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(54) **SYSTEM AND METHOD FOR DIAGNSTICS AND MAINTENANCE OF AN ELEVATOR INSTALLATION**

(57) The present invention concerns an elevator installation (1) and a method for diagnosing an elevator installation (1). Elevator installation (1) comprises an elevator group controller (2), at least one input device (10) for issuing an elevator service request, a modernization overlay (4A, 4B, 4C) communicatively connected to the group controller (2) and/or to the at least one input device (10) and at least one elevator (5A, 5B, 5C) communicatively connected to the overlay (4A, 4B, 4C). The overlay (4A, 4B, 4C) is configured for transferring elevator control signals between the at least one elevator (5A, 5B, 5C)

and at least one of the group controller (2) and the at least one input device (10). The elevator installation comprises a diagnostics function (6) configured to determine an operational anomaly of the at least one elevator (5A, 5B, 5C) based on at least one control signal (7A) to be sent from the group controller (2) and/or from the at least one input device (10) to the overlay (4A, 4B, 4C) of the at least one elevator (5A, 5B, 5C) and at least one response criteria associated with the response (7B) for the at least one control signal.

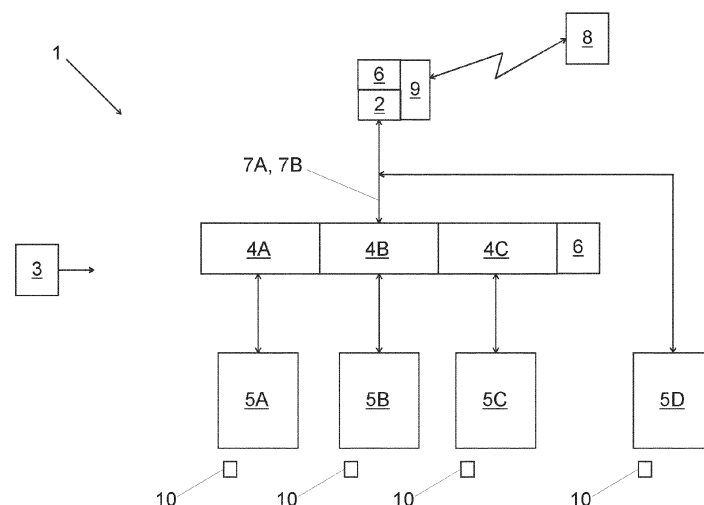


Fig. 1

Description

Field of the invention

[0001] The invention relates to solutions for diagnostics and maintenance of elevators connected to a modernization overlay.

Background

[0002] When an elevator installation of a building is being modernized, it may be composed of both modernized and still unmodernized elevators at the same time. Use of the elevators should be as smooth as possible from the viewpoint of an elevator passenger also during this transition period. Therefore, old, unmodernized elevators may be connected to the group control system of modernized elevators via an overlay to enhance operation of the elevator system.

[0003] This overlay provides a control data interface between the unmodernized elevators and the group control system. Amount of data sent to group controller via the standard overlay interface may be somewhat limited, hampering elevator service especially in case a fault or an operational anomaly of an unmodernized elevator remains unnoticed. One improvement could be to install tailored cabling and diagnostics devices directly between the unmodernized elevators and the group control system to obtain feedback of various operational anomalies. Adding new cabling and diagnostics devices to the unmodernized elevators is however difficult and laborious, and it increases overall complexity of the elevator installation.

Summary

[0004] The aim of the present invention is to solve at least partially at least one of the above-mentioned problems and / or the problems disclosed in the description below.

[0005] According to the base idea of the disclosure, an operational anomaly of an unmodernized elevator may be diagnosed based on at least one control signal issued by a call input device or by a group controller to a modernization overlay, and based on a response from an unmodernized elevator to the control signal.

