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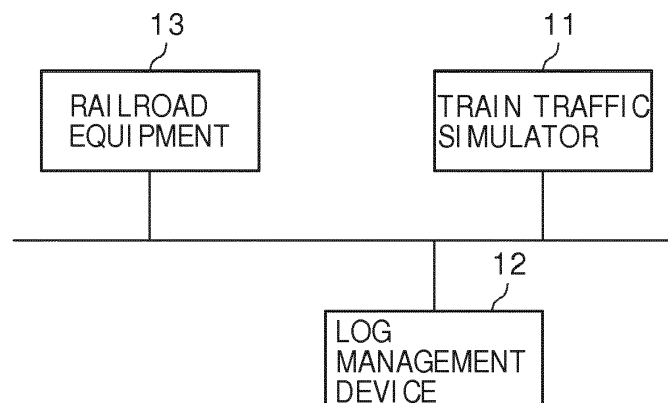
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(54) **Structure and mechanism of training system for train traffic management**

(57) A train traffic simulator (11, 105) simulates train operations, and varies and transmits internally stored train location information (202) and railroad equipment status information (219). When a command is input, the train traffic simulator (11, 105) applies the input command to the simulated train operations. A log management device (12, 110) records chronological train location information (202) and railroad equipment status information (219) prevailing during actual train operations as a first operation log, and records chronological train location information (202) and railroad equipment status information (219) prevailing during a simulation performed by

the train traffic simulator (11, 105) as a second operation log. In a first operating mode of simulation, the log management device (12, 110) reproduces the chronological train location information (202) and railroad equipment status information (219) by using the first operation log or by using the second operation log as well. When a predetermined procedure is performed, the log management device (12, 110) switches to a second operating mode to let the train traffic simulator (11, 105) perform a simulation in which the train location information (202) and railroad equipment status information (219) are re-lected.

FIG. 1



Description

Technical Field

[0001] The present invention relates to a system that enables an operator to conduct training for train traffic management.

Background

[0002] Train traffic is managed by allowing the operator to use a train traffic management system (TMS). The train traffic management system includes various devices such as a device for managing timetable, a device for providing train route control, and a device used by the operator to perform replanning.

[0003] Train traffic management is a task in which the operator is heavily responsible for performing commanding operations without mistakes. If replanning is erroneously performed, a massive delay or a serious accident may occur. Therefore, it is extremely important that training be conducted to improve the task execution capability of the operator.

[0004] If the operator is to be trained by allowing trains to actually run, it is extremely difficult to adjust the time, place, and equipment for training without affecting the real operations of trains. As such being the case, a train traffic simulator is occasionally used for operator training purposes.

[0005] The train traffic simulator simulates the running of trains and generates train location information and equipment status information, which are transmitted from wayside equipment to a control device when the trains actually run.

[0006] In order to let the train traffic simulator generate a failure incident, which is an incident concerning a failure such as a train delay and a railroad failure, it is generally necessary to manually preset the failure incident to be generated and the time of occurrence of the failure incident.

[0007] When a massive delay actually occurs, an enormous number of failure incidents are generated. Therefore, it is not easy to manually preset all the failure incidents and faithfully replicate the actual operations of trains.

[0008] In connection with the above, Japanese Unexamined Patent Application Publication No. 2000-016295 describes a means for initiating a simulation at an arbitrary time by using actual interlocking status such as track circuit information, signaling aspect status, and running direction information. According to Japanese Unexamined Patent Application Publication No. 2000-016295, a simulator has a history memory for recording and storing actual interlocking status and train detection information together with time, and performs a simulation by initially generating simulated trains from data about designated time that is included in train detection information stored in the history memory, initially generating simulated in-

terlocking status from data about the designated time that is included in interlocking status stored in the history memory, and then sequentially generating simulated interlocking status in accordance with a train timetable.

[0009] Further, there is a technology for replicating previous train operations that were performed in the event of a train delay or a railroad failure (refer to Japanese Unexamined Patent Application Publication No. Hei 7 (1995)-101337). This technology uses a traffic management system to reproduce previous train operations in accordance with history data managed by a log management device, such as train location information, equipment status information, traffic replanning data, and manual control data, and with a planned timetable managed by a real-time planning server. This makes it easy to analyze previously encountered massive delays and other accidents.

Summary

[0010] A technology described in Japanese Unexamined Patent Application Publication No. 2000-016295 first uses a system to simulate conditions for initiating a simulation at an arbitrary time in accordance with the records of actual running results in the past, and then uses a train traffic simulator to simulate the operations of trains in accordance with a planned timetable.

[0011] When an operator inputs an arbitrary time, a switching takes place to let the train traffic simulator simulate the operations of trains from an initial state in which actual operations in the past are replicated and within a time range of a stored operation history.

[0012] Meanwhile, it is conceivable that similar situations may be repeatedly simulated during training. When, for instance, training is conducted on the assumption that a train delay has occurred, a trainee may execute a certain replanning scheme, study the result of replanning, and then execute another replanning scheme under the same conditions. It is also conceivable that plural trainees may respectively execute their own replanning schemes under the same conditions.

[0013] However, when the technology described in Japanese Unexamined Patent Application Publication No. 2000-016295 is used in preparation for a new training session to replicate operating conditions prevailing at a certain point of time that were encountered during a previous training session, the operator must repeat the same procedure as a replanning procedure or other procedure performed during the previous training session. Hence, an enormous amount of time and labor is required for preparation. This results in poor efficiency of training.

[0014] An object of the present invention is to provide increased convenience when a train traffic simulator is used to conduct training about train traffic management.

[0015] According to a first aspect of the present invention, there is provided a (typically computer-based) train traffic management training system (TMS training system) including a train traffic simulator and a log manage-

ment device. The train traffic simulator simulates train operations, varies internally stored train location information and railroad equipment status information, and transmits the train location information and the railroad equipment status information. When a command is input, the train traffic simulator applies the input command to the simulated train operations. The log management device records chronological train location information and railroad equipment status information prevailing during actual train operations as a first operation log, and records chronological train location information and railroad equipment status information prevailing during a simulation performed by the train traffic simulator as a second operation log. In a first operating mode of simulation, the log management device reproduces the chronological train location information and railroad equipment status information by using the first operation log or by using the first operation log and the second operation log. When a predetermined procedure is performed in the first operating mode, the log management device switches to a second operating mode to let the train traffic simulator perform a simulation in which the train location information and railroad equipment status information prevailing in the first operating mode are reflected.

[0016] According to the present invention, an operation log derived from actual train operations and an operation log derived from a simulation can be both used to conduct training. This makes it possible to provide increased convenience when a train traffic simulator is used to conduct training about train traffic management.

[0017] A second aspect of the invention provides a train traffic management training device comprising: a data collection unit; and a management unit, wherein the data collection unit records chronological train location information and railroad equipment status information prevailing during actual train operations as a first operation log, and records chronological train location information and railroad equipment status information controlled by a train traffic simulator during a simulation performed by the train traffic simulator as a second operation log, wherein the train traffic simulator varies internally stored train location information and railroad equipment status information, and transmits the train location information and the railroad equipment status information, wherein, when a command is input, the train traffic simulator applies the input command to the simulated train operations, wherein, in a first operating mode of simulation, the management unit reproduces the chronological train location information and railroad equipment status information by using the first operation log or by using the first operation log and the second operation log, and wherein, when a predetermined procedure is performed in the first operating mode, the management unit switches to a second operating mode to let the train traffic simulator perform a simulation in which the train location information and railroad equipment status information

prevailing in the first operating mode are reflected.

[0018] A third aspect of the invention provides a train traffic management training method comprising:

recording chronological train location information and railroad equipment status information prevailing during actual train operations as a first operation log; recording chronological train location information and railroad equipment status information controlled by a train traffic simulator during a simulation performed by the train traffic simulator as a second operation log, the train traffic simulator varying internally stored train location information and railroad equipment status information, transmitting the train location information and the railroad equipment status information, and when a command is input, applying the input command to the simulated train operations;

in a first operating mode of simulation, reproducing the chronological train location information and railroad equipment status information by using the first operation log or by using the first operation log and the second operation log; and

when a predetermined procedure is performed in the first operating mode, switching to a second operating mode to let the train traffic simulator perform a simulation in which the train location information and railroad equipment status information prevailing in the first operating mode are reflected.

