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(54) IMPLEMENTATION METHOD FOR FULL-AUTOMATIC UNMANNED REMOTE REVERSE OPERATION, AND DEVICE AND MEDIUM

(57) The invention relates to a method for realizing remote reverse operation during unattended train operation, a device and a medium. The method comprises: S1, sending, by a zone controller, information of a train 1 and a train 2 to ATS; S2, displaying, by an ATS interface, state information of the train 1 and the train 2; S3, setting, by a dispatch terminal, an instruction for blocking a remote reverse operation protection area within a range from a platform A to a platform B; S4, generating a command for blocking the reverse operation protection area in a remote speed-limited mode of the trains according to the instruction for blocking the remote reverse operation protection area set by the dispatch terminal and sending the command for blocking the reverse operation protection area in the remote speed-limited mode of the trains to an interlocking subsystem, by the ATS; S5, after the interlocking subsystem receives the command for blocking the reverse operation protection area in the remote speed-limited mode of the trains sent from the ATS, checking blocking and interlocking conditions; when the blocking and interlocking conditions are satisfied, setting the remote reverse operation protection area to be blocked; and the like. Compared with the prior art, the invention guarantees the safety of reverse operation of trains.

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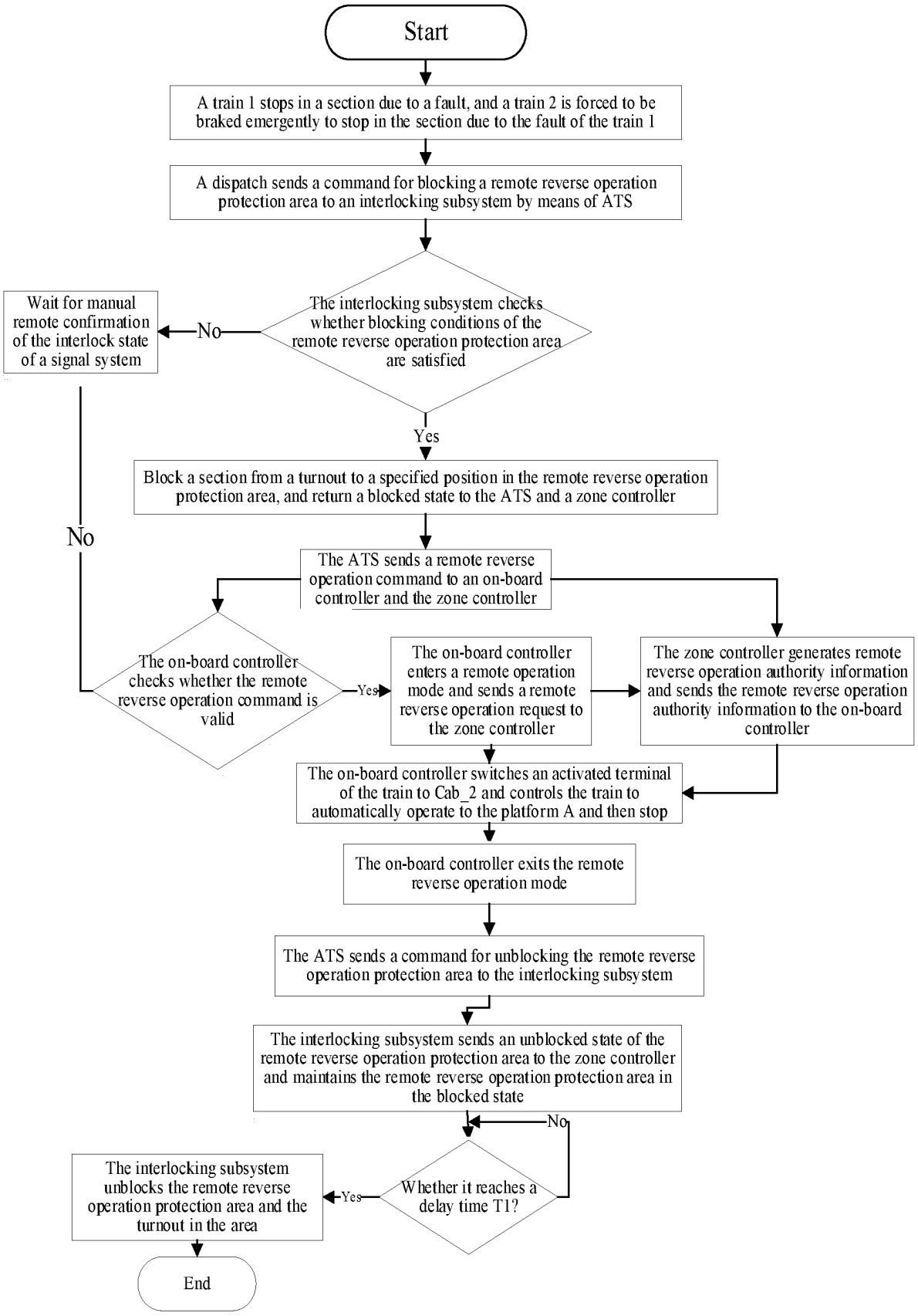
Start
A train 1 stops in a section due to a fault, and a train 2 is forced to be braked emergently to stop in the section due to the fault of the train 1
A dispatch sends a command for blocking a remote reverse operation protection area to an interlocking subsystem by means of ATS
The interlocking subsystem checks whether blocking conditions of the remote reverse operation protection area are satisfied
No
Wait for manual remote confirmation of the interlock state of a signal system
Yes
Block a section from a turnout to a specified position in the remote reverse operation protection area, and return a blocked state to the ATS and a zone controller
No
The ATS sends a remote reverse operation command to an on-board controller and the zone controller
The on-board controller checks whether the remote reverse operation command is valid
Yes
The on-board controller enters a remote operation mode and sends a remote reverse operation request to the zone controller
The zone controller generates remote reverse operation authority information and sends the remote reverse operation authority information to the on-board controller
The on-board controller switches an activated terminal of the train to Cab_2 and controls the train to automatically operate to the platform A and then stop
The on-board controller exits the remote reverse operation mode
The ATS sends a command for unblocking the remote reverse operation protection area to the interlocking subsystem
The interlocking subsystem sends an unblocked state of the remote reverse operation protection area to the zone controller and maintains the remote reverse operation protection area in the blocked state
No
Whether it reaches a delay time T1?
Yes
The interlocking subsystem unblocks the remote reverse operation protection area and the turnout in the area
End

FIG. 3

Description

Technical Field

[0001] The invention relates to train signal control systems, in particular to a method for realizing remote reverse operation during unattended train operation, a device and a medium.