[0006] In case said response doesn't fulfill a preset criteria, e.g. the response is not received at all or is not received within a given time period as expected, an operational anomaly of the unmodernized elevator may be determined. Based on the operation anomaly, or based on recurrence of operational anomalies, the faulty elevator may be taken out of group operation, e.g. such that no service requests are allocated to it by the group controller. A fault or a maintenance need of the elevator may also be issued to fix the problem and restore the elevator service. This way overall elevator service as well as diagnostics of elevators in modernization overlay may be

improved, without need to install new cabling and diagnostics devices to them.

[0007] According to a first aspect, an elevator installation is provided. Elevator installation comprises an elevator group controller; at least one input device for issuing an elevator service request; a modernization overlay communicatively connected to the group controller and/or to the at least one input device; and at least one elevator communicatively connected to the overlay. The overlay is configured for transferring elevator control signals between the at least one elevator and at least one of the group controller and the at least one input device. The elevator installation comprises a diagnostics function configured to determine an operational anomaly of the at least one elevator based on at least one elevator control signal to be sent from the group controller and/or from the at least one input device to the overlay of the at least one elevator and at least one response criteria associated with the response from the at least one elevator to the at least one control signal.

[0008] Preferably, said response is sent from the at least one elevator to the overlay of the at least one elevator.

[0009] Preferably, the elevator installation comprises at least two elevators communicatively connected to the overlay. The overlay is configured for transferring elevator control signals between the group controller and/or the at least one input device and the at least two elevators. The at least one, preferably the at least two elevators are subject of modernization of the elevator installation.

[0010] According to an embodiment, the at least one elevator control signal is one of an elevator run command, a service request and a destination call allocated to an elevator.

[0011] According to an embodiment, the at least one response criteria comprises receiving a response from the at least one elevator within a given time period from the at least one control signal, and the diagnostics function is configured to determine an operational anomaly of the at least one elevator in case a response is not received by the overlay within a given time period from issuance of the at least one control signal.

[0012] According to a preferred embodiment, the diagnostics function is configured for generating a command for taking the overlay of the at least one elevator out of elevator group operation, including cancelling the pending service requests already allocated to the at least one elevator, in case determining an operational anomaly of the at least one elevator.

[0013] According to an embodiment, the diagnostics function is configured for generating a command for restoring the overlay of the at least one elevator to elevator group operation after a specified time period from determination of the operational anomaly.

[0014] According to an embodiment, the diagnostics function comprises a counter, and the diagnostics function is configured for increasing the counter when determining an operational anomaly of the at least one elevator.

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[0015] According to an embodiment, the diagnostics function is configured for resetting the counter in case a response received by the overlay within a given time period from the at least one control signal.

[0016] According to an embodiment, the diagnostics function is configured for generating a command for taking the overlay of the at least one elevator out of elevator group operation, including cancelling the pending service requests already allocated to the at least one elevator, and issuing a fault or a maintenance request of the at least one elevator in case the counter reaches a preset threshold.

[0017] According to an embodiment, the installation comprises a communication computer configured for establishing a communication link to a remote entity external to the elevator installation. The communication computer is configured for sending information of at least one of a diagnosed operational anomaly, a fault and a maintenance request of the at least one elevator to the remote entity.

[0018] According to an embodiment, the elevator installation comprises a modernized elevator communicatively connected to the group controller in a manner bypassing the overlay.

[0019] According to a second aspect, a method for diagnosing an elevator installation is provided. The method comprises issuing a control signal by the group controller and/or by the at least one input device to an overlay of at least one elevator of the elevator installation; and determining an operational anomaly of the at least one elevator in case a response from the at least one elevator is not received by the overlay within a given time window from the at least one control signal.

[0020] According to an embodiment, taking the at least one elevator out of group operation for a specified time period when determining the operational anomaly.

[0021] The aforementioned summary, as likewise the additional features and advantages of the invention presented below, will be better understood by the aid of the following description of some embodiments, said description not limiting the scope of application of the invention.

Brief explanation of the figure

[0022] Fig. 1 schematically presents an elevator installation according to an exemplary embodiment.

[0023] For the sake of intelligibility, in fig. 1 only those features are represented which are deemed necessary for understanding the invention. Therefore, for instance, certain components / functions which are widely known to be present in the art may not be represented.

