other vehicle data I and properly associates the vehicle data II with the vehicle data I.

15. The vehicle data processing system according to any one of claims 1 to 14, wherein the vehicle data processing device further includes:

a vehicle data transmitting unit configured to transmit vehicle data including information of a vehicle included in at least one of the vehicle data I and the vehicle data II to an external device.

16. The vehicle data processing system according to claim 15, wherein, if the data associating unit has properly associated the vehicle data II with the vehicle data I, the vehicle data transmitting unit transmits vehicle data including the information of the vehicle included in the vehicle data I and the vehicle data II to the external device.

17. The vehicle data processing system according to claim 15 or 16, wherein, if the data associating unit has ended association of the vehicle data II with the vehicle data I without associating the vehicle data II with the vehicle data I by determining that there is no vehicle data II to be associated with the vehicle data I, the vehicle data transmitting unit transmits vehicle data including the information of the vehicle included in the vehicle data I to the external device.

18. The vehicle data processing system according to any one of claims 15 to 17,

wherein, if the imaging device having the imaging area overlapping the communication area of the wireless device receiving the vehicle data II captures a predetermined number of vehicles after a reception time of the vehicle data II if the data associating unit has provisionally associated the vehicle data II with the vehicle data I, the vehicle data transmitting unit transmits vehicle data including the information of the vehicle included in the vehicle data I and the vehicle data II and an image captured by the imaging device represented by information of an image included in the vehicle data I to the external device.

19. The vehicle data processing system according to any one of claims 15 to 18, wherein, if a predetermined time has elapsed from a reception time of the vehicle data II if the data associating unit has provisionally associated the vehicle data II with the vehicle data I, the vehicle data transmitting unit transmits vehicle data including the information of the vehicle included in the vehicle data I and the vehicle data II and an image captured by the imaging device represented by information of an image included in the vehicle data I to the external device.

20. A vehicle data processing method of processing vehicle data I including information of a vehicle captured by an imaging device continuously capturing an image of a road and vehicle data II including information of vehicles received by a wireless device having a communication area overlapping an imaging area of the imaging device from vehicle-mounted devices of the vehicles, the vehicle data processing method comprising:

a data associating step of associating (i) vehicle data II including information of a vehicle which has a possibility to be the same as information of a target vehicle of the

vehicle data I among the vehicle data II with (ii) the vehicle data I.

21. A vehicle data processing device for processing vehicle data I including information of a vehicle captured by an imaging device continuously capturing an image of a road and vehicle data II including information of vehicles received by a wireless device having a communication area overlapping an imaging area of the imaging device from vehicle-mounted devices of the vehicles, the vehicle data processing device comprising:

a data associating unit configured to associate (i) vehicle data II including information of a vehicle which has a possibility to be the same as information of a target vehicle of the vehicle data I among the vehicle data II with (ii) the vehicle data I.

22. A program for causing a computer to function as a vehicle data processing device for processing vehicle data I including information of a vehicle captured by an imaging device continuously capturing an image of a road and vehicle data II including information of vehicles received by a wireless device having a communication area overlapping an imaging area of the imaging device from vehicle-mounted devices of the vehicles,

wherein the program causes the computer to function as a data associating unit configured to associate (i) vehicle data II including information of a vehicle which has a possibility to be the same as information of a target vehicle of the vehicle data I among the vehicle data II with (ii) the vehicle data I.

23. A recording medium recording a program for causing a computer to function as a vehicle data processing device for processing vehicle data I including information of a

vehicle captured by an imaging device continuously capturing an image of a road and vehicle data II including information of vehicles received by a wireless device having a communication area overlapping an imaging area of the imaging device from vehicle-mounted devices of the vehicles,

wherein the program causes the computer to function as a data associating unit configured to associate (i) vehicle data II including information of a vehicle which has a possibility to be the same as information of a target vehicle of the vehicle data I among the vehicle data II with (ii) the vehicle data I.