Description of Related Art

[0002] In an unattended train operation system, safe and reliable operation of trains relies on cooperative work of on-board controllers, trackside devices, central automatic train supervision (ATS) and other devices, and all these devices work together to realize unattended operation of the trains, and only under the condition of no fault of trains, operation lines and communication devices of the system, the trains can reliably operate to the end of movement authority specified by a zone controller under the protection of the on-board controllers.

[0003] In a communication base train control (CBTC) mode, multiple trains may successively operate in the same section, and if a front train stops in the section due to a fault, a following train will also be braked emergently to stop in the section and stay in the section until the fault the front train is removed. In this case, necessary safety protection measures need to be taken to dispatch a driver to board the train to switch the train to a restricted manual drive mode and change the activated locomotive end of the train to allow the train to operate reversely to leave this section.

[0004] In case of such a fault, a conventional handling method has the following disadvantages:

1. When a following train is forced to be braked emergently to stop in the section where a front train stops due to a fault, the following train will stop in the section for a long time if it fails to be handled in time, thus affecting normal operation;

2. A series of safety protection measures need be taken to authorize a driver to board the train, so the efficiency is low, the handling time is long, and there exist some personal safety risks;

3. A long-term dwell of the train in the section easily causes panics of passengers;

4. After the driver gets on the train to switch the train to the restricted manual drive mode, an onboard signal system only provides speed protection, and operation safety in other aspects are in charge of the driver;

5. The whole rescue process of the train is implemented relying on manual field operation.

[0005] Therefore, a method for realizing remote reverse operation during unattended train operation needs to be provided to effectively overcome the disadvantages of the conventional handling method as mentioned above.

[0006] Upon patent search, Chinese Patent Publication No.CN_112572536 discloses a method for realizing a reverse jump function of unattended trains, which specifically comprises: defining a reverse jump area and a safety return distance of each platform according to actual conditions of the platform; calculating a reverse jump protection area and a reverse jump path of each platform according to the safety return distance to ensure that a train has no collision risk when returning backwards; and determining a return path of the train.

[0007] This patent expounds a technical method for accurately reparking a train by reverse jumping in a case where the train is parked beyond a standard area on a platform to solve the problem that unattended trains cannot return backwards after being parked beyond the standard area. However, this patent does not mention how to control an unattended train to automatically operate reversely from a section, where the train parks, to an area set by a dispatcher in a case where a route cannot be set.

[0008] In addition, Chinese Patent Publication No. CN_109969232 discloses a method for realizing remote restricted drive mode in an unattended train operation system, which specifically comprises: in a case where a train fails to be positioned due to a fault during unattended operation, controlling a trackside controller and the train to enter a remote restricted drive mode by means of related operations of a control center to control the train to operate automatically so as to be positioned again, thus resuming unattended operation.

[0009] This patent expounds how to control a zone controller and a train, which fails to be positioned in a section, to enter a remote restricted drive mode to control the train to operate forward and be positioned again to resume unattended operation in an unattended train operation system. However, this patent does not mention how to control a train to automatically operate reversely from a section, where the train is forced to stop due to a fault of a front train, to a destination set by a dispatcher in the remote restricted drive mode in a case where a route cannot be set.

[0010] Therefore, how to ensure that trains can still operate safely in case of a fault to overcome the disadvantages that normal operation is affected and panics of passengers are caused by a long-term dwell of the trains in a section in the prior art is a technical issue to be addressed.

BRIEF SUMMARY OF THE INVENTION

[0011] The objective of the invention is to overcome the abovementioned disadvantages of the prior art by providing a method for realizing remote reverse operation

during unattended train operation, a device and a medium.

[0012] The objective of the invention can be fulfilled by the following technical solution:

In a first aspect, the invention provides a method for realizing remote reverse operation during unattended train operation, comprising the following steps:

S1, sending, by a zone controller, information of a train 1 and a train 2 to ATS, wherein the train 1 is a front train stopping in a section due to a fault, and the train 2 is a following train which will be emergently braked to stop in the section;

S2, displaying, by an ATS interface, state information of the train 1 and the train 2;

S3, setting, by a dispatch terminal, an instruction for blocking a remote reverse operation protection area within a range from a platform A to a platform B;

S4, generating a command for blocking the reverse operation protection area in a remote speed-limited mode of the trains according to the instruction for blocking the remote reverse operation protection area set by the dispatch terminal and sending the command for blocking the reverse operation protection area in the remote speed-limited mode of the trains to an interlocking subsystem, by the ATS;

S5, after the interlocking subsystem receives the command for blocking the reverse operation protection area in the remote speed-limited mode of the trains sent from the ATS, checking blocking and interlocking conditions; when the blocking and interlocking conditions are satisfied, setting the remote reverse operation protection area to be blocked, and sending a blocked state of the remote reverse operation protection area to the ATS and the zone controller;

S6, feeding, by the ATS, the blocked state of the remote reverse operation protection area back to the dispatch terminal;

