RAILWAY TRAIN OPERATION CONTROL METHOD AND SYSTEM

[0001] The present application claims the priority to Chinese Patent Application No.201910085204.2, titled "RAILWAY TRAIN OPERATION CONTROL METHOD AND SYSTEM", filed on January 29, 2019 with the National Intellectual Property Administration, PRC, which is incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to the field of controlling trains, and in particular to an operation control method and operation control system for a train.

BACKGROUND

[0003] As the Guan-Hui line in the Pearl River Delta puts into operation in March 2016, intercity trains equipped with the CTCS2+ATO train control system started to provide services in China. The system has good performance and stability. At present, the autonomic operation technology is still not applied to CTCS3 level high-speed trains. If the automatic operation technology is applied to high-speed trains, operation efficiency can be improved, traction energy consumption can be reduced, and some operations of the driver can be done automatically to reduce labor intensity of the driver. Therefore, an important research direction is to perform automatic operation function on high-speed trains.

SUMMARY

[0004] In view of this, an operation control method for a train is provided according to the embodiments of the present disclosure, which is performed based on a CTCS3+ATO system, to realize an automatic operation function under a manned situation.

[0005] To achieve the above object, the following technical solutions are provided according to the embodiments of the present disclosure.

[0006] The operation control method for a train includes:

determining whether the train meets an automatic operation condition, and

outputting prompt information for indicating that the train is allowed to operate in an automatic operation mode if the train meets the automatic operation condition;

controlling the train to operate in the automatic operation mode in a case that an ATO starting button on a driver operation platform is triggered;

determining whether the train is located at an intermediate station and is not departed, and determining whether the train operates in the automatic operation mode if the train is not departed at the intermediate station, where the intermediate station is a station in a train traveling route other than a starting station and a terminal station; and

if the train is not departed at the intermediate station and operates in the automatic operation mode and if the ATO starting button is triggered by the driver, controlling the train in the automatic operation mode to perform station automatic departure, section automatic operation, station automatic parking, door opening protection, and train door and platform door linkage control.

[0007] In an embodiment, in the operation control method for a train, the determining whether the train meets the automatic operation condition includes:

determining whether the train operates in a fully monitored mode;

determining whether a direction handle of the train is arranged forward;

determining whether a driver controller handle of the train is located at a zero position;

determining whether an automatic operation system of the train operates normally;

determining whether an automatic protection system of the train outputs an emergency braking signal; and

determining whether units of the train are allowed to operate in an ATO mode, where

if the train operates in the fully monitored mode, the direction handle is arranged forward, the driver controller handle is located at the zero position, the automatic operation system operates normally, and the automatic protection system outputs no emergency braking signal, it is determined that the train meets the automatic operation condition.

[0008] In an embodiment, the operation control method for a train further includes:

determining whether the train is allowed to operate in the ATO mode, and controlling the train to exit the automatic operation mode if the train is not allowed to operate in the ATO mode.

[0009] In an embodiment, in the operation control method for a train, a condition for exiting the automatic operation mode includes:

tractions to two or more of units of the train are removed,

an air brake of at least one of the units of the train is unavailable,

the train is in a speed limiting protection state,

the train is in a service braking state,

the train is in an emergency braking state,

the train is in a state that holding braking is isolated, or

a communication between the train and an automatic operation system is ineffective.

[0010] The operation control system for a train includes: an automatic operation system, an operation mode switching system, and an automatic protection system. The automatic operation system is configured to control the train to operate in an automatic operation mode to perform automatic train operation. The operation mode switching system is configured to: determine whether the train meets an automatic operation condition, and output prompt information for indicating that the train is allowed to operate in the automatic operation mode if the train meets the automatic operation condition; control the automatic operation system to start in a case that an ATO starting button on a driver operation platform is triggered, to control the train to operate in the automatic operation mode; determine whether the train is located at an intermediate station and is not departed, and determine whether the train operates in the automatic operation mode if the train is not departed at the intermediate station, where the intermediate station is a station in a train traveling route other than a starting station and a terminal station; and if the train is not departed at the intermediate station and operates in the automatic operation mode and if the ATO starting button is triggered by the driver, control the train in the automatic operation mode to perform station automatic departure, section automatic operation, station automatic parking, door opening protection, and train door and platform door linkage control. The automatic protection system is configured to

control the train to travel at a traveling speed not greater than a target speed.