[0024] It is emphasized that identical parts or parts with the same functionality are designated by the same reference numbers in fig. 1.

[0025] Fig. 1 shows an elevator installation 1 subject to modernization. It has an elevator group controller 2

and a modernization overlay 4A, 4B, 4C communicatively connected to the group controller. The overlay 4A, 4B, 4C, as well as the group controller 2 have been installed to the elevator installation 1 at the beginning of the modernization work. Three old, unmodernized elevators 5A, 5B, 5C are communicatively connected to elevator-specific portions 4A, 4B, 4C of the overlay, respectively. The overlay 4A, 4B, 4C is configured for transferring elevator control signals between the group controller 2 and the unmodernized elevators 5A, 5B, 5C.

[0026] In the installation of Fig. 1 one of the elevators 5D has already been modernized. It has been communicatively connected to the group controller 2 directly, e.g. in a manner bypassing the overlay 4A, 4B, 4C. Alternatively, it could be connected via the overlay 4A, 4B, 4C as well.

[0027] The overlay 4A, 4B, 4C receives from input devices 10 of the elevators 5A, 5B, 5C, 5D service requests generated by elevator passengers. In group operation, said service requests are transmitted from the overlay 4A, 4B, 4C further to the group controller 2. At least some of the call input devices 10 may be so called destination call input devices. A service request issued by a destination call input device 10 is named destination call, and it contains information of both departure and arrival floors of an elevator passenger to be served.

[0028] Group controller 2 processes the received service requests by means of an optimization algorithm, which conforms a selected optimization criteria. As a result of the processing, group controller 2 allocates service requests to the elevators 5A, 5B, 5C, 5D of the elevator installation 1 such that elevator service will be optimized. For example, if selected optimization criteria is minimizing of elevator waiting times, service requests will be allocated such that overall waiting times of elevators to be minimized. Other optimization criteria may exist as well, such as minimizing energy consumption of elevator installation; co-existence of more than one optimization criteria is also possible. The aforementioned procedure is referred to as "elevator group operation" or "group operation".

[0029] Each elevator 5A, 5B, 5C, 5D takes care of servicing those service requests allocated to it, by transferring elevator passengers in elevator shaft between the landings as requested.

[0030] It is possible that elevator installation has only a single group controller 2 installed at the beginning of modernization. In some embodiments elevator installation may however have more than one group controller. For example, there may be an old group controller 3 for the unmodernized elevators 5A, 5B, 5C, working in tandem with the new group controller 2. The old group controller 3 may be connected directly to the unmodernized elevators 5A, 5B, 5C, and connected to the new group controller 2 via the modernization overlay 4A, 4B, 4C.

[0031] In some embodiments, service requests from input devices 10 are transmitted from the overlay 4A, 4B, 4C directly to the unmodernized elevators 5A, 5B, 5C,

without passing first through the to the group controller 2. In so called full collective operation or hybrid operation, car call for an unmodernized elevator 5A, 5B, 5C is registered by the user directly in an input device 10, and transmitted directly to the elevator via the overlay 4A, 4B, 4C connected to the input device 10.

[0032] Elevator installation 1 comprises a diagnostics function 6, which may be a software algorithm running in a processor of the overlay 4A, 4B, 4C. Alternatively or additionally, diagnostics function 6 may be run in the group controller 2, or in a separate edge computing unit or cloud computing unit associated with the elevator installation. Diagnostics function 6 may comprise predetermined algorithms, functions, state machines and data. Alternatively or additionally, it may comprise a self-learning portion based e.g. on artificial intelligence.

[0033] In the installation of Fig. 1, the diagnostics function 6 is configured to determine an operational anomaly of an elevator 5A, 5B, 5C based on an elevator control signal sent from the group controller 2 and/or from an input device 10 to the overlay 4A, 4B, 4C of the elevator 5A, 5B, 5C and at least one response criteria associated with the response from the elevator 5A, 5B, 5C to the control signal. The control signal may be one of an elevator run command and a service request e.g. a destination call allocated to an elevator.

