

**Method and control system for opening and/or closing a car door of an elevator car
and a hoistway door of the elevator system**

Description

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The present invention relates to an elevator system. Furthermore, the invention relates to a method and a control system for opening and/or closing a car door of an elevator car and a hoistway door of the elevator system.

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In elevator installations, typically at least one elevator car can be moved in an elevator shaft between height levels of different floors in a building. In a frequently used type of elevator, the elevator car is held by a cable-type suspension means. The elevator car can be vertically displaced within the elevator shaft by moving the cable-type suspension means. For this purpose, the suspension means generally runs over a traction sheave,
15 which can be driven in rotation by a driving machine.

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Such an elevator car has a car door opening through which the elevator car can be entered and/or exited, and at least one car door for closing or opening the car door opening. The car doors of elevator cars are usually designed as sliding doors - for example, as telescopic
20 sliding doors. Optionally, the elevator car can have two car doors that move towards each other during the closing process and away from each other during the opening process. The elevator car also has a car door drive which is provided for moving the car door.

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Depending upon the number of floors to be reached by the elevator car, the elevator shaft has
25 two or more hoistway door openings arranged one above the other, at each of which at least one hoistway door is arranged. If the elevator car has two car doors, two hoistway doors can be arranged at each of the hoistway door openings. If the elevator car stops at the corresponding hoistway door, the car door is usually mechanically coupled to the hoistway door by means of a coupling device provided on the car door. After the coupling, both the car
30 door and the hoistway door can be opened and re-closed by the car door drive. Alternatively, it is possible to open or close both the car door and the hoistway door by means of an active door drive specially provided therefor. With this variant, a mechanical coupling that transfers the car door movement caused by the car door drive to the hoistway door is no longer necessary. Nevertheless, it must be ensured in normal operation that both the car door and the

hoistway door can perform an opening movement only when the car door is arranged at the same height as the hoistway door, in order to thereby ensure the safety of the elevator system. Furthermore, it should be advantageously ensured that the car door and the hoistway door can be coordinated, i.e., in particular, synchronously opened and/or closed.

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WO 2022/228959 A1 describes an elevator system with an elevator car which is movable in an elevator shaft, a car door arranged on the elevator car, a car door drive for closing and/or opening the car door, at least one hoistway door arranged on a door opening of the elevator shaft, a hoistway door drive for closing and/or opening the hoistway door, a car door control unit, by means of which the car door drive can be directly controlled, and a hoistway door drive, by means of which the hoistway door drive can be directly controlled. The car door control unit and the hoistway door control unit are connected to one another, preferably wirelessly, via a communication connection so that a synchronous opening and/or closing of the hoistway door and the car door is made possible. The exact positions of the hoistway door or the car door can be determined by means of an encoder that is coupled to the respective door drive. The encoder generates a position signal that is representative of the state of the respective door drive and that can be used to determine the position of the respective door. This can already produce very good results. However, in some conditions and/or elevator systems, even more precise coordination of the door opening and closing movement is desired.

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Therefore, there can be a need for an elevator system in which a car door and corresponding hoistway doors can be opened and closed as synchronously and/or uniformly as possible. There can also be a need for a method and a control system for opening and/or closing the car door and the hoistway door that contributes to the car door and a corresponding one of the hoistway doors being able to be opened and closed as synchronously and/or uniformly as possible.

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A need of this kind can be satisfied by the subject matter according to one of the independent claims. Advantageous embodiments are defined in the dependent claims and in the following description.

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According to a first aspect of the invention, a method for opening and/or closing a car door of an elevator car and a hoistway door of an elevator system is described. The elevator car

is arranged to be vertically displaceable in an elevator shaft of a building and has a car door opening for entering or exiting the elevator car and a car door for opening or closing the car door opening. The hoistway door is arranged on a floor of the building at a hoistway door opening of the elevator shaft and is designed to open or close the hoistway door opening.

5 The car door or the hoistway door is designed as a leading door, and the other of the two doors is designed as a follower door. The method involves: generating a leading control signal for opening or closing the leading door, depending upon a specified leading door travel curve, after the elevator car has arrived at the floor; generating a position signal by means of a transmitter arranged on the leading door; receiving the position signal by means of a receiver arranged on the follower door; and generating a follower control signal for opening or closing the follower door, depending upon the received position signal, so that, when the leading door moves, the follower door follows the leading door.