[0011] In an embodiment, in the operation control system for a train, for determining whether the train meets the automatic operation condition, the operation mode switching system is further configured to:

determine whether the train operates in a fully monitored mode;

determine whether a direction handle of the train is arranged forward;

determine whether a driver controller handle of the train is located at a zero position;

determine whether an automatic operation system of the train operates normally;

determine whether an automatic protection system of the train outputs an emergency braking signal; and

determine whether units of the train are allowed to operate in an ATO mode, where

if the train operates in the fully monitored mode, the direction handle is arranged forward, the driver controller handle is located at the zero position, the automatic operation system operates normally, and the automatic protection system outputs no emergency braking signal, it is determined that the train meets the automatic operation condition.

[0012] In an embodiment, in the operation control system for a train, the operation mode switching system is further configured to:

determine whether the train is allowed to operate in the ATO mode, and control the train to exit the automatic operation mode if the train is not allowed to operate in the ATO mode.

[0013] In an embodiment, in the operation control system for a train, a condition for exiting the automatic operation mode includes:

tractions to two or more of units of the train are removed,

an air brake of at least one of the units of the train is unavailable,

the train is in a speed limiting protection state,

the train is in a service braking state,

the train is in an emergency braking state,

the train is in a state that holding braking is isolated, or

a communication between the train and an automatic operation system is ineffective.

[0014] With the above technical solutions according to the embodiments of the present disclosure, it is determined whether the train meets an automatic operation condition. If the train meets the automatic operation condition and an ATO starting button on a driver operation platform is triggered, the train is controlled to operate in the automatic operation mode. In a case that the train is to leave an intermediate station, if the train is not departed at the intermediate station and operates in the automatic operation mode and of the ATO starting button is triggered, the train is controlled to depart from the intermediate station in the automatic operation mode. In this way, the train can operate in the automatic operation mode, and a safe operation of the train can be ensured by performing manual intervention when the train leaves the intermediate station.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The drawings to be used in the description of the embodiments or the conventional technology will be described briefly as follows, so that the technical solutions according to the embodiments of the present disclosure or according to the conventional technology will become clearer. It is apparent that the drawings in the following description only illustrate some embodiments of the present disclosure. For those skilled in the art, other drawings may be obtained according to these drawings without any creative work.

[0016] Figure 1 is a flow chart of an operation control method for a train according to an embodiment of the present disclosure; and

[0017] Figure 2 is a schematic structural diagram of an operation control system for a train according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0018] Technical solutions according to embodiments of the present disclosure are described clearly and completely hereinafter in conjunction with drawings used in the embodiments of the present disclosure. Apparently, the described embodiments are only some

embodiments of the present disclosure rather than all the embodiments. Any other embodiments obtained by those skilled in the art based on the embodiments of the present disclosure without any creative work fall in the scope of protection of the present disclosure.

[0019] As the Guan-Hui line in the Pearl River Delta puts into operation in March 2016, intercity trains equipped with the CTCS2+ATO train control system started to provide services in China. The CTCS2+ATO train control system is an autonomic operation system and has good performance and stability. At present, the autonomic operation technology is still not applied to CTCS3 level high-speed trains. Therefore, an important research direction is to apply the automatic operation technology to high-speed trains to perform automatic operation function on the high-speed trains.

[0020] To realize the automatic operation function under a manned situation, the high-speed train is equipped with the CTCS3+ATO train control system, such that with an automatic train protection (ATP) system, safe operation of the train can be ensured, the operation efficiency can be improved, traction energy consumption can be reduced, and some operations of the driver can be done automatically to reduce labor intensity of the driver.

[0021] Therefore, an operation control method for a train is provided according to the present disclosure, which is performed based on the CTCS3+ATO train control system. The method may be applied to high-speed trains.

[0022] Figure 1 is a flow chart of an operation control method for a train according to an embodiment of the present disclosure. Referring to Figure 1, the method includes the following steps S101 to S106.

[0023] In step S101, it is determined whether the train meets an automatic operation condition, and step S102 is performed if the train meets the automatic operation condition.