[0034] An operational anomaly may be diagnosed if the response doesn't fulfill a preset criteria, for example, the response is not received at all in the overlay 4A, 4B, 4C or is not received within a given time period from the issued control signal. Response may be any suitable response or a combination of them. For example, response may be an acknowledgment signal sent from the elevator 5A, 5B, 5C back to the overlay 4A, 4B, 4C and further to the group controller 2. Response may also be a direct or indirect signal indicative of operation of the elevator. For example, if the control signal is a run command or a service request of the elevator, then the response signal may be an indication of departure of an elevator car from a floor, an arrival of the car to an expected destination floor, or opening of an expected landing door or car door; i.e. a response signal which is in line with the issued run command / service request.

[0035] After diagnosing an operational anomaly, the diagnostics function 6 generates a command to take the overlay 4A, 4B, 4C of the elevator with the operational anomaly 5A, 5B, 5C out of elevator group operation, meaning that no more service requests are allocated to said elevator 5A, 5B, 5C by the group controller 2. This may also include cancelling pending service requests already allocated to said elevator 5A, 5B, 5C. Further, no service requests will be allocated to it for a specified time period. After completion of the time period, the diagnostics function 6 will generate a command for restoring the group operation again, to find out if the operational anomaly was temporary only.

[0036] In some embodiments, the diagnostics function 6 has elevator-specific counters, each elevator 5A, 5B,

5C connected to the overlay 4A, 4B, 4C having a counter of its own. Each time an operational anomaly is determined, diagnostics function 6 increases the respective counter. In case a counter reaches a preset threshold, diagnosis function 6 generates a command to take the overlay 4A, 4B, 4C of that elevator 5A, 5B, 5C out of elevator group operation, and issues a fault or a maintenance request of said elevator 5A, 5B, 5C. It also cancels the pending service requests already allocated to the faulty elevator 5A, 5B, 5C. Group operation of the faulty elevator is not restored until inspection and maintenance operations have been performed, such that the elevator is in working order again. Therefore, overall group operation of the elevator installation 1 will be improved, as service requests will no more be allocated to faulty elevators not able to serve them.

[0037] On the other hand, if the operational anomaly was only temporary or misdiagnosed - and responses to the control signals are received as expected again - the diagnostics function 6 will reset the counter, and the group operation continues normally.

[0038] The elevator installation may comprise a communication computer 9, such as a transceiver device connected to the overlay 4A, 4B, 4C and/or to the group controller 2. The communication computer 9 may be configured for establishing a wireless or wired communication link to a remote entity 8 external to the elevator installation 1. The communication computer 9 may be configured for sending information of a diagnosed operational anomaly, a fault and/or a maintenance request of the elevators 5A, 5B, 5C to the remote entity to facilitate maintenance of the elevator installation 1. Remote entity may be, for example, a remote service center of elevators or a remote cloud system. Remote cloud system may be operable for processing information received from the elevator installation 1, as well as for determining maintenance need and/or maintenance visits and/or providing maintenance guidelines based on the processing.

[0039] It is obvious to the person skilled in the art that the invention is not limited solely to the examples described above, but that it may be varied within the scope of the claims presented below.

Claims

1. An elevator installation (1), comprising:

an elevator group controller (2);
at least one input device (10) for issuing an elevator service request;
a modernization overlay (4A, 4B, 4C) communicatively connected to the group controller (2) and/or to the at least one input device (10);
at least one elevator (5A, 5B, 5C) communicatively connected to the overlay (4A, 4B, 4C);
wherein the overlay (4A, 4B, 4C) is configured for transferring elevator control signals between

the at least one elevator (5A, 5B, 5C) and at least one of the group controller (2) and the at least one input device (10);

wherein the elevator installation comprises a diagnostics function (6) configured to determine an operational anomaly of the at least one elevator (5A, 5B, 5C) based on:

at least one elevator control signal (7A) to be sent from the group controller (2) and/or from the at least one input device (10) to the overlay (4A, 4B, 4C) of the at least one elevator (5A, 5B, 5C), and

at least one response criteria associated with the response (7B) from the at least one elevator (5A, 5B, 5C) to the at least one control signal.