15 According to a second aspect of the invention, a control system for opening and/or closing a car door of an elevator car and a hoistway door of an elevator system is described. The elevator car is arranged to be vertically displaceable in an elevator shaft of a building and has a car door opening for entering or exiting the elevator car and a car door for opening or closing the car door opening. The hoistway door is arranged on a floor of the building at a hoistway door opening of the elevator shaft and is designed to open or close the hoistway door opening. The control system has: a car door control unit for controlling a car door drive for opening or closing the car door, wherein the car door drive is mechanically coupled to the car door; and a hoistway door control unit for controlling a hoistway door drive for opening or closing the hoistway door, wherein the hoistway door drive is mechanically coupled to the hoistway door. The car door or the hoistway door is designed as a leading door, and the other of the two doors is designed as a follower door, and, accordingly, the car door control unit or the hoistway door control unit is designed as a leading control unit, and the other of the two control units is designed as a follower control unit. The leading control unit is designed to generate a leading control signal for opening or closing the leading door, depending upon a specified leading door travel curve, after the elevator car has arrived at the floor. The follower control unit is designed to generate a follower control signal for the follower door drive for opening or closing the follower door, depending upon a position signal that is generated by a transmitter that is to be arranged on the leading door and is received by a receiver that is communicatively coupled to the

follower control unit and that is to be arranged on the follower door, in such a way that, when the leading door moves, the follower door follows the leading door.

5 According to a third aspect of the invention, an elevator system is described. The elevator system has: a control system according to the second aspect of the invention, the elevator car, which is arranged to be vertically displaceable in the elevator shaft of the building, which has the car door opening for entering or exiting the elevator car and which has the car door for opening or closing the car door opening; the car door drive, which is mechanically coupled to the car door; the hoistway door, which is arranged on a floor of the building at a
10 hoistway door opening of the elevator shaft and which is designed to open or close the hoistway door opening; the hoistway door drive, which is mechanically coupled to the hoistway door; wherein the car door control unit is communicatively coupled to the car door drive; and the hoistway door control unit is communicatively coupled to the hoistway door drive, wherein the car door or the hoistway door is designed as a leading door, the
15 corresponding control unit as a leading control unit, and the corresponding door drive as a leading door drive, and wherein the other of the two doors is designed as a follower door, the other of the two control units as a follower control unit, and the other of the two door drives as a follower door drive; the transmitter for generating a position signal which is arranged on the leading door and faces the follower door; the receiver for receiving the
20 position signal, which is arranged on the follower door, which faces the leading door and which is communicatively coupled to the follower control unit.

Using one of the two doors as a leading door which dictates the movement of the doors and the other of the two doors as a follower door which follows the movement of the leading door
25 makes it easy to control the two doors in such a way that the opening and closing of the two doors is perceived as synchronous and/or simultaneous by a person who uses the elevator system. This can help contribute to the person's travel experience when using the elevator system being particularly pleasant. In addition, using one of the two doors as a leading door and the other of the two doors as a follower door can easily make it possible to ensure that one
30 of the two doors is not open when the other of the two doors is closed, which can contribute to particularly high safety for the person when using the elevator system.

If the hoistway door is the leading door, the hoistway door control unit is the leading control unit, the hoistway door drive is the leading door drive, the specified travel curve

is a hoistway door travel curve, the car door is the follower door, the car door control unit is the follower control unit, and the car door drive is the follower door drive. If the car door is the leading door, the car door control unit is the leading control unit, the car door drive is the leading door drive, the specified travel curve is a car door travel curve, the hoistway door is the follower door, the hoistway door control unit is the follower control unit, and the hoistway door drive is the follower door drive.

The transmitter can, for example, be a magnet or an excitation coil, a radiation source, e.g., a light source, or a sound source, e.g., an ultrasound source, which actively generates the position signal in the form of a magnetic field, radiation, in particular light, or sound, in particular ultrasound. Accordingly, the receiver can be a Hall sensor or an induction coil, a radiation sensor, in particular a light sensor, or a microphone that receives the corresponding position signal. Alternatively thereto, the transmitter can be merely a passive transmitter, e.g., an optical marker, wherein, in this connection, the receiver can be designed as a camera, in particular as a line scan camera, by means of which a position of the optical marker can be detected.

The fact that the car door control unit is communicatively coupled to the car door drive means, for example, that the car door control unit can transmit control signals to the car door drive - for example, wirelessly or via cable. The fact that the hoistway door control unit is communicatively coupled to the hoistway door drive means, for example, that the hoistway door control unit can transmit control signals to the hoistway door drive - for example, wirelessly or via cable. The specified travel curve can be determined in advance - for example, empirically and/or by a manufacturer of the elevator system. The specified leading door travel curve can, for example, be stored on a memory unit of the leading control unit.