S7, setting, by the dispatch terminal, a remote reverse operation instruction of the train 2;

S8, generating a remote reverse operation command according to the remote reverse operation instruction of the train 2 set by the dispatch terminal and sending the remote reverse operation command to an on-board controller, by the ATS;

S9, after the on-board controller receives the remote reverse operation command sent from the ATS, checking the validity of the remote reverse operation command and returning a check result to the ATS;

S10, calculating an end of remote reverse operation authority and sending remote reverse operation authority information to the on-board controller, by the zone controller;

S11, automatically completing head-tail exchange of the train 2 and controlling the train 2 to automatically operate to the platform A according to the remote reverse operation authority information, by the on-board controller, and automatically exiting a remote reverse operation mode;

S12, after the train 2 operates to the platform A and stops, setting, by the dispatch terminal, an instruction for unblocking the remote reverse operation protection area;

S13, generating a command for unblocking the remote reverse operation protection area according to the instruction for unblocking the remote reverse operation protection area and sending the command for unblocking the remote reverse operation protection area to the interlocking subsystem, by the ATS; and

S14, after the interlocking subsystem receives the command for unblocking the remote reverse operation protection area sent from the ATS, returning an unblocked state of the remote reverse operation protection area to the zone controller.

[0013] As a preferred technical solution, the information in S1 comprise a positioning state of the trains, coordinates of a head and a tail of the trains, and ID numbers of on-board controllers at the head and tail of the trains.

[0014] As a preferred technical solution, the state information in S2 comprises fault information of the train 1 and location information of the train 1 and the train 2.

[0015] As a preferred technical solution, in S3, the platform A is a departure platform of the train 1 and the train 2, and the platform B is an arrival platform of the train 1 and the train 2.

[0016] As a preferred technical solution, the blocking and interlocking conditions checked in S5 comprise:

① whether the position of a turnout in the remote reverse operation protection area is correct;

② whether the remote reverse operation protection area has a risk of face-to-face collision with routes established outside the remote reverse operation protection area and other blocked remote reverse operation protection areas;

③ whether the remote reverse operation protection area has a risk of side collision with the routes established outside the remote reverse operation protection area, protection sections, and the other

blocked remote reverse operation protection areas; and

④ whether a section in the remote reverse operation protection area is blocked.

[0017] As a preferred technical solution, only if all the blocking and interlocking conditions of the remote reverse operation protection area are satisfied, the remote reverse operation protection area will be set to be blocked.

[0018] As a preferred technical solution, S7 specifically comprises: setting, by the dispatch terminal, the remote reverse operation instruction of the train 2 according to the display of the ATS interface.

[0019] As a preferred technical solution, the remote reverse operation command in S8 comprises a vehicle terminal Cab_2 to be activated for remote reverse operation and an ID number of the zone controller associated with the train 2.

[0020] As a preferred technical solution, the ID number of the zone controller associated with the train 2 is obtained by calculation according to position coordinates of the train 2.

[0021] As a preferred technical solution, checking the validity of the remote reverse operation command in S9 specifically comprises:
if the remote reverse operation command is valid, enabling the on-board controller to enter the remote reverse operation mode, and sending a remote reverse operation request to the zone controller; otherwise, waiting for manual remote confirmation of an interlock state of a signal system.

[0022] As a preferred technical solution, calculating an end of remote reverse operation authority in S10 specifically comprises:
after the zone controller receives the remote reverse operation request from the on-board controller, calculating the end of remote reverse operation authority according to the blocked state of the remote reverse operation protection area provided by the interlocking subsystem.

[0023] As a preferred technical solution, the instruction for unblocking the reverse operation protection area in S12 is set by the ATS.

[0024] As a preferred technical solution, S14 further comprises: truly unblocking the remote reverse operation protection area after the remote reverse operation protection area is maintained in the blocked state for a set time.

[0025] As a preferred technical solution, the method provides protection for safe protection of the trains under the condition where a reverse route TD fails to be established for the trains.

[0026] In a second aspect, the invention provides an electronic device, comprising a memory and a processor, wherein a computer program is stored in the memory, and when executing the computer program, the processor implements the method mentioned above.

[0027] In a third aspect, the invention provides a computer-readable storage medium having a computer program stored therein, wherein the method mentioned above is implemented when the computer program is executed.

[0028] Compared with the prior art, the invention has the following advantages:

1. In the invention, an automatic remote reverse operation function of trains is designed to ensure that the trains can still operate safely in case of a fault, thus overcoming the defects that normal operation of trains is affected and panics of passengers are caused due to a long-term dwell of the trains in a section in the prior art;

2. In the invention, the remote reverse operation protection area is blocked by means of the interlocking subsystem, and is protected against the risk of face-to-face collision with routes established outside the area and other blocked remote reverse operation protection areas, as well as the risk of side collision with routes established outside the area, protection sections and other blocked remote reverse operation protection areas, thus guaranteeing the safety of reverse operation of trains;

3. In the invention, the zone controller calculates the remote reverse operation authority information of trains, and the on-board controller controls the trains to operate automatically according to the authority information, such that safety risks existing in the manual restricted drive mode where the on-board controller only provide speed protection are avoided, and such faults can be handled more automatically;

4. In the invention, after the interlocking subsystem sends the unblocked state of the remote reverse operation protection area to the zone controller, the remote reverse operation protection area will not be truly unblocked until a delay time later to ensure that the reverse operation area is truly unblocked after the zone controller has received the unblocked state of the reverse operation protection area, thus preventing safety accidents caused by unblocking the reverse operation protection area when the train is still in operation in a case where the train is parked beyond a standard area;

5. The invention provides a protection solution to safe operation of trains under the condition where a reverse route TD fails to be established for the trains.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0029]

FIG. 1 is a schematic diagram of a remote reverse operation process of a train;

FIG. 2 is a diagram of information exchange of subsystems during a remote reverse operation realization process of the train;

FIG. 3 is a flow diagram of the remote reverse operation realization process of the train.