[0019] Optional features of the train traffic management training system of the first aspect may be applied singly or in any combination to the train traffic management training device of the second aspect and the train traffic management training method of the third aspect.

[0020] Further aspects of the present invention provide: a computer program comprising code which, when run on a computer, causes the computer to perform the method of the third aspect; and a computer readable medium storing a computer program comprising code which, when run on a computer, causes the computer to perform the method of the third aspect.

Brief Description of the Drawings

[0021]

FIG. 1 is a block diagram illustrating a train traffic management training system (TMS training system) according to an embodiment of the present invention.

FIG. 2 is a block diagram illustrating a log management device 12.

FIG. 3 is a block diagram illustrating the details of the TMS training system according to the embodiment.

FIG. 4 is a diagram illustrating an operation log 1162.

FIG. 5 is a diagram illustrating the operation log 1161.

FIG. 6 is a diagram illustrating an example of a planned timetable 1151.

FIG. 7 is a diagram illustrating an example of a running result 215.

FIG. 8 is a diagram illustrating an example of a modified timetable 220.

FIG. 9 is a flowchart 401 illustrating a process of switching from one operating mode to another.

FIG. 10 is a diagram illustrating the relationship between operating modes of a log management device 110 and of a train traffic simulator 105.

FIG. 11 is a flowchart illustrating a process of replicating train operations.

FIG. 12 is a diagram illustrating an example of an input form for a train operation replication request.

FIG. 13 is a flowchart illustrating a process of creating a planned timetable.

FIG. 14 is a flowchart illustrating a process of creating snapshot data.

FIG. 15 is a diagram illustrating an exemplary configuration of a snapshot data table 1163.

FIG. 16 is a set of diagrams illustrating how training is conducted.

Detailed Description

[0022] An embodiment of the present invention will now be described with reference to the accompanying drawings.

[0023] FIG. 1 is a block diagram illustrating a train traffic management training system (TMS training system) according to an embodiment of the present invention. Referring to FIG. 1, the TMS training system includes a train traffic simulator 11 and a log management device 12. TMS training is conducted by letting the train traffic simulator 11 coordinate with the log management device 12 without allowing actual trains to run. First of all, an operation log obtained during actual train operations in the past and an operation log generated during a previous simulation are used to reproduce train operations (a first operating mode). Then, in the resulting state, train operations are simulated in accordance with control operations that are performed for training purposes (a second operating mode).

[0024] The train traffic simulator 11 simulates train operations, varies internally stored train location information and railroad equipment status information, and transmits the train location information and the railroad equipment status information to the log management device 12. Further, when a command is input by an operator for replanning or other purposes, the train traffic simulator 11 applies the input command to the simulated train operations.

[0025] The log management device 12 records chronological train location information and railroad equipment status information prevailing during actual train operations as a first operation log, and records chronological train location information and railroad equipment status

information prevailing during a simulation performed by the train traffic simulator 11 as a second operation log. In the first operating mode of simulation, the log management device 12 reproduces desired chronological train location information and railroad equipment status information by using the first operation log or by using the first operation log and the second operation log. Further, when a predetermined procedure is performed in the first operating mode, the log management device 12 switches to the second operating mode to let the train traffic simulator 11 perform a simulation in which the train location information and railroad equipment status information prevailing in the first operating mode are reflected. In the present embodiment, an operation log derived from actual train operations and an operation log generated during a simulation can be both used to conduct training. This makes it possible to provide increased convenience when the train traffic simulator 11 is used to conduct training about train traffic management.

[0026] When chronological train location information and railroad equipment status information is to be reproduced, the log management device 12 distributes train location information and railroad equipment status information to a control device 13 in chronological order and allows the control device 13 to replicate the train location information and railroad equipment status information. The control device 13 includes various devices, such as those for display control, route control, and replanning. This permits all the devices included in the control device 13 to synchronously replicate train operations.

[0027] If a switching occurs from the first operating mode to the second operating mode during a certain simulation (a first simulation), the log management device 12 starts recording the train location information and railroad equipment status information derived from the train traffic simulator 11 as the second operation log. In the first operating mode during another simulation (a second simulation) during which the result of the first simulation is used, the log management device 12 combines the operation log reproduced during the first simulation with the second operation log recorded during the first simulation and reproduces the resulting combination. The log management device 12 does not record an operation log while it is reproducing a previous operation log. This makes it possible to avoid a situation where an operation log is duplicately recorded in the log management device 12. As a result, a recording device can be efficiently used. Further, the log management device 12 can combine operation logs derived from the operating modes used during a previous training session during which a switching occurred from an operating mode in which an operation log is reproduced to an operating mode in which an operation log derived from a simulation is recorded, and reproduce the resulting combination. This ensures that simulation using the operation logs can seamlessly be performed free of influence from the previous operating modes during a subsequent training session.

[0028] In the above instance, the log management de-

vice 12 associates the operation log reproduced during the first simulation with the second operation log recorded during the first simulation, manages the associated operation logs as a simulation log, and reproduces the simulation log during the second simulation. Hence, the operation logs can be associated with each other for management purposes with respect to each series of simulations during which an old operation log is reproduced and a new operation log is recorded. This makes it easy to reproduce a previous simulation.

[0029] Upon receipt of a command for starting a training session at a designated date and time, the log management device 12 replicates a state prevailing when a predetermined period of time (for example, several minutes) elapses after the designated date and time, and starts an operation in the first operating mode in the resulting state. As reproduction begins with a state prevailing when the predetermined period of time elapses after the start of an actual training session, the operator to be trained can smoothly start receiving training.

[0030] FIG. 2 is a block diagram illustrating the log management device 12. Referring to FIG. 2, the log management device 12 includes a data collection unit 21 and a management unit 22.

[0031] The data collection unit 21 records chronological train location information and railroad equipment status information prevailing during actual train operations as the first operation log, and records chronological train location information and railroad equipment status information controlled by the train traffic simulator 11 during a simulation performed by the train traffic simulator 11 as the second operation log.

[0032] In the first operating mode of simulation, the management unit 22 reproduces the chronological train location information and railroad equipment status information by using the first operation log or by using the first operation log and the second operation log. Further, when a predetermined procedure is performed in the first operating mode, the management unit 22 switches to the second operating mode to let the train traffic simulator perform a simulation in which the train location information and railroad equipment status information prevailing in the first operating mode are reflected.

[0033] The present embodiment will now be described in more detail.

[0034] A system according to the present embodiment, which records and reproduces train operations and simulates the running of trains from a point of time at which reproduction starts, will be described below as an example.

<Description of system configuration>

[0035] A train traffic management system, which includes the TMS training system, is formed of a training system having various control devices such as a real-time planning server, an automatic route setting, a track diagram, and a train graph. The training system has the

same configuration as an online system that is used for traffic management of actual trains. The devices included in the training system are basically equivalent to those included in the online system.

[0036] FIG. 3 is a block diagram illustrating the TMS training system according to the present embodiment.

[0037] Referring to FIG. 3, the TMS training system according to the present embodiment includes a real-time planning server 101, an automatic route setting 102, a track diagram 103, a train graph 104, a train traffic simulator 105, a time management device 106, and a log management device 110. The real-time planning server 101, the automatic route setting 102, the track diagram 103, and the train graph 104 are training system devices of the train traffic management system.

[0038] The log management device 110 includes a comprehensive management unit 111, a data creation unit 112, a data collection unit 113, a data distribution unit 114, an operation log database 116, and a timetable database 115. The operation log database 116 stores an operation log 1161, which is a collection of history data on train operations. The timetable database 115 stores a planned timetable 1151 of the day.

<Description of data>

[0039] Data related to the description of the present embodiment will now be described. The data used to record and reproduce train operations are described below. In one case, the data to be recorded is derived from signals transmitted from actual trains and railroad equipment. In the other case, the data to be recorded is derived from signals transmitted from the train traffic simulator 105, which simulates trains and railroad equipment.