2. The elevator installation according to claim 1, wherein the elevator installation comprises at least two elevators (5A, 5B, 5C) communicatively connected to the overlay (4A, 4B, 4C), and wherein the overlay (4A, 4B, 4C) is configured for transferring elevator control signals between the group controller (2) and the at least two elevators (5A, 5B, 5C).
3. The elevator installation according to any of the preceding claims, wherein the at least one elevator (5A, 5B, 5C) is subject of modernization of the elevator installation (1).
4. The elevator installation according to any of the preceding claims, wherein the at least one elevator control signal is one of an elevator run command, a service request and a destination call allocated to an elevator.
5. The elevator installation according to any of the preceding claims, wherein the at least one response criteria comprises receiving a response within a given time period from the at least one control signal; and wherein the diagnostics function (6) is configured to determine an operational anomaly of the at least one elevator (5A, 5B, 5C) in case a response is not received by the overlay (4A, 4B, 4C) within a given time period from the at least one control signal.
6. The elevator installation according to any of the preceding claims, wherein the diagnostics function (6) is configured for generating a command for taking the overlay (4A, 4B, 4C) of the at least one elevator (5A, 5B, 5C) out of elevator group operation in case determining an operational anomaly of the at least one elevator (5A, 5B, 5C).
7. The elevator installation according to claim 6, wherein the taking the overlay (4A, 4B, 4C) of the at least one elevator (5A, 5B, 5C) out of elevator group op-

eration comprises cancelling service requests allocated to the at least one elevator (5A, 5B, 5C).

8. The elevator installation according to claim 6 or 7, wherein the diagnostics function (6) is configured for generating a command for restoring the overlay (4A, 4B, 4C) of the at least one elevator (5A, 5B, 5C) to elevator group operation after a specified time period from the operational anomaly.
9. The elevator installation according to any of the preceding claims, wherein the diagnostics function (6) comprises a counter, and wherein the diagnostics function (6) is configured for increasing the counter responsive to determining an operational anomaly of the at least one elevator (5A, 5B, 5C).
10. The elevator installation according to claim 9, wherein the diagnostics function is configured for resetting the counter in case a response was received by the overlay (4A, 4B, 4C) within a given time period from the at least one control signal.
11. The elevator installation according to claim 9 or 10, wherein the diagnostics function is configured for generating a command for taking the overlay (4A, 4B, 4C) of the at least one elevator (5A, 5B, 5C) out of elevator group operation, and issuing a fault or a maintenance request of the at least one elevator (5A, 5B, 5C) in case the counter reaches a preset threshold.
12. The elevator installation according to any of the preceding claims, wherein the installation comprises a communication computer (9) configured for establishing a communication link to a remote entity (8) external to the elevator installation (1); and wherein the communication computer (9) is configured for sending information a diagnosed operational anomaly, fault and/or maintenance request of the at least one elevator (5A, 5B, 5C) to the remote entity.
13. The elevator installation according to any of the preceding claims, wherein the elevator installation comprises a modernized elevator (5D) communicatively connected to the group controller (2) in a manner bypassing the overlay (4A, 4B, 4C).
14. A method for diagnosing an elevator installation (1) comprising at least one elevator (5A, 5B, 5C), an elevator group controller (2), an input device (10) for issuing an elevator service request, and a modernization overlay (4A, 4B, 4C), the method comprising:
 - issuing (7A) an elevator control signal by the

group controller (2) and/or by the at least one input device (10) to the overlay (4A, 4B, 4C) of the at least one elevator, and

- determining an operational anomaly of the at least one elevator, in case a response (7B) from at least one elevator (5A, 5B, 5C) is not received by the overlay (4A, 4B, 4C) within a given time window from the at least one control signal.