DETAILED DESCRIPTION OF THE INVENTION

[0030] The technical solutions of the embodiments of the invention will be clearly and completely described below in conjunction with the accompanying drawings of the embodiments of the invention. Obviously, the embodiments in the following description are merely illustrative ones, and are not all possible ones of the invention. All other embodiments obtained by those ordinarily skilled in the art according to the following ones without creative labor should also fall within the protection scope of the invention.

[0031] As shown in FIG. 1 and FIG. 2, during unattended train operation, a train 1 and a train 2 both departure from a platform A to a platform B; if the front train 1 stops in a section due to a fault, the following train 2 will also be emergently braked to stop in the section; and the train 2 has to stop in the section until the fault of the train 1 is removed. In this case, necessary safety protection measures need to be taken to dispatch a driver to board the train 2 to switch the train 2 to a manual restricted drive mode and change the activated locomotive end of the train 2 to allow the train 2 to operate reversely to leave the section. To overcome the disadvantages of the conventional handling method in this case, the invention provides a method for realizing remote reverse operation during unattended train operation. The specific process is as follows:

S1: a zone controller sends information of the train 1 and the train 2, such as the positioning state of the trains, coordinates of a head and a tail of the trains, and ID numbers of on-board controllers at the head and tail of the trains, to ATS;

S2: an ATS interface displays a fault of the train 1, the location of the train 1 and the location of the train 2;

S3: a dispatch terminal sets an instruction for blocking a remote reverse operation protection area within a range from the platform A to the platform B by means of the ATS;

S4: the ATS generates a command for blocking the remote reverse operation protection area in a remote speed-limited mode of the trains according to the instruction for blocking the remote reverse operation protection area set by the dispatch terminal and sends the command for blocking the remote reverse operation protection area to an interlocking subsystem;

S5: after receiving the command for blocking the remote reverse operation protection area sent from the ATS, the interlocking subsystem checks whether the following conditions are satisfied: ① whether the position of a turnout in the remote reverse operation protection area is correct; ② whether the remote reverse operation protection area has a risk of face-to-face collision with routes established outside the remote reverse operation protection area and other blocked remote reverse operation protection areas; ③ whether the remote reverse operation protection area has a risk of side collision with the routes established outside the remote reverse operation protection area, protection sections, and other blocked remote reverse operation protection areas; ④ whether a section in the remote reverse operation protection area is blocked; if all the blocking and interlocking check conditions of the remote reverse operation protection area are satisfied, the remote reverse operation protection area is set to be blocked, and a blocked state of the remote reverse operation protection area is sent to the ATS and the zone controller;

S6: the ATS feeds the blocked state of the remote reverse operation protection area back to the dispatch terminal;

S7: the dispatch terminal sets a remote reverse operation instruction of the train 2 according to the display of the ATS interface;

S8: the ATS generates a remote reverse operation command according to the remote reverse operation instruction of the train 2 set by the dispatch terminal and sends the remote reverse operation command to the on-board controller, wherein the remote reverse operation command in S8 comprises a vehicle terminal Cab_2 to be activated for remote reverse operation and an ID number of the zone controller associated with the train , and the ID number of the zone controller associated with the train 2 is obtained by calculation according to position coordinates of the train 2;

S9: after receiving the remote reverse operation command sent from the ATS, the on-board controller checks the validity of the remote reverse operation command and returns a check result to the ATS; if the remote reverse operation command is valid, the on-board controller enters a remote reverse operation mode and sends a remote reverse operation request to the zone controller; otherwise, the on-board

controller waits for manual remote confirmation of the interlock state of a signal system;

S10: after receiving the remote reverse operation request form the on-board controller, the zone controller calculates an end of remote reverse operation authority according to the blocked state of the remote reverse operation protection area provided by the interlocking subsystem and sends remote reverse operation authority information to the on-board controller;

S11: the on-board controller completes automatic head-tail exchange of the train 2 (changes an activated vehicle terminal from Cab_1 to Cab_2) according to the remote reverse operation authority information, controls the train 2 to automatically operate to the platform A, and then automatically exits the remote reverse operation mode;

S12: after the train 2 operates to the platform A and stops, the dispatch terminal sets an instruction for unblocking the remote reverse operation area by means of the ATS;

S13: the ATS generates a command for unblocking the remote reverse operation area according to the instruction for unblocking the remote reverse operation area and sends the command for unblocking the remote reverse operation area to the interlocking subsystem; and

S14: after receiving the command for unblocking the remote reverse operation area sent from the ATS, the interlocking subsystem returns an unblocked state of the remote reverse operation area to the zone controller and truly unblocks the remote reverse operation protection area after maintaining the remote reverse operation protection area in the blocked state for a time T1.

[0032] The embodiment of the method is introduced above, and the technical solution of the invention is further described below with reference to embodiments of an electronic device and a storage medium.

[0033] An electronic device provided the invention comprises a central processing unit (CPU), which can perform various appropriate actions and processing according to computer program instructions stored in a read only memory (ROM) or computer program instructions loaded into a random access memory (RAM) from a storage unit. Various programs and data required for operations of the device can also be stored in the RAM. The CPU, ROM and RAM are connected by means of a bus. An input/output (I/O) interface is also connected to the bus.

[0034] Multiple components in the device are connected to the I/O interface, including an input unit such as a keyboard or a mouse; an output unit such as various displays or speakers; a storage unit such as a magnetic disk or a compact disc; and a communication unit such as a network card, a modem or a wireless communication transceiver. The communication unit allows the device to exchange information/data with other devices by means of, for example, computer networks based on the internet and/or various telecommunication networks.