(Operation log)

[0040] First of all, the operation log 1161 is described below.

[0041] The operation log 1161 is a collection of data obtained by recording the history of train operations. The operation log 1161 includes a running result 201, train location information 202, railway signal status 203, route status 204, track circuit status 205, and control information 206.

[0042] The running result 201 is data indicative of the result of the running of trains. It is expressed by the time of train arrival at a station or the time of train departure from a station.

[0043] The train location information 202 is data indicative of a section in which a train is located. It is expressed by a section in which a train is located. The train location information 202 is issued when the location of a train is changed, that is, when the train moves from one section to another.

[0044] The railway signal status 203, the route status 204, and the track circuit status 205 are data indicative of railroad equipment status, and indicate the status of a

railway signal, the status of a route, and the status of a track circuit, respectively. The railway signal status 203 is issued when the status of a railway signal is changed. The route status 204 is issued when the status of a route is changed. The track circuit status 205 is issued when the status of a track circuit is changed.

[0045] The control information 206 is data indicative of control exercised. It is issued when replanning or manual control is executed by an operator.

[0046] FIGS. 4 and 5 are diagrams illustrating an operation log 1161. FIG. 4 depicts an example of an operation log management table 1162. FIG. 5 depicts an exemplary list of items included in the operation log 1161.

[0047] Referring to the examples depicted in FIGS. 4 and 5, the operation log 1161, which is chronologically generated, is managed by the operation log management table 1162. The operation log management table 1162 includes an operation log table number 231, a total log information count 232, and log information (array) 233.

[0048] The operation log 1161 is recorded not only during an actual train operation but also during a simulation for training. Therefore, plural sets of operation logs 1161 including a series of operation log data may exist. Further, plural sets of operation logs 1161 concerning the same time zone may exist. In the operation log table 1162, each set of operation logs 1161 is managed as one operation log table. The operation log table number 231 is assigned to each operation log table for management purposes.

[0049] The total log information count 232 indicates the number of operation logs 1161 included in the operation log table that is managed by using the operation log table number 231. Issued operation logs 1161 are chronologically recorded as log information (array) 233.

[0050] As depicted in FIG. 5, the operation log 1161 includes plural types of log data, namely, the running result 201, the train location information 202, the railway signal status 203, the track circuit status 205, and the control information 206. These different types of log data are included in different data items.

[0051] Referring to a matrix depicted in FIG. 5, a circle indicates effective elements (items) for each log data type. For example, the data concerning the running result 201 in the operation log 1161 includes a log management number 211, an occurrence time 212, a log data type 213, a train number 214, and a running record 215.

[0052] The log management number 211 is a number that identifies each operation log 1161. The occurrence time 212 is the time of occurrence of an event for which the operation log 1161 is issued. The log data type 213 indicates the type of the operation log 1161. The train number 214 indicates the number of a train that is involved in the event for which the operation log 1161 is issued. The running record 215 describes the event for which the operation log 1161 is issued. As depicted in FIG. 5, the other items are a track circuit number 216, track circuit status 217, an equipment number 218, equipment status 219, and a modified timetable 220. The track circuit number 216 is the number of a track circuit involved

in the event for which the operation log 1161 is issued. The track circuit status 217 is the status of the track circuit involved in the event for which the operation log 1161 is issued. The equipment number 218 is the number of pieces of equipment involved in the event for which the operation log 1161 is issued. The equipment status 219 is the status of the equipment involved in the event for which the operation log 1161 is issued. The modified timetable 220 is a portion of a timetable that is modified due to the event for which the operation log 1161 is issued.

[0053] In the present embodiment, the data creation unit 112 uniquely assigns the operation log table number 231 at a timing at which a daily train operation starts or at a timing at which the train traffic simulator is used to initiate replanning or manual control during the running of trains.

[0054] Subsequently, at a timing at which, for example, an event for which the log data 201-206 are issued occurs, the log management device 110 causes the data collection unit 113 to acquire the status of each target involved in the event and causes the data creation unit 112 to generate the operation log 1161 by subjecting the acquired status to format conversion. Further, the data creation unit 112 determines the log management number 211 for identifying the operation log 1161, the occurrence time 212 at which a history is issued, and the log data type 213 indicative of the type of the history, and records them in the operation log database 116.

[0055] The data creation unit 112 uses the log information (array) 233 in the operation log management table 1162 to manage the log management numbers 211 for a period between the beginning of log acquisition and the latest operation log acquisition and handles the total number of operation logs as the total log information count 232.

[0056] For example, when a new operation log 1161 is created, the data creation unit 112 appends the log management number 211 of the operation log 1161 to the end of the log information (array) 233 and updates the total number of operation log records.

(Planned timetable)

[0057] A planned timetable 1151 will now be described. In the description of the present embodiment, the planned timetable having a simple data structure will be described below as an example.

[0058] FIG. 6 is a diagram illustrating an example of the planned timetable 1151. FIG. 7 is a diagram illustrating an example of a running result 215. FIG. 8 is a diagram illustrating an example of a modified timetable 220.

[0059] The planned timetable 1151 includes information necessary for the running of trains during the use of the train traffic simulator 105. More specifically, the planned timetable 1151 includes a train number 301 of each train, a station number 302 of a station at which an arrival time and a departure time are recorded, train association 303 for the station, a planned arrival time 304,

and a planned departure time 305.

[0060] The planned timetable 1151 also includes a record of train running, namely, an actual arrival time 306 and an actual departure time 307. The actual arrival time 306 is the time at which a train arrived at the station. The actual departure time 307 is the time at which the train departed from the station.

[0061] The planned timetable changes depending on the running result 215 and on the modified timetable 220. The running result 215 and the modified timetable 220 will now be described.

[0062] In the event of train arrival at a station or in the event of train departure from the station, the log management device 110 stores the running result 215 in the timetable database 115.

[0063] Further, the log management device 110 stores the modified timetable 220, which is changed due to re-planning or manual control executed by the operator, in the operation log database 116 as the operation log 1161.

[0064] In an initial state, no values are input as the values of the actual arrival times 306, 313, and 324 and of the actual departure times 307, 314, and 325. At a timing at which the real-time planning server 101 receives the running result 215, which is the result of running, from station equipment, the actual arrival time 313 or the actual departure time 314 is recorded. The recorded data is stored as the actual arrival times 306, 313, and 324 or as the actual departure times 307, 314, and 325.

<Switching from a training state where train operations are replicated to a training state where a simulation is performed by the train traffic simulator>

[0065] A switching occurs during training from a state where train operations are replicated to a state where a simulation is performed by the train traffic simulator 105 when the operator performs a control procedure.

[0066] When train operations are to be replicated, the log management device 110 causes the data creation unit 112 to convert the operation log 1161 stored in the operation log database 116 to various items of information, namely, the train location information 202, the equipment status information 203-205, the running result 201, and the control information 206, and distributes the converted information to various devices while maintaining chronological temporal relationship.

[0067] While the train operations are being reproduced as described above, the log management device 110 converts, for instance, the operation log of the train location information 202 and the operation log of the equipment status information 203-205 to the train location information 202 and to the information indicative of the railway signal status 203, the route status 204, and the track circuit status 205, respectively, in such a manner as to match an interface to each of the various devices, and transmits the converted information indicative of various statuses to the train traffic simulator 105, which simulates the trains and the various devices.

[0068] In accordance with the train location information 202 and with the information about the railway signal status 203, the route status 204, and the track circuit status 205, which are received from the log management device 110, the train traffic simulator 105 varies internally stored train running status and equipment status.

[0069] When, as described above, the operator performs a replanning or other control procedure with respect to the trains and equipment in a situation where the operation log 1161 is distributed, the log management device 110 switches from the operating mode (distribution mode) for distributing the operation log 1161 to the operating mode (collection mode) for collecting the operation log 1161. In such an instance, the log management device 110 determines the operation log table number 231 for subsequently acquired information about train operations and assigns the log management number 211 to a newly acquired operation log 1161.

[0070] FIG. 9 is a flowchart 401 illustrating a process of switching from one operating mode to another.