[0024] In the technical solution according to the embodiment of the present disclosure, when the train is at a starting station, it is required to manually start the train by the driver. After the train departs from the starting station, a traveling condition of the train is automatically monitored. During operation, if the train operates in a fully monitored mode and meets the automatic operation condition, the train may operate in the automatic operation mode.

[0025] In step S102, a prompt information for indicating that the train is allowed to operate

in the automatic operation mode is outputted.

[0026] In the technical solution according to the embodiment of the present disclosure, if it is determined in step S101 that the train may operate in the automatic operation mode, prompt information for indicating that the train is allowed to operate in the automatic operation mode is outputted. The prompt information may be used for prompting the driver of the train in a form of text, voice or light. For example, in the technical solution according to the embodiment of the present disclosure, an ATO starting button is arranged on a driver operation platform of the train, and a control signal for controlling the ATO starting button to flicker may be outputted to the ATO starting button. A flicker signal of the ATO starting button may be used as the prompt information for indicating that the train is allowed to operate in the automatic operation mode. When the ATO starting button is triggered, a control signal is outputted to the automatic operation system to activate the automatic operation system. Apparently, an ATO exiting button may further be arranged on the driver operation platform of the train. When the ATO exiting button is triggered, a control signal is outputted to the automatic operation system to control the automatic operation system to stop operating.

[0027] In step S103, the train is controlled to operate in the automatic operation mode if an ATO starting button on a driver operation platform is triggered.

[0028] In step S104, it is determined whether the train is located at an intermediate station and is not departed, and step S105 is performed if the train is not departed at the intermediate station.

[0029] In this step, in a case that the train travels between a starting station and a terminal station, the train may be completely controlled by the automatic operation system.

[0030] The intermediate station is a station in a train traveling route other than a starting station and a terminal station. In a case that the train enters the intermediate station or the terminal station, the automatic operation system performs position correction for the train by using a positioning transponder, such that the automatic operation system can obtain a current position of the train, and continuously adjusts a braking level to be outputted based on the current position and a current speed of the train, to control the train to accurately park at a stop mark along a station track. A braking force is applied to the train based on a corresponding outputted braking level. When the train is completely braked, the train is in a parked state, and the train may leave the station after a period of time. Before leaving the

station, the train is not departed.

[0031] In step S105, it is determined whether the train operates in the automatic operation mode, and step S106 is performed if the train operates in the automatic operation mode.

[0032] When the train is parked at the intermediate station, the train may be in a manual operation state or in an automatic operation state. According to the present disclosure, an operation process of the train in the automatic operation state is mainly described.

[0033] In step S106, the train is controlled to depart in the automatic operation mode if the train meets a departure condition and the ATO starting button is triggered.

[0034] In the technical solution according to the embodiment of the present disclosure, since various conditions may occur when the train departs, it is required to perform manual intervention in a case that the train pulls out of the intermediate station to ensure the safety of passengers and staffs. Only if the ATO starting button is triggered by the driver of the train, the train can be controlled by the automatic operation system to leave the intermediate station.

[0035] The departure condition that the train met may be set by a user, for example, the departure condition may be set to determine whether all doors are closed. If the departure condition is met, a trigger signal is outputted to the driver of the train to prompt the driver that the train may depart.

[0036] In the technical solution according to the embodiment of the present disclosure, it is determined whether the train meets the automatic operation condition. If the train meets the automatic operation condition and an ATO starting button on a driver operation platform is triggered, the train is controlled to operate in the automatic operation mode. In a case that the train is to leave an intermediate station, if the train is not departed at the intermediate station and operates in the automatic operation mode and if the ATO starting button is triggered, the train is controlled to depart from the intermediate station in the automatic operation mode. In this way, the train can operate in the automatic operation mode, and a safe operation of the train can be ensured by performing manual intervention when the train departs from the intermediate station.

[0037] In the technical solution according to the embodiment of the present disclosure, the automatic operation condition may be set by the user according to requirements. For example, if the train is in a fully monitored mode, a direction handle is arranged forward, a driver

controller handle is located at a zero position, an ATO device operates normally, an ATP device does not output an emergency braking signal, and units are allowed to operate in an ATO mode, the train may operate in the automatic operation mode. Therefore, in the technical solution according to an embodiment of the present disclosure, the process of determining whether the train meets an automatic operation condition may include:

determining whether the train operates in a fully monitored mode;

determining whether a direction handle of the train is arranged forward;

determining whether a driver controller handle of the train is located at a zero position;

determining whether an automatic operation system of the train operates normally; and

determining whether an automatic protection system of the train outputs an emergency braking signal.