[0035] The processing unit performs the steps and processing described above, such as the method S1-S14. For example, in some embodiments, the method S1-S14 can be implemented as a computer software program, which is tangibly stored in a machine-readable medium such as the storage unit. In some other embodiments, the computer program may be partially or entirely loaded and/or installed on the device by means of the ROM and/or the communication unit. When the computer program is loaded into the RAM and executed by the CPU, one or more of the steps of the method S1-S14 described above can be performed. Alternatively, in other embodiments, the CPU can be configured to implement the method S1-S14 in any other appropriate ways (such as, by means of firmware).

[0036] At least part of the functions described above can be performed by one or more hardware logic components. For example, non-restrictively, illustrative hardware logic components that can be used include: a field programmable gate array (FPGA), an application-specific integrated circuit (ASIC), an application-specific standard product (ASSP), a system on chip (SOC), a complex programmable logic device (CPLD), and the like.

[0037] Program codes for implementing the method of the invention may be written in one programming language or any combination of multiple programming languages. These program codes can be provided to a processor or a controller of a general-purpose computer, a special-purpose computer or other programmable data processing devices, such that when the program codes are executed by the processor or controller, the functions/operations specified in the flow diagram and/or block diagram are performed. The program codes may be entirely executed on a machine, partially executed on a machine, partially executed on a machine as an independent software package and partially executed on a remote machine, or entirely executed on a remote machine or server.

[0038] In the context of the invention, the machine-readable medium may be a tangible medium, and may comprise or store a program, which is used by or in conjunction with an instruction execution system, apparatus or device. The machine-readable medium may be a machine-readable signal medium or a machine-readable storage medium. The machine-readable medium may comprise, but is not limited to, electronic, magnetic, optical, electromagnetic, infrared or semiconductor systems, apparatuses or devices, or any suitable combinations thereof. More specific examples of the machine-readable storage medium comprise an electrical connec-

tion based on one or more wires, a portable computer disk, a hard disk, a random access memory (RAM), a read only memory (ROM), an erasable programmable read only memory (EPROM or flash memory), an optical fiber, a portable compact disc read only memory (CD-ROM), an optical storage device, a magnetic storage device, or any combinations thereof.

[0039] The above embodiments are merely specific ones of the invention, and the protection scope of the invention is not limited to the above embodiments. Any skilled in the art can easily think of various equivalent modifications or substitutions within the technical scope disclosed by the invention, and all these equivalent modifications or substitutions should fall within the protection scope of the invention. Therefore, the protection scope of the invention should be subject to the protection scope of the claims.

Claims

1. A method for realizing remote reverse operation during unattended train operation, comprising the following steps:

   S1, sending, by a zone controller, information of a train 1 and a train 2 to ATS, wherein the train 1 is a front train stopping in a section due to a fault, and the train 2 is a following train which will be emergently braked to stop in the section;
   S2, displaying, by an ATS interface, state information of the train 1 and the train 2;
   S3, setting, by a dispatch terminal, an instruction for blocking a remote reverse operation protection area within a range from a platform A to a platform B;
   S4, generating a command for blocking the reverse operation protection area in a remote speed-limited mode of the trains according to the instruction for blocking the remote reverse operation protection area set by the dispatch terminal and sending the command for blocking the reverse operation protection area in the remote speed-limited mode of the trains to an interlocking subsystem, by the ATS;
   S5, after the interlocking subsystem receives the command for blocking the reverse operation protection area in the remote speed-limited mode of the trains sent from the ATS, checking blocking and interlocking conditions; when the blocking and interlocking conditions are satisfied, setting the remote reverse operation protection area to be blocked, and sending a blocked state of the remote reverse operation protection area to the ATS and the zone controller;
   S6, feeding, by the ATS, the blocked state of the remote reverse operation protection area back to the dispatch terminal;
   S7, setting, by the dispatch terminal, a remote reverse operation instruction of the train 2;
   S8, generating a remote reverse operation command according to the remote reverse operation instruction of the train 2 set by the dispatch terminal and sending the remote reverse operation command to an on-board controller, by the ATS;
   S9, after the on-board controller receives the remote reverse operation command sent from the ATS, checking the validity of the remote reverse operation command and returning a check result to the ATS;
   S10, calculating an end of remote reverse operation authority and sending remote reverse operation authority information to the on-board controller, by the zone controller;
   S11, automatically completing head-tail exchange of the train 2 and controlling the train 2 to automatically operate to the platform A according to the remote reverse operation authority information, by the on-board controller, and automatically exiting a remote reverse operation mode;
   S12, after the train 2 operates to the platform A and stops, setting, by the dispatch terminal, an instruction for unblocking the remote reverse operation protection area;
   S13, generating a command for unblocking the remote reverse operation protection area according to the instruction for unblocking the remote reverse operation protection area and sending the command for unblocking the remote reverse operation protection area to the interlocking subsystem, by the ATS; and
   S14, after the interlocking subsystem receives the command for unblocking the remote reverse operation protection area sent from the ATS, returning an unblocked state of the remote reverse operation protection area to the zone controller.

2. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein the information in S1 comprise a positioning state of the trains, coordinates of a head and a tail of the trains, and ID numbers of on-board controllers at the head and tail of the trains.

3. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein the state information in S2 comprises fault information of the train 1 and location information of the train 1 and the train 2.

4. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein in S3, the platform A is a departure platform of the train 1 and the train 2, and the platform

B is an arrival platform of the train 1 and the train 2.

5. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein the blocking and interlocking conditions checked in S5 comprise:

① whether the position of a turnout in the remote reverse operation protection area is correct;
(2) whether the remote reverse operation protection area has a risk of face-to-face collision with routes established outside the remote reverse operation protection area and other blocked remote reverse operation protection areas;
③ whether the remote reverse operation protection area has a risk of side collision with the routes established outside the remote reverse operation protection area, protection sections, and the other blocked remote reverse operation protection areas; and
④ whether a section in the remote reverse operation protection area is blocked.