[0071] When the operator performs a replanning procedure or a manual control procedure, the log management device 110 regards such a procedure as a trigger 402 (step 402) and then causes the data creation unit 112 to create a new operation log management table 1162 (step 403) and assign a unique operation log table number 231 to it (step 404).

[0072] Next, the comprehensive management unit 111 in the log management device 110 switches the operating mode from the operation log distribution mode to the operation log collection mode (step 405). Further, the train traffic simulator 105 switches from the operating mode (acquisition mode) for acquiring distributed train location information and equipment status information to the operating mode (train running mode) for simulating the running of trains and outputting the train location information and equipment status information (step 406).

[0073] FIG. 10 is a diagram illustrating the relationship between the operating modes of the log management device 110 and of the train traffic simulator 105. As depicted in FIG. 10, at the time of operation log reproduction, the log management device 110 distributes log data (distribution mode shown at 421 in FIG. 10), and the train traffic simulator 105 collects the train location information and equipment status information (collection mode shown at 431 in FIG. 10). At the time of train running simulation, the log management device 110 collects log data (collection mode shown at 422 in FIG. 10), and the train traffic simulator 105 simulates train locations and equipment status (train running mode shown at 432 in FIG. 10).

[0074] Distributed elements included in the log information (array) 233 in the operation log management table used for reproduction before operating mode switching are associated with the log information (array) 233 in the newly created operation log management table.

[0075] After operating mode switching, the log management device 110 collects information transmitted

from the train traffic simulator 105 as an operation log by performing the procedure described under <Description of data>.

<Replication of train operations>

[0076] As described above, the log management device 110 reproduces train operations by distributing an internally stored operation log. Operations performed by the system in such an instance will now be described in detail.

[0077] FIG. 11 is a flowchart illustrating a process of replicating train operations.

[0078] When, for instance, the operator issues a request for the replication of train operations for training purposes, the log management device 110 starts replicating the train operations by using the operation log. An input for train operation replication may be performed by any device included in the system. Here, it is assumed, for example, that the log management device 110 performs the input for train operation replication.

[0079] FIG. 12 is a diagram illustrating an example of an input form for a train operation replication request. The operator enters desired information into a date input field 901, a time input field 902, and an operation log table number input field 903 of a graphical user interface (UI) depicted in FIG. 12, and then touches an apply button 904.

[0080] Referring to FIG. 11, at a desired timing at which, for example, operations described in a certain operation log are being reproduced or the train traffic simulator 105 is performing a simulation for training purposes, the operator uses the graphical user interface (UI) of the log management device 110 to enter relevant information into the input fields 901-903 (step 502). The information to be entered into the input fields 901-903 includes the date and time of train operations to be replicated during training and the train operation number of the operation log management table indicative of the train operations to be used during training.

[0081] The data creation unit 112 in the log management device 110 checks whether the input values for the date, time, and train operation number are within a proper range (step 503). Further, the data creation unit 112 determines the current operating mode of the train traffic simulator 105 (step 504).

[0082] If the train traffic simulator 105 is used to simulate the running of trains, the log management device 110 requests the train traffic simulator 105 to stop the running of trains and stops its acquisition of the operation log (step 505).

[0083] If, for example, the operation log 1161 is being used to reproduce train operations, the log management device 110 stops the distribution of the operation log 1161 to all devices (step 506).

[0084] Subsequently, the log management device 110 sets a replication time that is earlier than the date and time entered by the operator in step 502 by a predeter-

mined period of time (for example, N minutes) (step 507).

[0085] Next, the log management device 110 issues a request for the deletion of the planned timetable retained by the real-time planning server 101, the automatic route setting 102, and the train graph 104 (step 508).

[0086] Next, the log management device 110 accesses the timetable database 115 to acquire a planned timetable having the date entered by the operator, and causes the data creation unit 112 to create a planned timetable required for the reproduction of train operations (step 509). The creation of the planned timetable will be described below in detail.

[0087] Further, the log management device 110 checks all operation log records managed by the log information (array) in the operation log management table 1162 related to a train operation management number designated by the operator and acquires all records whose log data type is either the running result 201 or the control information 206.

[0088] Data whose log data type is the "running result" is converted to a running result depicted in FIG. 7. Data whose log data type is the "control information" is converted to a modified timetable depicted in FIG. 8. The obtained running records and modified timetables for a period up to the replication time are chronologically merged with the planned timetable.

[0089] Next, the data creation unit 112 creates snapshot data related to the train operation management number entered in step 502 by the operator (step 510). The snapshot data is obtained by replicating train status and equipment status prevailing at a predetermined date and time.

[0090] In the above instance, the log management device 110 checks all operation log records managed by the log information (array) in the operation log management table related to the train operation management number designated by the operator and acquires all records whose log data type is the train location information, the railway signal status, the route status, or the track circuit status. Subsequently, the data creation unit 112 creates a snapshot data table by chronologically adding or updating the records of individual status information 202-205 for a period up to the replication time.

[0091] The creation of snapshot data will be described below in detail.

[0092] The log management device 110 distributes the planned timetable, which has been created as described above, to the real-time planning server 101, the automatic route setting 102, and the train graph 104, and distributes the snapshot data to the track diagram 103 and the train traffic simulator 105 (step 511). The real-time planning server 101 manages the planned timetable. The automatic route setting 102 uses the planned timetable for train route control purposes. The train graph 104, which manages the planned timetable and displays a timetable graph, uses the distributed planned timetable as a re-planning target. The track diagram 103 uses the snapshot data as an initial state to provide display control of

train location information and equipment status information. The train traffic simulator 105 uses the snapshot data as an initial state for simulation.

[0093] After the snapshot data and planned timetable created in the above-described manner are distributed to various devices, the log management device 110 issues a request for the replication of train locations and equipment status in accordance with the snapshot data (step 512). Subsequently, the time management device 106 requests all devices to perform replication at the same time (step 513). After the same replication time is applied to all devices, the log management device 110 starts distributing the operation log 1161 (step 514) and causes the train traffic simulator 105 to start acquiring the train location information and equipment status information.

[0094] FIG. 13 is a flowchart illustrating a process of creating the planned timetable. This flowchart describes the details of step 509 in FIG. 11. The process depicted in FIG. 13 is given a date and time and an operation log table number as an input.

[0095] First of all, the data creation unit 112 in the log management device 110 acquires the data of the planned timetable of the day in its initial state from the timetable database 115 (step 702).

[0096] Next, the log management device 110 acquires the records of the operation log 1161 in the log information (array) managed by the entered operation log table number 231 one by one in chronological order of the occurrence time 212 (step 703). If the log data type is either the running result 201 or the control information 206 (step 704), the log management device 110 adds the running result 215 and the modified timetable 220 to the planned timetable 1151 or updates the planned timetable 1151 (step 705), repeats the procedure performed in step 705 until the last data prevailing before the replication time is handled (step 706), and uses the resulting planned timetable for replication purposes.

[0097] FIG. 14 is a flowchart illustrating a process of creating the snapshot data. This flowchart describes the details of step 510 in FIG. 11. The process depicted in FIG. 14 is given a date and time and an operation log table number as an input.

[0098] FIG. 15 is a diagram illustrating an exemplary configuration of the snapshot data table 1163. The snapshot data table 1163 includes a date/time 801, the number of trains 802, train information 803, and equipment information 804. The date/time 801 is information indicative of the date and time of the snapshot data table 1163. The number of trains 802 indicates the number of trains whose train information 803 is included in the snapshot data table 1163. The train information 803 is information about each train. The equipment information 804 is information about each piece of equipment. A table of the train information 803 includes a train number 811, an execution date 812, and location information 813, which indicates a location at which each train is located. A table of the equipment information 804 includes the number

of railway signals 821, railway signal status 822, the number of routes 823, route status 824, the number of track circuits 825, and track circuit status 826. The number of railway signals 821 indicates the number of railway signals included in the table. The railway signal status 822 indicates the status of each railway signal. The number of routes 823 indicates the number of routes included in the table. The route status 824 indicates the status of each route. The number of track circuits 825 indicates the number of track circuits included in the table. The track circuit status 826 indicates the status of each track circuit.