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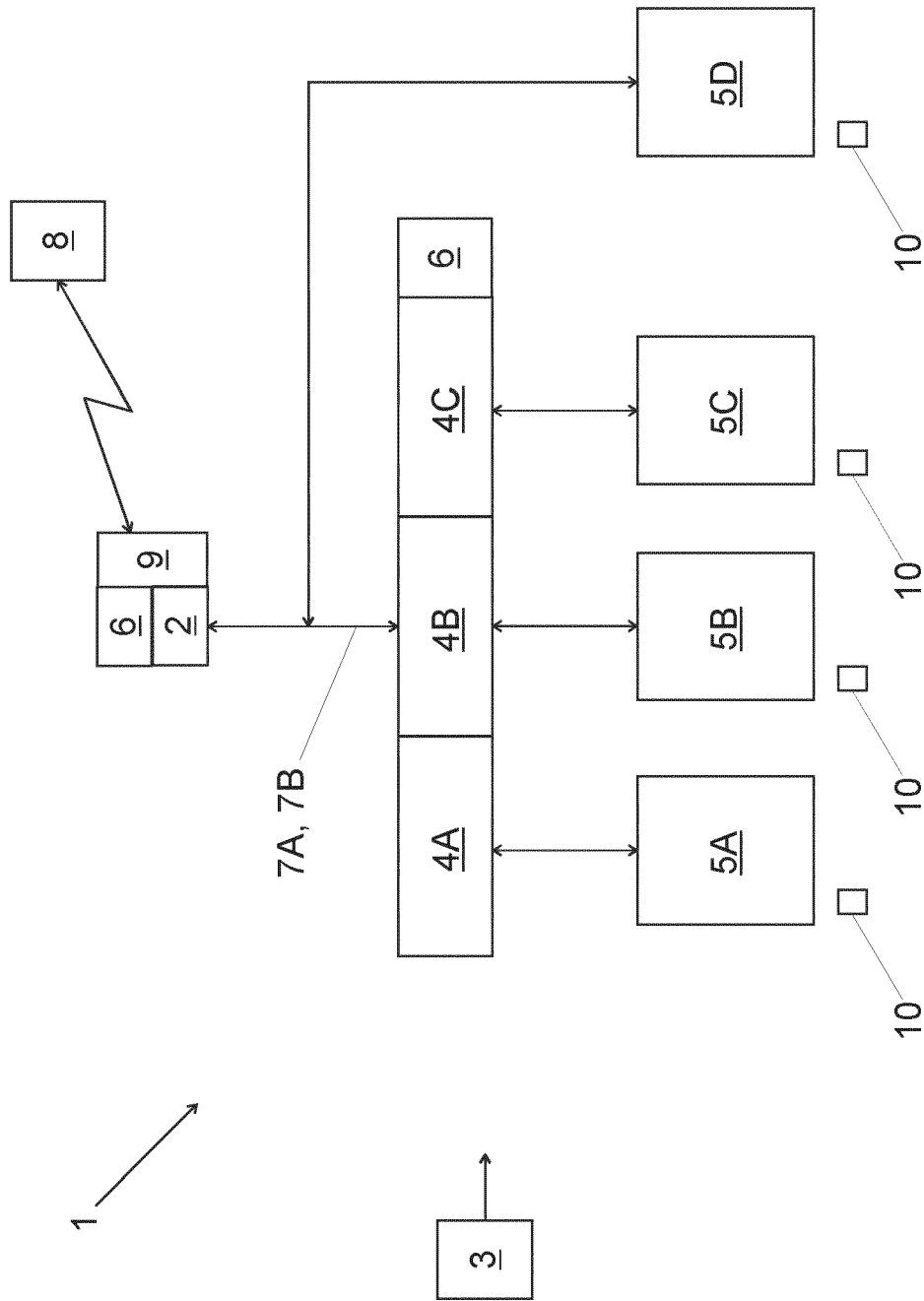


Fig. 1



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Application Number

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		27 March 2023	Lohse, Georg
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