If the train operates in the fully monitored mode, the direction handle is arranged forward, the driver controller handle is located at the zero position, the automatic operation system operates normally, and the automatic protection system does not output any emergency braking signal, it is indicated that the train meets the automatic operation condition.

[0038] In the technical solution according to an embodiment of the present disclosure, in addition to that the train may be controlled to operate in the automatic operation mode, the train may also be controlled to exit the automatic operation mode. The operation control method for a train may further include: determining whether the train meets a condition for exiting the automatic operation mode, and controlling the train to exit the automatic operation mode if the train meets the condition for exiting the automatic operation mode.

[0039] The condition for exiting the automatic operation mode may include the following situations, that is, the train exits the automatic operation mode if any of the following situations occurs. The condition for exiting the automatic operation mode includes:

tractions to two or more of units of the train are removed,

an air brake of at least one of the units of the train is unavailable,

the train is in a speed limiting protection state,

the train is in a service braking state,

the train is in an emergency braking state,

the train is in a state that holding braking is isolated, and

a communication between the train and an automatic operation system is ineffective.

[0040] In addition, a control process of the automatic operation system is further described according to the present disclosure. The control process may include the following periods: section automatic operation, station automatic parking, train operation section changing, door opening protection, and train door and platform door linkage control.

[0041] During section automatic operation, if the train operates in the automatic operation mode, a network system of the train may collect a signal from the automatic operation system. If the collected signal is effective, a traction control system of the train performs an operation in response to a traction control command sent by the automatic operation system, and a brake control system of the train performs an operation in response to a brake control command sent by the automatic operation system. The train first performs determination based on a "traction/brake command state flag" signal from the automatic operation system. If the "traction/brake command state flag" signal indicates traction, the network system of the train sends command information at a corresponding field to the traction control system of the train, and the traction control system performs traction with a traction control amount corresponding to the command information. If the "traction/brake command state flag" signal indicates braking, the network system of the train sends command information at a corresponding field to the brake control system of the train, and the brake control system performs braking with a brake control amount corresponding to the command information. The network system cooperates with the traction control system and the brake control system to perform operations in response to the control commands from the automatic operation system, thereby performing section automatic operation. During this period, it is unnecessary for the driver to operate the driver controller handle.

[0042] During station automatic parking, the automatic operation system performs position correction by using an accurate positioning transponder, and the automatic operation system continuously adjusts a braking level to be outputted based on a current position and a current speed of the train to control the train to accurately park at a stop mark along a station track.

[0043] In a case that the train parks stably and accurately, the network system transmits a

"holding braking instruction" from an automatic control device to the brake control system. The brake control system performs a holding braking operation based on a highest braking level outputted from a train control system. If the network system of the train determines that a holding braking releasing condition is met, the network system of the train may automatically release the holding braking.

[0044] During train operation section changing, the train exits the automatic operation mode, and the holding braking is applied by the train.

[0045] During door opening protection, if the train parks accurately and stably, a ground device of the train control system sends platform side information to an in-train device, and the automatic train protection (ATP) system outputs a door opening permission instruction based on the platform side information. The door releasing permission signal outputted by the ATP system is superimposed to an existing door releasing hard-wire control signal by using a hard-wire control circuit. A switch is provided for determining whether a door releasing operation is performed by the driver or by the ATP system. That is, if the switch is at a first state, the door releasing operation is performed by the driver using a button on the operation platform; and if the switch is at a second state, the door releasing operation is automatically performed by the ATP system. In addition, the network system of the train collects the door opening permission instruction outputted by the ATP system to turn on a "door releasing" indicator light. After the "door releasing" indicator light is turned on, the automatic operation system determines a door opening signal based on a traveling direction of the train and a current station. The door opening signal indicates whether to open a left door or to open a right door. The automatic operation system superimposes the door opening signal to an existing door opening hard-wire control signal by using a relay dry contact. Based on the door opening signal and the door opening hard-wire control signal, a "left door opening" operation or a "right door opening" operation is performed. The network system sends the state of the switch to a door controller. If the switch is at the second state, the door controller disables a local door opening function, that is, the driver cannot control opening and closing of the door on the operation platform, such that the door can not be opened locally, thereby ensuring the safety of the passengers.