[0099] Referring to FIG. 14, first of all, the data creation unit 112 in the log management device 110 creates a new snapshot data table (step 602). Next, the log management device 110 acquires operation logs in the log information (array) managed by the entered operation log table number 231 from the operation log database 116 one by one in chronological order of the occurrence time 212 (step 603). If the log data type is the train location information 202, the railway signal status 203, the route status 204, or the track circuit status 205 (step 604), the log management device 110 adds the relevant status information to the snapshot data table (step 605), repeats the procedure performed in step 605 until the last data prevailing before the replication time is handled (step 606), and uses the resulting table as the snapshot data table.

<Execution of training>

[0100] An example of training conducted by using the TMS training system according to the present embodiment will now be described.

[0101] FIG. 16 is a set of diagrams illustrating how training is conducted.

[0102] Referring to FIG. 16, the symbol S denotes a simulation start time, the symbols A-1 to A-3 each denote a replanning procedure performed by the operator, and the train operation management numbers a to d each denote a train operation management number for each train operation derived from replanning.

[0103] Individual routes between S and A-a to A-d in each of graphs A1 to A4 of FIG. 16 are each set as a train operation prevailing during training.

[0104] A case where train operations are merely reproduced will now be described with reference to graph A1.

[0105] Operation log table number A-a for use during the reproduction of an actual train operation is assigned as an initial state prevailing before the start of a simulation.

[0106] The operator enters a desired replication date/time T0 and operation log table number A-a in the date and time input fields 901, 902 and operation log table number input field 903 of the graphical user interface of the log management device 110, and then touches the apply button 904.

[0107] Upon completion of train operation replication, the track diagram 103 displays train locations and equipment status prevailing several minutes earlier than a designated time, and the train graph 104 displays a timetable graph.

[0108] The log management device 110 starts distributing the operation log 1161. Further, the track diagram 103 and the train graph 104 provide an on-screen display of actual train operations or the history of training conducted by the train traffic simulator 105.

[0109] Next, a case where simulation is initiated at time T1 after replication of train operations will be described with reference to graph A2.

[0110] The operator enters a desired replication date/time T0 and operation log table number A-a in the date and time input fields 901, 902 and operation log table number input field 903 of the graphical user interface of the log management device 110, and then touches the apply button 904. This starts the reproduction of the operation log 1161.

[0111] Here, the operator performs replanning procedure A-1 at time T1. This causes the operation of the log management device 110 to switch from the reproduction of the operation log 1161 to training provided by the train traffic simulator.

[0112] When the operating mode of the log management device 110 changes in response to replanning, operation log table number A-b is automatically assigned to a newly created operation log management table 1162 so that an operation log prevailing at and after time T1 is acquired and stored.

[0113] Next, a case where simulation is initiated at time T2 after replication of train operations will be described with reference to graph A3.

[0114] The operator enters a desired replication date/time T0 and operation log table number A-a in the date and time input fields 901, 902 and operation log table number input field 903 of the graphical user interface of the log management device 110, and then touches the apply button 904.

[0115] Here, the operator performs replanning procedure A3-2 at time T2. This causes the operation of the log management device 110 to switch. Operation log table number A-c is then assigned to a newly created operation log management table 1162 as a number for managing a train operation branched off from train operation A-a. An operation log prevailing at and after time T2 is acquired and stored.

[0116] Next, a case where new simulation is initiated at time T3 after reproduction of simulated train operations will be described with reference to graph A4.

[0117] The operator enters a desired replication date/time T1 and operation log table number A-b in the date and time input fields 901, 902 and operation log table number input field 903 of the graphical user interface of the log management device 110, and then touches the apply button 904.

[0118] When the operator performs replanning procedure

A4-3 at time T3, the log management device 110 changes its operating mode. A new operation log management table is then created, and operation log table number A-d is assigned to the newly created operation log management table as a number for managing a train operation branched off from train operation A-b. Subsequently, an operation log prevailing at and after time T3 is acquired and stored.

[0119] As described above, the operator can store plural different train operations, which are created when training is conducted repeatedly by using the train traffic simulator 105, and read the stored train operations for replication purposes. Further, in such an instance, the log management device 110 can acquire and store actual train operations and all train operations provided by the train traffic simulator 105 and replicate them subsequently while avoiding the possession of duplicate operation logs.

[0120] The individual devices according to the above-described embodiment may also be implemented by allowing a computer to execute a software program in which relevant processing steps are defined. Further, the individual devices need not exist in their respective computers, but may be disposed in the same computer.

[0121] Although the present invention has been described with reference to the foregoing embodiment and examples thereof, it will be understood by those skilled in the art that the present invention is not limited to the foregoing embodiment and examples thereof, and that the foregoing embodiment and examples thereof may be combined or partly reconfigured without departing from the scope of the present invention.

Claims

1. A train traffic management training system comprising:

a train traffic simulator (11, 105); and
a log management device (12, 110),
wherein the train traffic simulator (11, 105) simulates train operations, varies internally stored train location information (202) and railroad equipment status information (219), and transmits the train location information (202) and the railroad equipment status information (219),
wherein, when a command is input, the train traffic simulator (11, 105) applies the input command to the simulated train operations;
wherein the log management device (12, 110) records chronological train location information (202) and railroad equipment status information (219) prevailing during actual train operations as a first operation log, and records chronological train location information (202) and railroad equipment status information (219) prevailing during a simulation performed by the train traffic

- simulator (11, 105) as a second operation log, wherein, in a first operating mode of simulation, the log management device (12, 110) reproduces the chronological train location information (202) and railroad equipment status information (219) by using the first operation log or by using the first operation log and the second operation log, and wherein, when a predetermined procedure is performed in the first operating mode, the log management device (12, 110) switches to a second operating mode to let the train traffic simulator (11, 105) perform a simulation in which the train location information (202) and railroad equipment status information (219) prevailing in the first operating mode are reflected.
2. The train traffic management training system according to claim 1, wherein, when reproducing the chronological train location information (202) and railroad equipment status information (219), the log management device (12, 110) chronologically distributes the train location information (202) and the railroad equipment status information (219) to a control device (13) for replication purposes.
 3. The train traffic management training system according to claim 1 or 2, wherein, if a switching occurs from the first operating mode to the second operating mode during a first simulation, the log management device (12, 110) starts recording the train location information (202) and railroad equipment status information (219) derived from the train traffic simulator (11, 105) as the second operation log, and wherein, in the first operating mode during a second simulation during which the result of the first simulation is used, the log management device (12, 110) combines the operation log reproduced during the first simulation with the second operation log recorded during the first simulation and reproduces the resulting combination.
 4. The train traffic management training system according to claim 3, wherein the log management device (12, 110) associates the operation log reproduced during the first simulation with the second operation log recorded during the first simulation, manages the associated operation logs as a simulation log, and reproduces the simulation log during the second simulation.
 5. The train traffic management training system according to any one of the previous claims, wherein, upon receipt of a command for starting a training session at a designated date and time, the log management device (12, 110) replicates a state prevailing when a predetermined period of time elapses after the designated date and time, and starts an operation in the first operating mode in the resulting state.
 6. A train traffic management training device comprising:
 - a data collection unit (21, 113); and
 - a management unit (22),
 wherein the data collection unit (21, 113) records chronological train location information (202) and railroad equipment status information (219) prevailing during actual train operations as a first operation log, and records chronological train location information (202) and railroad equipment status information (219) controlled by a train traffic simulator (11, 105) during a simulation performed by the train traffic simulator (11, 105) as a second operation log, wherein the train traffic simulator (11, 105) varies internally stored train location information (202) and railroad equipment status information (219), and transmits the train location information (202) and the railroad equipment status information (219), wherein, when a command is input, the train traffic simulator (11, 105) applies the input command to the simulated train operations, wherein, in a first operating mode of simulation, the management unit (22) reproduces the chronological train location information (202) and railroad equipment status information (219) by using the first operation log or by using the first operation log and the second operation log, and wherein, when a predetermined procedure is performed in the first operating mode, the management unit (22) switches to a second operating mode to let the train traffic simulator (11, 105) perform a simulation in which the train location information (202) and railroad equipment status information (219) prevailing in the first operating mode are reflected.
 7. A train traffic management training method comprising:
 - recording chronological train location information (202) and railroad equipment status information (219) prevailing during actual train operations as a first operation log;
 - recording chronological train location information (202) and railroad equipment status information (219) controlled by a train traffic simulator (11, 105) during a simulation performed by the train traffic simulator (11, 105) as a second operation log, the train traffic simulator (11, 105) varying internally stored train location information

tion (202) and railroad equipment status information (219), transmitting the train location information (202) and the railroad equipment status information (219), and when a command is input, applying the input command to the simulated train operations; 5
in a first operating mode of simulation, reproducing the chronological train location information (202) and railroad equipment status information (219) by using the first operation log or by using 10
the first operation log and the second operation log; and
when a predetermined procedure is performed in the first operating mode, switching to a second operating mode to let the train traffic simulator 15
(11, 105) perform a simulation in which the train location information (202) and railroad equipment status information (219) prevailing in the first operating mode are reflected.