According to one embodiment, the transmitter is arranged on the leading door, and the receiver is arranged on the follower door in such a way that a signal strength of the received position signal is maximal when a displacement of the follower door relative to the leading door in the direction of movement of the follower door is minimal.

The direction of movement of the follower door is parallel to the direction of movement of the leading door. When the elevator car is arranged as intended, both directions of movement are aligned horizontally - in other words, level. The directions of movement

refer, for example, to closing directions of the two doors or to opening directions of the two doors, wherein the closing directions are parallel to each other and parallel to the opening directions, wherein the opening directions are parallel to each other, and wherein the closing directions are opposite to the corresponding opening directions.

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The displacement refers to the relative positions of the two doors to each other. The displacement refers, for example, to a distance between a movable, vertical outer edge of the leading door and a movable, vertical outer edge of the follower door, wherein the distance is measured parallel to the direction of movement. In this connection, the transmitter can be arranged horizontally at the same distance from the corresponding outer edge of the leading door as the receiver is arranged in the horizontal direction from the corresponding outer edge of the follower door. In this arrangement, the distance from the transmitter to the receiver is minimal when the displacement is minimal, and, when the displacement is minimal, the signal strength of the position signal is maximal. In an ideal case, the displacement is so minimal that it cannot be detected by a person who uses the elevator system without aid and/or that the opening and closing of the two doors is perceived by the person as synchronous and/or simultaneous.

According to one embodiment, the follower control unit is designed to generate the follower control signal in such a way that the displacement of the follower door relative to the leading door in the direction of movement of the two doors is minimized. For example, the follower control unit can have a control that influences the follower control signal such that the displacement is minimal. In an ideal case, the displacement is so minimal that it cannot be detected by a person who uses the elevator system without aid and/or that the opening and closing of the two doors is perceived by the person as synchronous and/or simultaneous.

According to one embodiment, the follower control unit is configured to generate the follower control signal in such a way that the signal strength of the received position signal is maximized. For example, the follower control signal can be generated in such a way that the signal strength of the received position signal is maximal at any time during the opening and/or closing of the two doors. For example, the follower control unit can have a control that influences the follower control signal such that the signal strength of the received position signal is maximal.

According to one embodiment, the follower control unit is designed to generate the follower control signal depending upon a specified follower door travel curve. The follower control signal can therefore be generated depending upon the received position signal and depending upon the specified follower door travel curve. For example, the specified follower door travel curve can be corrected depending upon the position signal, and the follower control signal can be generated based upon the corrected follower door travel curve. In other words, the specified follower door travel curve can be a kind of reference curve that roughly specifies the movement of the follower door and that is corrected based upon the position signal. The specified follower door travel curve can correspond to the specified leading door travel curve. Alternatively, the specified follower door travel curve can deviate from the specified leading door travel curve. Furthermore, a separate travel curve can be provided for each floor, in particular for each of the hoistway doors, in particular corresponding leading door travel curves or follower door travel curves, since the hoistway doors exhibit slightly different behavior due to usual tolerances when the corresponding hoistway door drives are controlled in the same way - for example, due to different friction values of the corresponding guide rails. In particular, in the case of hoistway doors as leading doors, a separate leading door travel curve can be specified for each floor, in particular for each hoistway door. Alternatively thereto, in the case of hoistway doors as follower doors, a separate follower door travel curve can be specified for each floor, in particular for each hoistway door.

According to one embodiment, the specified follower door travel curve is adapted depending upon the received position signal. For example, the specified follower door travel curve can be dynamically adapted depending upon the position signal, and the follower control signal can be generated depending upon the dynamically adapted follower door travel curve. Accordingly, in this embodiment, the follower door travel curve can remain the same over several opening and/or closing processes and can be readapted for each opening and/or closing process based upon the position signal. Alternatively thereto, the specified follower door travel curve can be adapted based upon the position signal and saved in an adapted form such that the follower door travel curve needs to be adapted less with each new opening and/or closing process. Furthermore, these two variants can be combined with each other in such a way that, for each opening and/or closing process, the follower door travel curve is first dynamically adapted based upon the position signal, the follower control signal is generated depending upon the dynamically adapted follower door

travel curve, and then this adapted follower door travel curve is stored and specified as the follower door travel curve for the next opening or closing process.