[0046] During train door and platform door linkage control, a train door and platform door opening linkage control is triggered by the driver or the automatic operation device, and train

door and platform door closing linkage control is triggered by the driver. Due to a long transmission distance of a ground signal, a delay process may be performed for the door controller of the train, to ensure that the door and the platform door can be opened and closed synchronously.

[0047] Based on the method, an operation control system for a train is further provided according to the present disclosure. Referring to Figure 2, the system includes an automatic operation system 100, an operation mode switching system 200, and an automatic protection system 300.

[0048] The automatic operation system 100 is configured to control the train to operate in an automatic operation state to perform automatic train operation.

[0049] The operation mode switching system 200 is configured to:

determine whether the train meets an automatic operation condition, and output prompt information for indicating that the train is allowed to operate in the automatic operation mode if the train meets the automatic operation condition,

control the automatic operation system to start in a case that an ATO starting button on a driver operation platform is triggered, to control the train to operate in the automatic operation mode,

determine whether the train is located at an intermediate station and is not departed, and determine whether the train operates in the automatic operation mode if the train is not departed at the intermediate station, where the intermediate station is a station in a train traveling route other than a starting station and a terminal station, and

if the train is not departed at the intermediate station and operates in the automatic operation mode and if the ATO starting button is triggered by the driver, control the train in the automatic operation mode to perform station automatic departure, section automatic operation, station automatic parking, door opening protection, and train door and platform door linkage control.

[0050] The automatic protection system 300 is configured to control the train to travel at a traveling speed not greater than a target speed.

[0051] Corresponding to the method, the operation control system for a train may further include a network system. The network system is configured to transmit signals for multiple

systems of the train.

[0052] Corresponding to the method, for determining whether the train meets the automatic operation condition, the operation mode switching system 200 is further configured to:

determine whether the train operates in a fully monitored mode;

determine whether a direction handle of the train is arranged forward;

determine whether a driver controller handle of the train is located at a zero position;

determine whether an automatic operation system of the train operates normally;

determine whether an automatic protection system of the train outputs an emergency braking signal; and

determine whether units of the train are allowed to operate in an ATO mode, where

if the train operates in the fully monitored mode, the direction handle is arranged forward, the driver controller handle is located at the zero position, the automatic operation system operates normally, and the automatic protection system outputs no emergency braking signal, it is determined that the train meets the automatic operation condition.

[0053] Corresponding to the method, the operation mode switching system 200 is further configured to determine whether the train meets a condition for exiting the automatic operation mode, and control the train to exit the automatic operation mode if the train meets the condition for exiting the automatic operation mode.

[0054] Corresponding to the method, the condition for exiting the automatic operation mode includes:

tractions to two or more of units of the train are removed,

an air brake of at least one of the units of the train is unavailable,

the train is in a speed limiting protection state,

the train is in a service braking state,

the train is in an emergency braking state,

the train is in a state that holding braking is isolated, or

a communication between the train and an automatic operation system is ineffective.

[0055] Corresponding to the method, the operation mode switching system is further configured to determine whether the train is allowed to operate in the ATO mode, and control the train to exit the automatic operation mode if the train is not allowed to operate in the ATO mode.

[0056] Corresponding to the method, a control process of the automatic operation system may include the following periods: section automatic operation, station automatic parking, train operation section changing, door opening protection, and train door and platform door linkage control.

[0057] During section automatic operation, if the train operates in the automatic operation mode, a network system of the train may collect a signal from the automatic operation system. If the collected signal is effective, a traction control system of the train performs an operation in response to a traction control command sent by the automatic operation system, and a brake control system of the train performs an operation in response to a brake control command sent by the automatic operation system. The train first performs determination based on a "traction/brake command state flag" signal from the automatic operation system. If the "traction/brake command state flag" signal indicates traction, the network system of the train sends command information at a corresponding field to the traction control system of the train, and the traction control system performs traction with a traction control amount corresponding to the command information. If the "traction/brake command state flag" signal indicates braking, the network system of the train sends command information at a corresponding field to the brake control system of the train, and the brake control system performs braking with a brake control amount corresponding to the command information. The network system cooperates with the traction control system and the brake control system to perform operations in response to the control commands from the automatic operation system, thereby performing section automatic operation. During this period, it is unnecessary for the driver to operate the driver controller handle.