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8. A computer program comprising code which, when run on a computer, causes the computer to perform the method of claim 7.

9. A computer readable medium storing a computer 25
program comprising code which, when run on a computer, causes the computer to perform the method of claim 7.

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FIG. 1

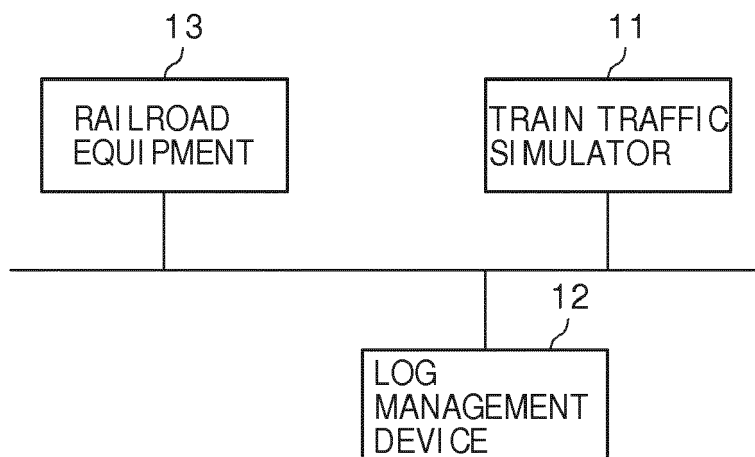


FIG. 2

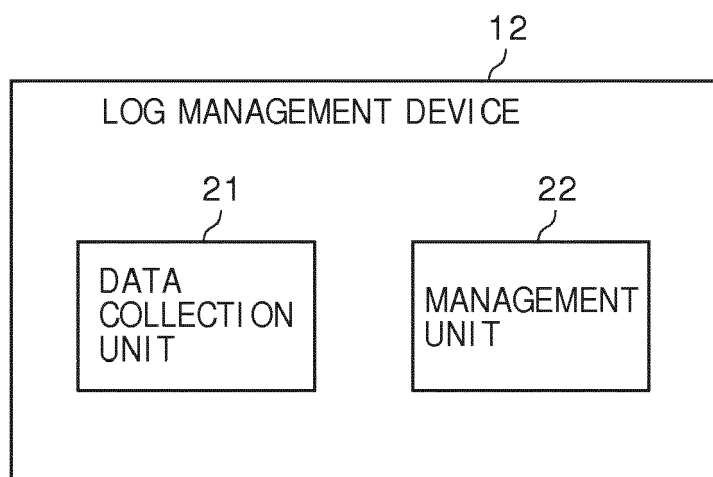


FIG. 3

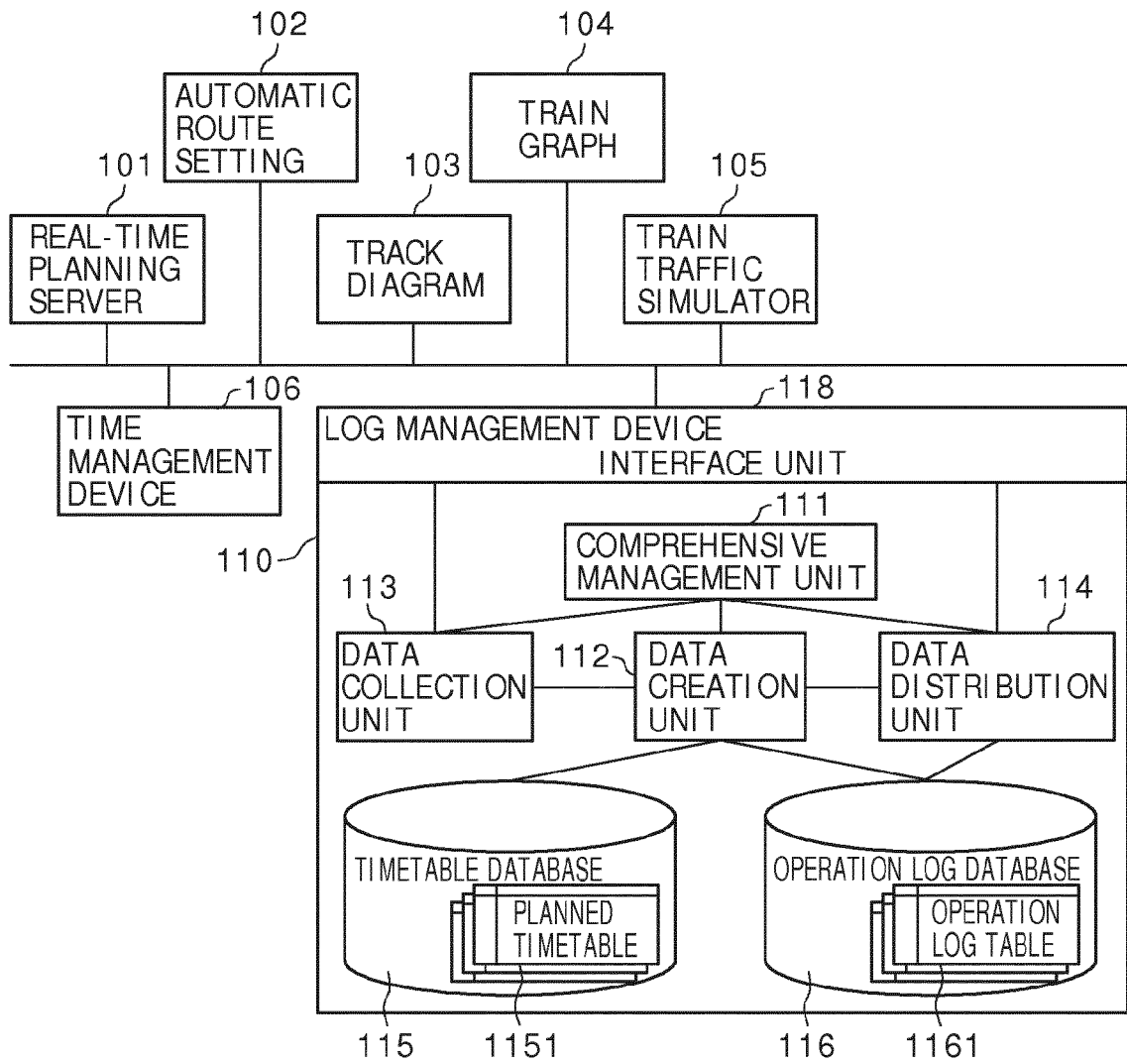


FIG. 4

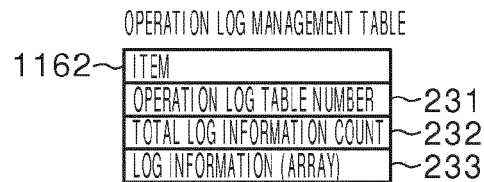


FIG. 5

OPERATION LOG

ITEM	201	202	203	204	205	206
	RUNNING RESULT	TRAIN LOCATION INFORMATION	TRAFFIC LIGHT STATUS	ROUTE STATUS	TRACK CIRCUIT STATUS	CONTROL INFORMATION
LOG MANAGEMENT NUMBER	○	○	○	○	○	○
OCCURRENCE TIME	○	○	○	○	○	○
LOG DATA TYPE	○	○	○	○	○	○
TRAIN NUMBER	○	○				
RUNNING RESULT	○					
TRACK CIRCUIT NUMBER		○			○	
TRACK CIRCUIT STATUS					○	
EQUIPMENT NUMBER			○	○	○	
EQUIPMENT STATUS			○	○	○	
MODIFIED TIMETABLE						○