5 According to one embodiment, the follower control signal is generated in such a way that the displacement of the follower door relative to the leading door in the direction of movement of the two doors is minimized.

10 According to one embodiment, the follower control signal is generated in such a way that the signal strength of the received position signal is maximized.

According to one embodiment, the follower control signal is generated depending upon the specified follower door travel curve.

15 The leading door travel curve(s) and the follower door travel curve(s) can, for example, be stored in a memory unit of the leading control unit or of the follower control unit. The stored leading door travel curve(s) and follower door travel curve(s) can then be adapted regularly, e.g., every time, when the elevator car stops at one of the floors, and the car door and the corresponding hoistway door are opened and/or closed.

20 It should be noted that some of the possible features and advantages of the invention are described herein with reference to one of the aforementioned aspects. However, a person skilled in the art will recognize that the features can be combined, adapted, or exchanged in a suitable manner in order to arrive at further embodiments of the invention and/or to achieve further advantages, in particular across the various aspects.

25 Embodiments of the invention will be described below with reference to the accompanying drawings, wherein neither the drawings nor the description are intended to be interpreted as limiting the invention.

30 Fig. 1 is a side sectional view of an elevator system according to an embodiment of the present invention.

Fig. 2 is a sectional plan view of a car door and a hoistway door of the elevator system according to Fig. 1, according to an embodiment of the present invention.

Fig. 3 is a flowchart of an exemplary embodiment of a method for opening and/or closing a car door of an elevator car of an elevator system and a hoistway door of an elevator shaft of a building, according to an embodiment of the present invention.

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The figures are merely schematic and not to scale. Like reference signs denote like or equivalent features in the various figures.

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Fig. 1 shows a side sectional view of an elevator system 1 according to an embodiment of the present invention. The elevator system 1 is arranged in a building which has an elevator shaft 3. The elevator system 1 is designed to transport one or more persons and/or one or more loads within the building from one floor 10 to another floor 10 of the building.

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The elevator system 1 has an elevator car 5. The elevator car 5 is arranged in the elevator shaft 3 to be vertically displaceable. The elevator car 5 is mechanically coupled to a counterweight 2 of the elevator system 1 via at least one support means 4 - for example, a rope. The support means 4 can be guided between the elevator car 5 and the counterweight 2 via one or more deflection pulleys 12. The support means 4 and therefore the elevator car 5 and the counterweight 2 are movable by means of a drive machine (not shown) of the elevator system 1, whereby the vertical displacement of the elevator car 5 can be realized. The drive machine can be controlled by means of an elevator control unit 16. In the exemplary embodiment according to Figure 1, the elevator control unit 16 is arranged on the elevator car 5. However, the elevator control unit 16 can also be arranged at another location in the elevator system 1 - for example, in the region of a ceiling of the elevator shaft 3.

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The elevator car 5 serves to accommodate the person(s) and/or load(s) to be transported. The elevator car 5 has a car door opening 6 through which the people can enter or leave the elevator car 5 or through which the loads can be brought into or taken out of the elevator car 5. The elevator car 5 has a car door 7 for opening or closing the car door opening 6.

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The elevator system 1 has a car door drive 8 which is mechanically coupled to the car door 7 in such a way that the car door 7 can be moved by means of the car door drive 8, in particular can be opened or closed. Corresponding mechanical couplings are known from the prior art. The elevator system 1 has a car door control unit 14 which is communicatively coupled to the

car door drive 8 in such a way that the car door drive 8 can be controlled by means of the car door control unit 14. In particular, the car door control unit 14 is communicatively coupled to the car door drive 8 in such a way that the car door control unit 14 can transmit control signals to the car door drive 8 - for example, wirelessly or via cable.

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The elevator shaft 3 has a hoistway door opening 9 on each floor 10 to allow access to the respective floors 10 of the building from the elevator car. A hoistway door 11 is arranged at each of these hoistway door openings 9. If the elevator car 5 is located on one of the floors 10, the corresponding hoistway door 9 is arranged opposite the car door 7. When
10 the car door 7 is open and the hoistway door 11 is open, the elevator car 5 can then be entered or exited from the corresponding floor 10. Optionally, the elevator car 5 can have two car doors 7 (see Figure 2), wherein two hoistway doors 11 are arranged on each floor, each of which is assigned to one of the car doors 7. The fact that the hoistway doors 11 are assigned to the car doors 7 means, for example, that the hoistway doors 11 shall be
15 moved synchronously with the car doors 5 that are assigned to them. In other words, the doors that are assigned to each other shall be moved synchronously.