[0058] During station automatic parking, the automatic operation system performs position correction by using an accurate positioning transponder, and the automatic operation system continuously adjusts a braking level to be outputted based on a current position and a current speed of the train to control the train to accurately park at a stop mark along a station track.

[0059] In a case that the train parks stably and accurately, the network system transmits a

"holding braking instruction" from an automatic control device to the brake control system. The brake control system performs a holding braking operation based on a highest braking level outputted from a train control system. If the network system of the train determines that a holding braking releasing condition is met, the network system of the train may automatically release the holding braking.

[0060] During train operation section changing, the train exits the automatic operation mode, and the holding braking is applied by the train.

[0061] During door opening protection, if the train parks accurately and stably, a ground device of the train control system sends platform side information to an in-train device, and the automatic train protection (ATP) system outputs a door opening permission instruction based on the platform side information. The door releasing permission signal outputted by the ATP system is superimposed to an existing door releasing hard-wire control signal by using a hard-wire control circuit. A switch is provided for determining whether a door releasing operation is performed by the driver or by the ATP system. That is, if the switch is at a first state, the door releasing operation is performed by the driver using a button on the operation platform; and if the switch is at a second state, the door releasing operation is automatically performed by the ATP system. In addition, the network system of the train collects the door opening permission instruction outputted by the ATP system to turn on a "door releasing" indicator light. After the "door releasing" indicator light is turned on, the automatic operation system determines a door opening signal based on a traveling direction of the train and a current station. The door opening signal indicates whether to open a left door or to open a right door. The automatic operation system superimposes the door opening signal to an existing door opening hard-wire control signal by using a relay dry contact. Based on the door opening signal and the door opening hard-wire control signal, a "left door opening" operation or a "right door opening" operation is performed. The network system sends the state of the switch to a door controller. If the switch is at the second state, the door controller disables a local door opening function, that is, the driver cannot control opening and closing of the door on the operation platform, such that the door can not be opened locally, thereby ensuring the safety of the passengers.

[0062] During train door and platform door linkage control, a train door and platform door opening linkage control is triggered by the driver or the automatic operation device, and train

door and platform door closing linkage control is triggered by the driver. Due to a long transmission distance of a ground signal, a delay process may be performed for the door controller of the train, to ensure that the door and the platform door can be opened and closed synchronously.

[0063] An operation control system for a high-speed train based on automatic train operation is further provided according to the present disclosure, which is based on the CTCS3+ATO system, to realize automatic train operation under a manned situation.

[0064] According to the solution, the train state is considered, and the solution is designed to use functions of the traction control system, the brake control system, the network control system, and the door control system. With the solution, the automatic operation system can realize functions of station automatic departure, section automatic operation, station automatic parking, door opening protection, and train door and platform door linkage control.

[0065] According to the solution, operation modes are switched via a switch button. If the train meets an automatic operation condition, the network system provide a prompt to the driver, and the driver may operate the switch button to control the train to operate in the automatic operation mode.

[0066] According to the solution, a control circuit of the door control system is designed to ensure the door opening function in the automatic operation mode. By using a switch, the driver may switch between a manual door opening operation and an automatic door opening operation. A circuit for the manual door opening and a circuit for automatic door opening do not affect each other. According to the solution, the door controller is improved to realize the train door and platform door linkage control function in automatic operation mode.

[0067] According to the solution, even if the train does not meet the automatic operation condition, the automatic protection system of the train is not affected and may still control the train, and the safety level of the train control system is not reduced. With the solution, commands for performing traction, braking, constant speed control, and door opening and the like can be sent automatically without the driver, such that the labor intensity of the driver can be reduced, traction energy consumption is reduced, train punctuality is improved, and the train operation efficiency is improved.