1161

211
212
213
214
215
216
217
218
219
220

FIG. 6

PLANNED TIMETABLE

1151	ITEM	
	TRAIN NUMBER	301
	STATION	302
	TRAIN ASSOCIATION	303
	PLANNED ARRIVAL TIME	304
	PLANNED DEPARTURE TIME	305
	ACTUAL ARRIVAL TIME	306
	ACTUAL DEPARTURE TIME	307

FIG. 7

RUNNING RESULT

215	ITEM	
	TRAIN NUMBER	311
	STATION	312
	ACTUAL ARRIVAL TIME	313
	ACTUAL DEPARTURE TIME	314

FIG. 8

MODIFIED TIMETABLE

220	ITEM	
	TRAIN NUMBER	321
	STATION	322
	TRAIN ASSOCIATION	323
	ACTUAL ARRIVAL TIME	324
	ACTUAL DEPARTURE TIME	325

FIG. 9

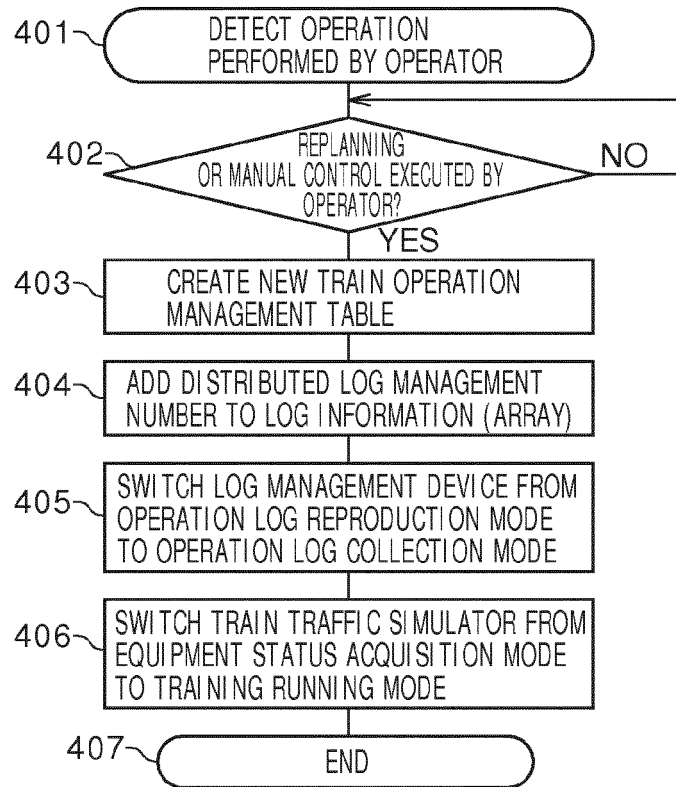


FIG. 10

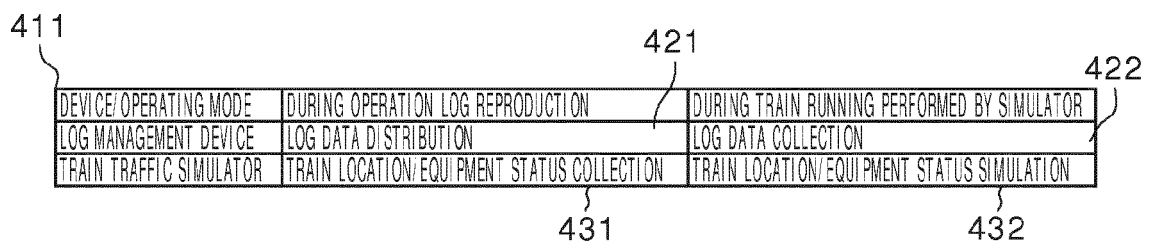


FIG. 11

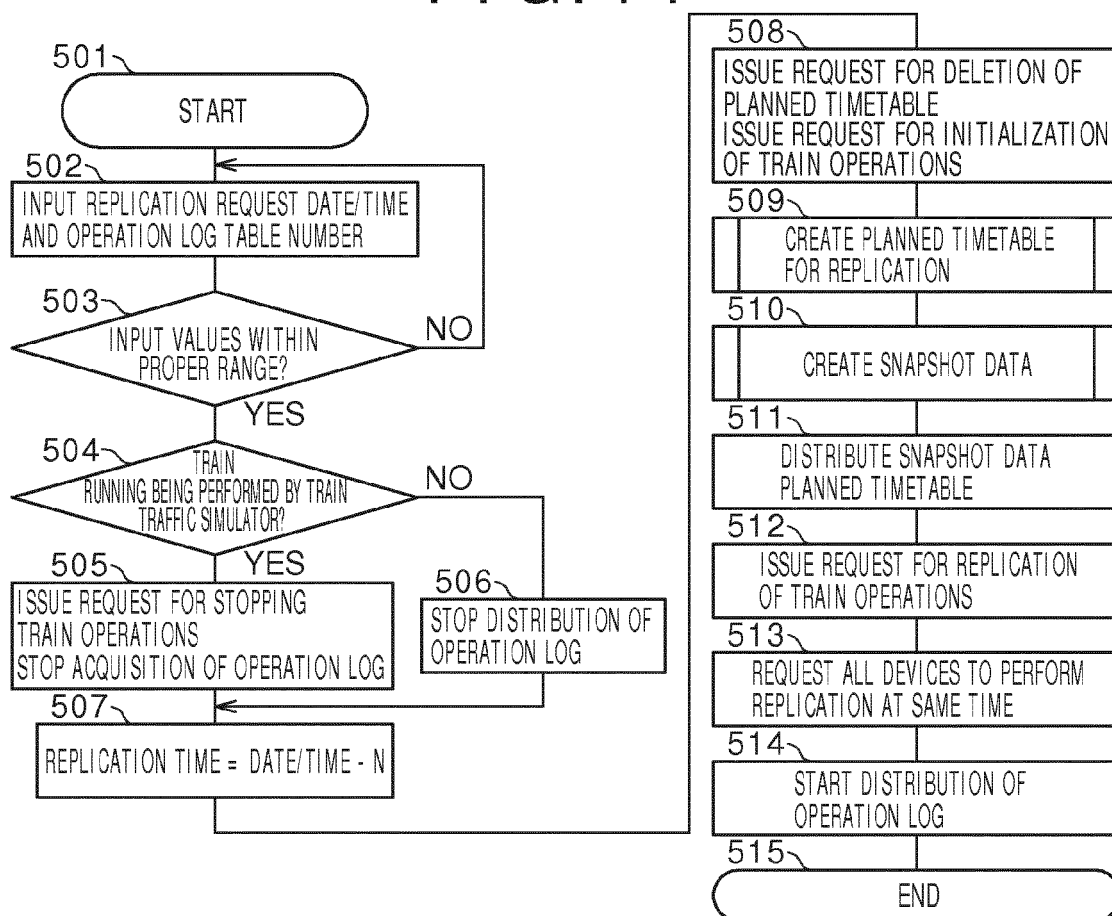


FIG. 12

INPUT FORM FOR TRAIN OPERATION REPLICATION	
DATE	19/04/2012
TIME	19:05:20
OPERATION LOG TABLE NUMBER	50