6. The method for realizing remote reverse operation during unattended train operation according to Claim 5, wherein only if all the blocking and interlocking conditions of the remote reverse operation protection area are satisfied, the remote reverse operation protection area will be set to be blocked.

7. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein S7 specifically comprises: setting, by the dispatch terminal, the remote reverse operation instruction of the train 2 according to the display of the ATS interface.

8. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein the remote reverse operation command in S8 comprises a vehicle terminal Cab_2 to be activated for remote reverse operation and an ID number of the zone controller associated with the train 2.

9. The method for realizing remote reverse operation during unattended train operation according to Claim 8, wherein the ID number of the zone controller associated with the train 2 is obtained by calculation according to position coordinates of the train 2.

10. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein checking the validity of the remote reverse operation command in S9 specifically comprises:
if the remote reverse operation command is valid, enabling the on-board controller to enter the remote reverse operation mode, and sending a remote reverse operation request to the zone controller; otherwise, waiting for manual remote confirmation of an interlock state of a signal system.

11. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein calculating an end of remote reverse operation authority in S10 specifically comprises:
after the zone controller receives the remote reverse operation request from the on-board controller, calculating the end of remote reverse operation authority according to the blocked state of the remote reverse operation protection area provided by the interlocking subsystem.

12. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein the instruction for unblocking the reverse operation protection area in S12 is set by the ATS.

13. The method for realizing remote reverse operation during unattended train operation according to Claim 1, wherein S14 further comprises: truly unblocking the remote reverse operation protection area after the remote reverse operation protection area is maintained in the blocked state for a set time.

14. The method for realizing remote reverse operation during unattended train operation according to Claim 13, the method provides protection for safe protection of the trains under the condition where a reverse route TD fails to be established for the trains.

15. An electronic device, comprising a memory and a processor, a computer program being stored in the memory, wherein the method according to any one of Claims 1-14 is implemented when the processor executes the computer program.

16. A computer-readable storage medium, having a computer program stored therein, wherein the method according to any one of Claims 1-14 is implemented when the computer program is executed by a processor.

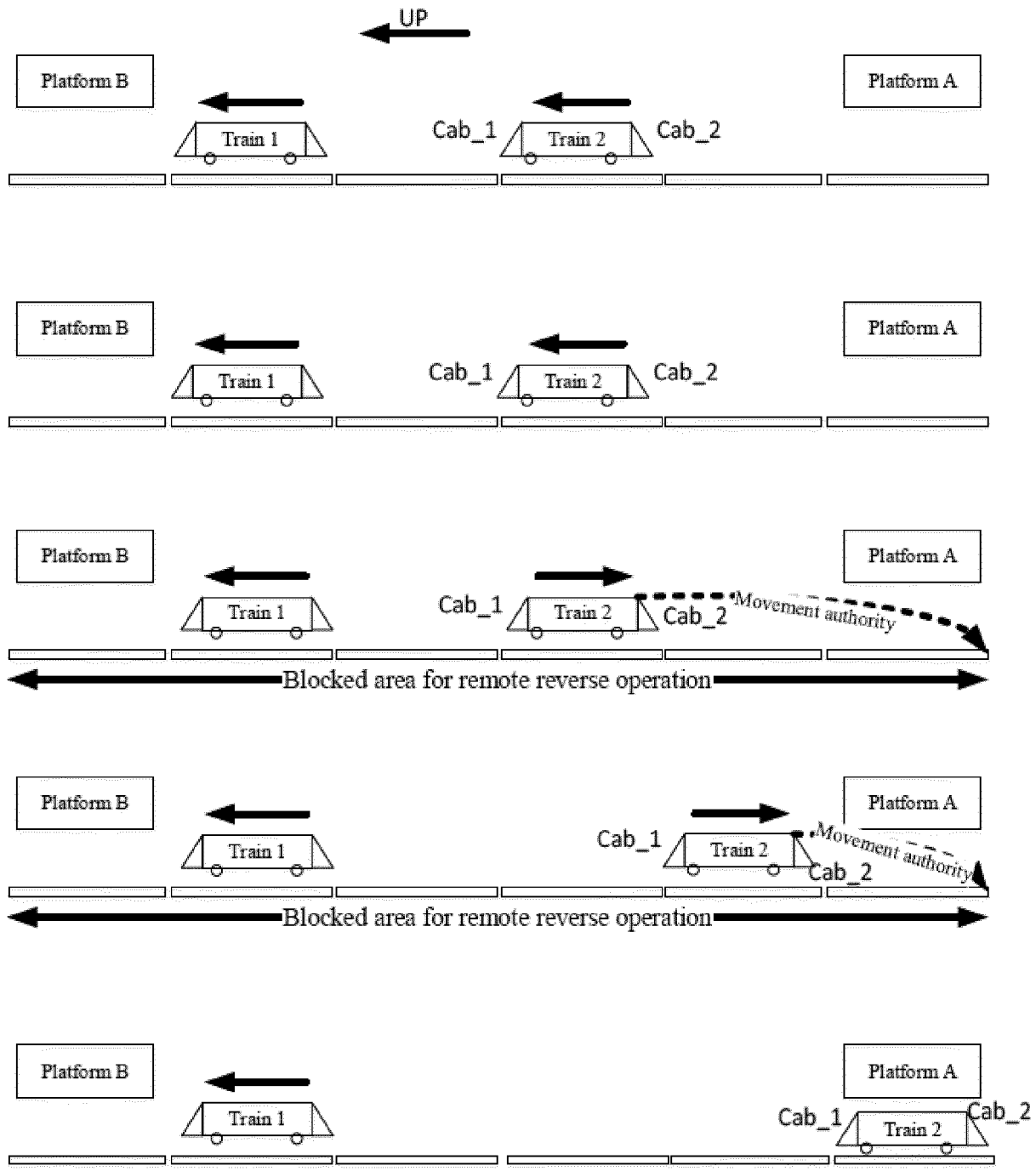
UP
Platform B
Platform A
Train 1
Cab_1
Train 2
Cab_2
Platform B
Platform A
Train 1
Cab_1
Train 2
Cab_2
Platform B
Platform A
Train 1
Cab_1
Train 2
Cab_2
Movement authority
Blocked area for remote reverse operation
Platform B
Platform A
Train 1
Cab_1
Train 2
Movement authority
Cab_2
Blocked area for remote reverse operation
Platform B
Platform A
Train 1
Cab_1
Train 2
Cab_2