[0068] It can be seen from the solutions according to the embodiments of the present

disclosure, the train state is considered, and the solution is designed to use functions of the traction control system, the brake control system, the network control system, and the door control system. With the solution, the automatic operation system can realize functions of station automatic departure, section automatic operation, station automatic parking, door opening protection, and train door and platform door linkage control.

[0069] According to the solution, operation modes are switched via a switch button. If the train meets an automatic operation condition, the network system provide a prompt to the driver, and the driver may operate the switch button to control the train to operate in the automatic operation mode.

[0070] According to the solution, a control circuit of the door control system is designed to ensure the door opening function in the automatic operation mode. By using a switch, the driver may switch between a manual door opening operation and an automatic door opening operation. A circuit for the manual door opening and a circuit for automatic door opening do not affect each other. According to the solution, the door controller is improved to realize the train door and platform door linkage control function in automatic operation mode.

[0071] According to the solution, even if the train does not meet the automatic operation condition, the automatic protection system of the train is not affected and may still control the train, and the safety level of the train control system is not reduced. With the solution, commands for performing traction, braking, constant speed control, and door opening and the like can be sent automatically without the driver, such that the labor intensity of the driver can be reduced, traction energy consumption is reduced, train punctuality is improved, and the train operation efficiency is improved.

[0072] For the convenience of description, the system is divided into various modules based on functions thereof and is described on a module basis. Apparently, the functions of each module may be realized in the same one or more software and/or hardware in implementing the present disclosure.

[0073] The embodiments in this specification are described in a progressive way, each of which emphasizes the differences from others, and the same or similar parts among the embodiments can be referred to each other. Since the system or the system embodiments disclosed in the embodiments corresponds to the method therein, the description thereof is relatively simple, and for relevant matters references may be made to the description of the

method. The system and the system embodiments described above are just schematic, units described as separate components may be or may not be separated physically, a component shown as a unit may be or may not be a physical unit, that is, may be placed in a same position or may be distributed in multiple network units. A part of or all modules may be selected if desired to realize the object of the embodiments. Those skilled in the art can understand and implement the embodiments without making any creative work.

[0074] It may be further known by those skilled in the art that, units and algorithm steps in each example described in conjunction with the embodiments disclosed herein can be implemented by electronic hardware, computer software or a combination thereof. In order to clearly illustrate interchangeability of the hardware and the software, steps and composition of each embodiment have been described generally in view of functions in the above specification. Whether the function is executed by hardware or software depends on application of the technical solution and design constraint condition. Those skilled in the art can use different method for each application to realize the described function, and this should not be considered to beyond the scope of the application.

[0075] The steps of the methods or algorithms described in conjunction with the embodiments of the present disclosure can be implemented with hardware, software modules executed by a processor, or a combination thereof. The software modules may reside in a Random Access Memory (RAM), an internal memory, a Read Only Memory (ROM), an Electrically Programmable ROM, an Electrically-Erasable Programmable ROM, a register, a hard disk, a removable disk drive, CD-ROM, or other types of storage media well known in the technical field.

[0076] It should be further noted that the relationship terminologies such as "first", "second" and the like are only used herein to distinguish one entity or operation from another, rather than to necessitate or imply that the actual relationship or order exists between the entities or operations. Furthermore, terms of "include", "comprise" or any other variants are intended to be non-exclusive. Therefore, a process, method, article or device including a plurality of elements includes not only the elements but also other elements that are not enumerated, or also include the elements inherent for the process, method, article or device. Unless expressively limited otherwise, the statement "comprising (including) one…" does not exclude the case that other similar elements may exist in the process, method, article or

device.

[0077] With the above descriptions of the disclosed embodiments, those skilled in the art may practice or use the present disclosure. Various modifications to the embodiments are apparent for the skilled in the art. The general principle suggested herein can be implemented in other embodiments without departing from the spirit or scope of the disclosure. Therefore, the present disclosure should not be limited to the embodiments disclosed herein, but has the widest scope that conforms with the principle and the novel features disclosed herein.