APPLY	

FIG. 13

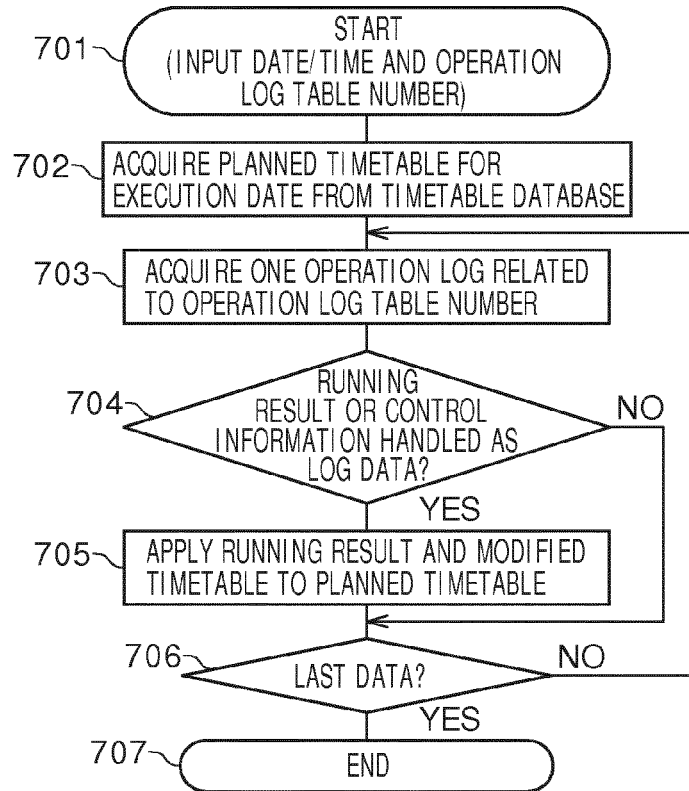


FIG. 14

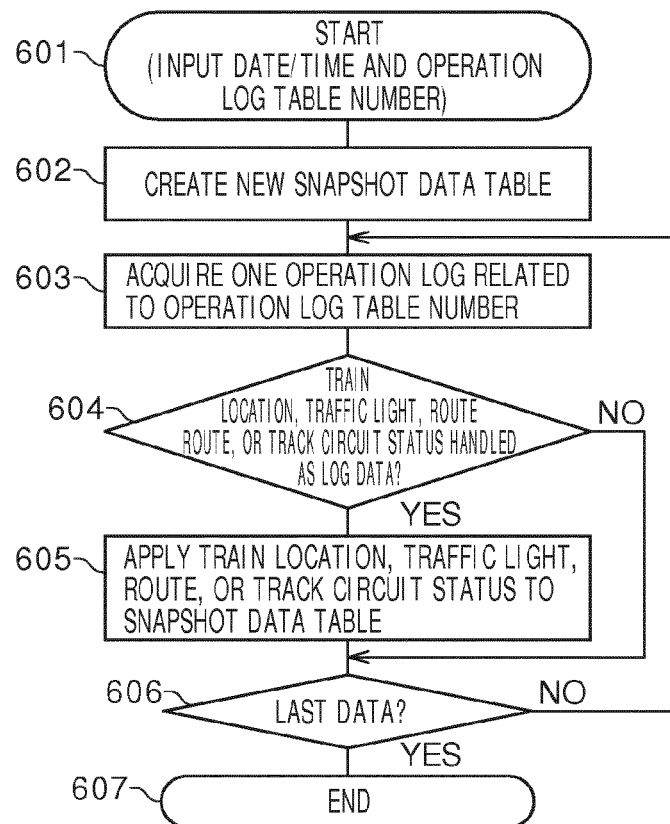


FIG. 15

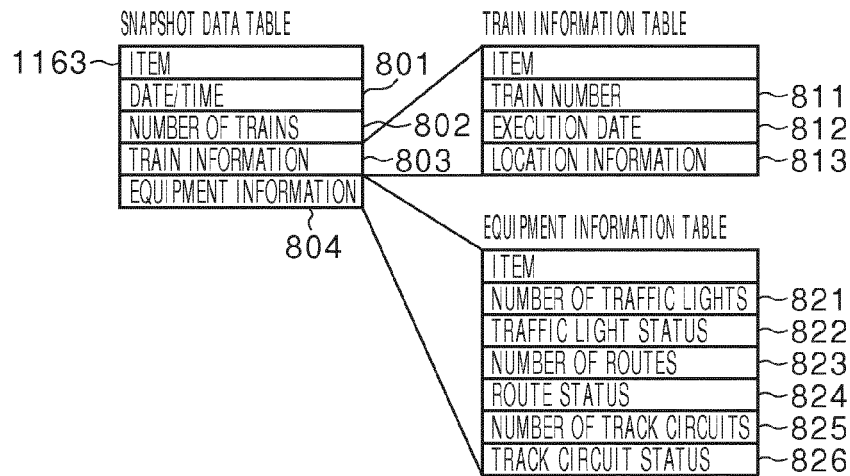
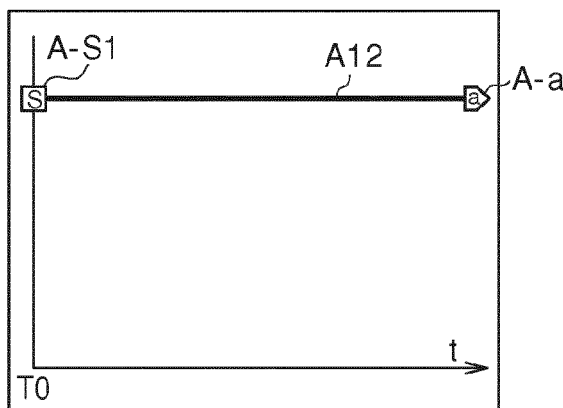
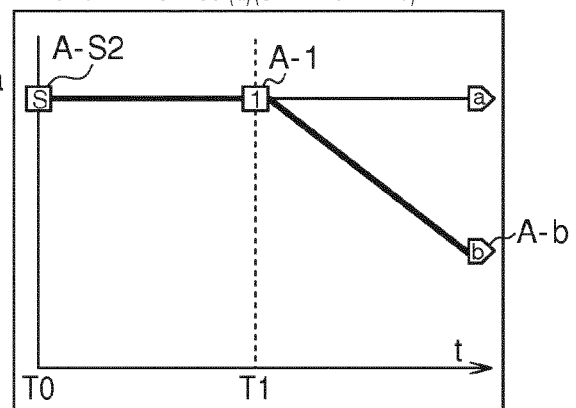


FIG. 16

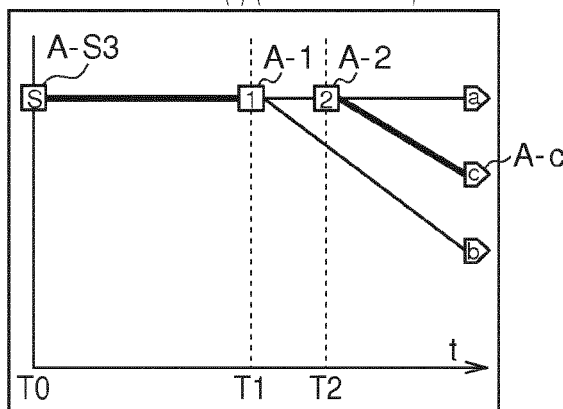
A1: REPRODUCTION OF OPERATION LOG (a)



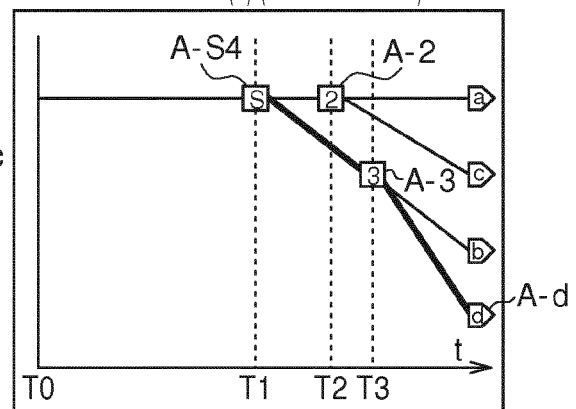
A2: REPLANNING AT TIME T1 DURING REPRODUCTION OF OPERATION LOG (a) (START POINT: T0)



A3: REPLANNING AT TIME T2 DURING REPRODUCTION OF OPERATION LOG (a) (START POINT: T0)



A4: REPLANNING AT TIME T3 DURING REPRODUCTION OF OPERATION LOG (b) (START POINT: T1)



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000016295 A [0008] [0010] [0013]
- JP HEI71995101337 B [0009]