FIG. 1

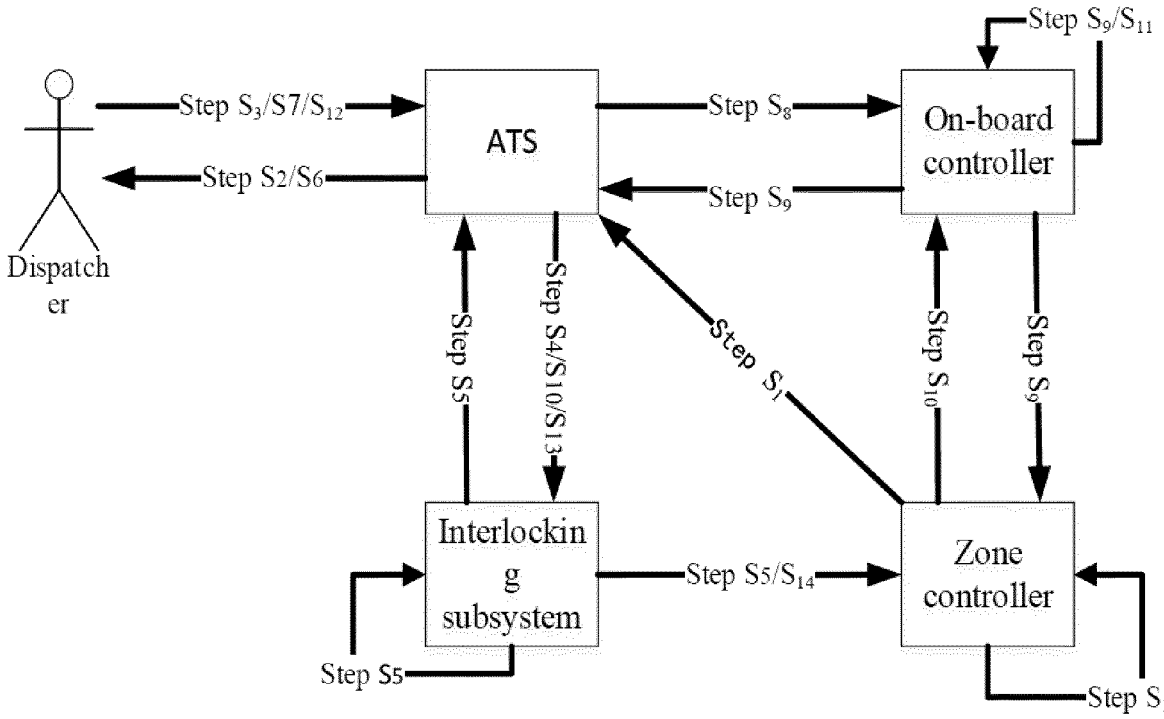
Step S9/S11
Step S3/S7/S12
Step S2/S6
ATS
Step S8
Step S9
On-board controller
Dispatcher
Step S5
Step S4/S10/S13
Step S1
Step S10
Step S6
Interlocking subsystem
Step S5/S14
Zone controller
Step S5
Step S10