CLAIMS

1. An operation control method for a train, comprising:

determining whether the train meets an automatic operation condition, and outputting prompt information for indicating that the train is allowed to operate in an automatic operation mode if the train meets the automatic operation condition;

controlling the train to operate in the automatic operation mode in a case that an ATO starting button on a driver operation platform is triggered;

the operation control method characterised by further comprising;

determining whether the train is located at an intermediate station and is not departed, and determining whether the train operates in the automatic operation mode if the train is not departed at the intermediate station, wherein the intermediate station is a station in a train traveling route other than a starting station and a terminal station; and

if the train is not departed at the intermediate station and operates in the automatic operation mode and if the ATO starting button is triggered by the driver, controlling the train in the automatic operation mode to perform station automatic departure, section automatic operation, station automatic parking, door opening protection, and train door and platform door linkage control.

2. The operation control method for a train according to claim 1, wherein the determining whether the train meets an automatic operation condition comprises:

determining whether the train operates in a fully monitored mode;

determining whether a direction handle of the train is arranged forward;

determining whether a driver controller handle of the train is located at a zero position;

determining whether an automatic operation system of the train operates normally;

determining whether an automatic protection system of the train outputs an emergency braking signal; and

determining whether units of the train are allowed to operate in an ATO mode, wherein

if the train operates in the fully monitored mode, the direction handle is arranged forward,

the driver controller handle is located at the zero position, the automatic operation system operates normally, and the automatic protection system outputs no emergency braking signal, it is determined that the train meets the automatic operation condition.

3. The operation control method for a train according to claim 2, further comprising:

determining whether the train is allowed to operate in the ATO mode, and controlling the train to exit the automatic operation mode if the train is not allowed to operate in the ATO mode.

4. The operation control method for a train according to claim 3, wherein a condition for exiting the automatic operation mode comprises:

tractions to two or more of units of the train are removed,

an air brake of at least one of the units of the train is unavailable,

the train is in a speed limiting protection state,

the train is in a service braking state,

the train is in an emergency braking state,

the train is in a state that holding braking is isolated, or

a communication between the train and an automatic operation system is ineffective.

5. An operation control system for a train, comprising:

an automatic operation system, configured to control the train to operate in an automatic operation mode to perform automatic train operation;

an operation mode switching system, configured to:

determine whether the train meets an automatic operation condition, and output prompt information for indicating that the train is allowed to operate in the automatic operation mode if the train meets the automatic operation condition,

control the automatic operation system to start in a case that an ATO starting button on a driver operation platform is triggered, to control the train to operate in the automatic operation mode,

characterised in that,

the operation mode switching system is further configured to determine whether the train is located at an intermediate station and is not departed, and determine whether the train operates in the automatic operation mode if the train is not departed at the intermediate station, wherein the intermediate station is a station in a train traveling route other than a starting station and a terminal station, and

if the train is not departed at the intermediate station and operates in the automatic operation mode and if the ATO starting button is triggered by the driver, control the train in the automatic operation mode to perform station automatic departure, section automatic operation, station automatic parking, door opening protection, and train door and platform door linkage control; and

the operation control system further comprising an automatic protection system, configured to control the train to travel at a traveling speed not greater than a target speed.

6. The operation control system for a train according to claim 5, wherein for determining whether the train meets the automatic operation condition, the operation mode switching system is further configured to:

determine whether the train operates in a fully monitored mode;

determine whether a direction handle of the train is arranged forward;

determine whether a driver controller handle of the train is located at a zero position;

determine whether an automatic operation system of the train operates normally;

determine whether an automatic protection system of the train outputs an emergency braking signal; and

determine whether units of the train are allowed to operate in an ATO mode, wherein

if the train operates in the fully monitored mode, the direction handle is arranged forward, the driver controller handle is located at the zero position, the automatic operation system operates normally, and the automatic protection system outputs no emergency braking signal, it is determined that the train meets the automatic operation condition.

7. The operation control system for a train according to claim 6, wherein the operation mode switching system is further configured to:

determine whether the train is allowed to operate in the ATO mode, and control the train

to exit the automatic operation mode if the train is not allowed to operate in the ATO mode.

8. The operation control system for a train according to claim 7, wherein a condition for exiting the automatic operation mode comprises:

tractions to two or more of units of the train are removed,

an air brake of at least one of the units of the train is unavailable,

the train is in a speed limiting protection state,

the train is in a service braking state,

the train is in an emergency braking state,

the train is in a state that holding braking is isolated, or

a communication between the train and an automatic operation system is ineffective.