FIG. 2

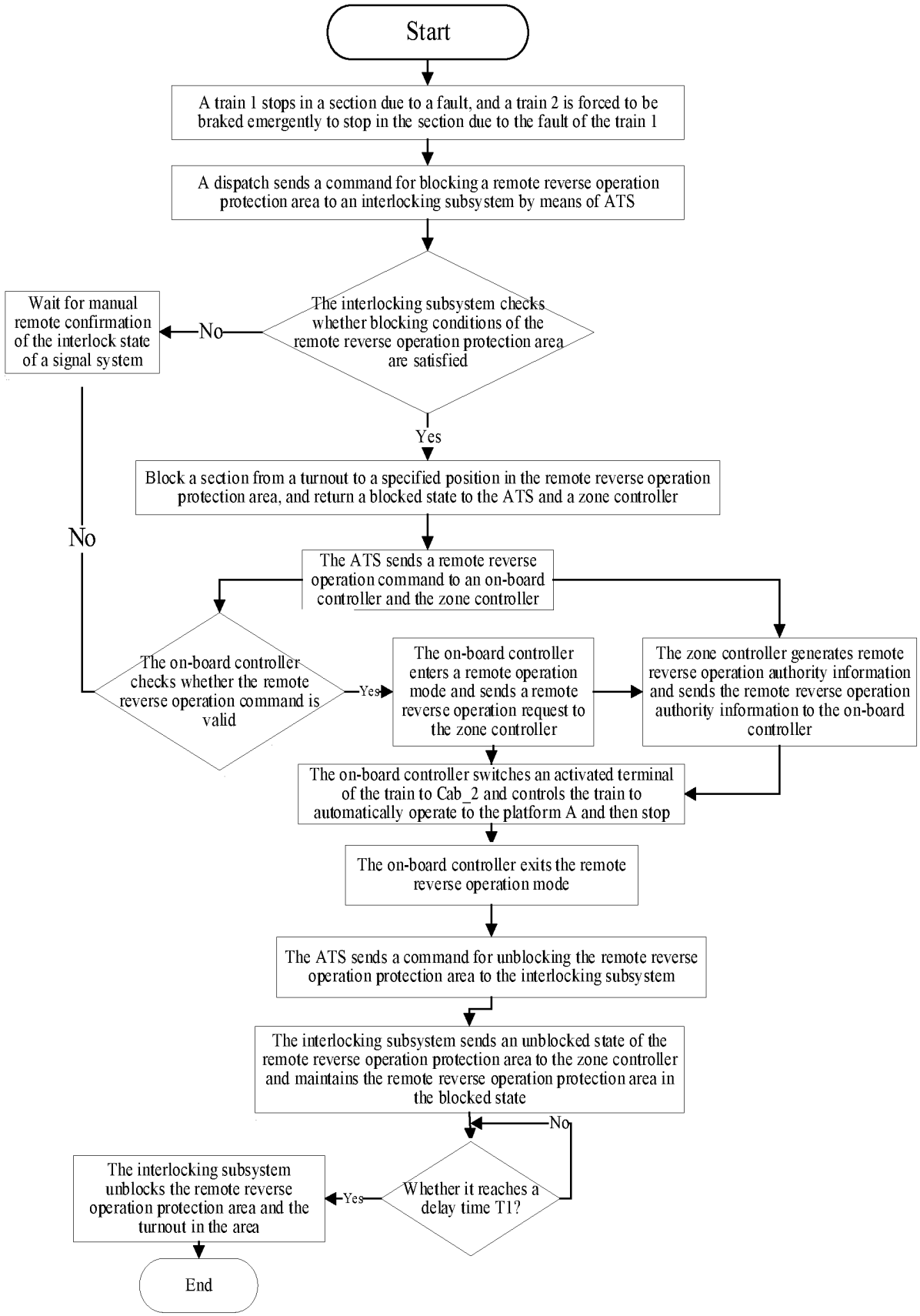
Start
A train 1 stops in a section due to a fault, and a train 2 is forced to be braked emergently to stop in the section due to the fault of the train 1
A dispatch sends a command for blocking a remote reverse operation protection area to an interlocking subsystem by means of ATS
The interlocking subsystem checks whether blocking conditions of the remote reverse operation protection area are satisfied
No
Wait for manual remote confirmation of the interlock state of a signal system
Yes
Block a section from a turnout to a specified position in the remote reverse operation protection area, and return a blocked state to the ATS and a zone controller
No
The ATS sends a remote reverse operation command to an on-board controller and the zone controller
The on-board controller checks whether the remote reverse operation command is valid
Yes
The on-board controller enters a remote operation mode and sends a remote reverse operation request to the zone controller
The zone controller generates remote reverse operation authority information and sends the remote reverse operation authority information to the on-board controller
The on-board controller switches an activated terminal of the train to Cab_2 and controls the train to automatically operate to the platform A and then stop
The on-board controller exits the remote reverse operation mode
The ATS sends a command for unblocking the remote reverse operation protection area to the interlocking subsystem
The interlocking subsystem sends an unblocked state of the remote reverse operation protection area to the zone controller and maintains the remote reverse operation protection area in the blocked state
No
Whether it reaches a delay time T1?
Yes
The interlocking subsystem unblocks the remote reverse operation protection area and the turnout in the area
End

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/135000

A. CLASSIFICATION OF SUBJECT MATTER

B61L23/00(2006.01)i;B61L27/00(2022.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B61L 23 , B61L 27

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, DWPI, VEN, ENTXT, ENTXTC, CNKI: 列车, 反向运行, 全自动, 退行, 无人驾驶, 控制, 防护区段, 防护区域, 解锁, 锁闭, 卡斯柯, 折返, 联锁, 区域控制器, train, control+, ATS, unmanned remote, full-automatic, reverse+, reverse operation, interlock, lock+, unlock+, ZC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 114261432 A (CASCO SIGNAL LTD.) 01 April 2022 (2022-04-01) claims 1-16	1-16
A	CN 113650657 A (TIANJIN JINHANG INSTITUTE OF COMPUTING TECHNOLOGY) 16 November 2021 (2021-11-16) description, paragraphs [0002]-[0060], and figures 1-6	1-16
A	CN 109677459 A (UNITTEC CO., LTD.) 26 April 2019 (2019-04-26) entire document	1-16
A	CN 110936987 A (CASCO SIGNAL LTD.) 31 March 2020 (2020-03-31) entire document	1-16
A	CN 111806523 A (CRSC URBAN RAIL TRANSIT TECHNOLOGY CO., LTD.) 23 October 2020 (2020-10-23) entire document	1-16
A	US 2016304107 A1 (ELECTRO-MOTIVE DIESEL, INC.) 20 October 2016 (2016-10-20) entire document	1-16

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2023-02-20	**20 February 2023**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/135000

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	刘江 等 (LIU, Jiang et al.). "CBTC系统在车站保护区段的解锁优化方案 (Optimum Scheme of Overlap Releasing in Urban Rail Transit CBTC System)" *城市轨道交通研究 (Urban Mass Transit)*, No. 08, 10 August 2017 (2017-08-10), ISSN: 1007-869X, entire document	1-16

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/135000

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 114261432 A	01 April 2022	None	
CN 113650657 A	16 November 2021	None	
CN 109677459 A	26 April 2019	None	
CN 110936987 A	31 March 2020	None	
CN 111806523 A	23 October 2020	None	
US 2016304107 A1	20 October 2016	None	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 112572536 **[0006]**
- CN 109969232 **[0008]**