The elevator system 1 further has a hoistway door drive 13 and a hoistway door control unit 19. The hoistway door drive 13 is mechanically coupled to the hoistway door 11 in such a
20 way that the hoistway door 11 can be moved by means of the hoistway door drive 11, in particular can be opened or closed. Corresponding mechanical couplings are known from the prior art. The hoistway door control unit 19 is communicatively coupled to the hoistway door drive 13 in such a way that the hoistway door drive 13 can be controlled by means of the hoistway door control unit 19. In particular, the hoistway door control unit 19 is
25 communicatively coupled to the hoistway door drive 13 in such a way that the hoistway door control unit 19 can transmit control signals to the hoistway door drive 13 - for example, wirelessly or via cable. A control system for opening and/or closing the car door 7 and the hoistway door 11 includes the car door control unit 14 and the hoistway door control unit 19.

30 The car door 7 or the hoistway door 11 is designed as a leading door, the corresponding control unit as a leading control unit, and the corresponding door drive as a leading door drive. The other of the two doors is designed as a follower door, the other of the two control units as a follower control unit, and the other of the two door drives a follower door drive. If the hoistway door 11 is the leading door, the hoistway door

control unit 19 is the leading control unit, the hoistway door drive 13 is the leading door drive, the car door 7 is the follower door, the car door control unit 14 is the follower control unit, and the car door drive 8 is the follower door drive. If the car door 7 is the leading door, the car door control unit 14 is the leading control unit, the car door drive 8 is the leading door drive, the hoistway door 11 is the follower door, the hoistway door control unit 19 is the follower control unit, and the hoistway door drive 13 is the follower door drive.

In the exemplary embodiments described in detail in this description, it is assumed for the sake of simplicity and to avoid unnecessary repetition that the hoistway door 11 is the leading door and that the car door 7 is the follower door. However, the features and advantages described herein can be readily applied to an exemplary embodiment in which the car door 7 is the leading door and the hoistway door 11 is the follower door.

The elevator system 1 further has a transmitter 15 for generating a position signal and a receiver 17 for receiving the position signal. The transmitter 15 is arranged on the leading door, in particular the hoistway door 11, and faces the follower door, in particular the car door 7. The receiver 17 is arranged on the follower door, faces the leading door, and is communicatively coupled to the follower control unit, in particular the car door control unit 14. The leading control unit, in particular the hoistway door control unit 19, is designed to generate a leading control signal for the leading door drive, in particular the hoistway door drive 13, for opening or closing the leading door, depending upon a specified leading door travel curve, after the elevator car 5 has arrived at one of the floors 10. The follower control unit is designed to generate, depending upon the received position signal, a follower control signal for the follower door drive, in particular the car door drive 8, for opening or closing the follower door, in such a way that, when the leading door moves, the follower door follows the leading door, as explained in more detail below with reference to Figures 2 and 3.

The transmitter 15 can be arranged on the leading door, and the receiver 17 can be arranged on the follower door in such a way that a signal strength of the received position signal is maximal when a displacement of the follower door relative to the leading door in the direction of movement of the follower door is minimal (see Figure 2). The follower control unit can be designed to generate the follower control signal in such a way that the displacement of the follower door relative to the leading door in the direction of

movement of the two doors is minimized. For example, the follower control unit can have a control that influences the follower control signal such that the displacement is minimal. In an ideal case, the displacement is so minimal that it cannot be detected by a person who uses the elevator system without aid and/or that the opening and closing of the two doors is perceived by the person as synchronous and/or simultaneous.

For example, the follower control unit is designed to generate the follower control signal in such a way that the signal strength of the received position signal is maximized. For example, the follower control signal can be generated in such a way that the signal strength of the received position signal is maximal at any time during the opening and/or closing of the two doors. For example, the follower control unit can have a control that influences the follower control signal such that the signal strength of the received position signal is maximal.

The transmitter 15 can, for example, be a magnet or an excitation coil, a radiation source, e.g., a light source, or a sound source, e.g., an ultrasound source, which actively generates the position signal in the form of a magnetic field, radiation, in particular light, or sound, in particular ultrasound. Accordingly, the receiver 17 can be a Hall sensor or an induction coil, a radiation sensor, in particular a light sensor, or a microphone, which receives the corresponding position signal. Alternatively, the transmitter 15 can be merely a passive transmitter, e.g., an optical marking, wherein, in this connection, the receiver 17 can be designed as a camera, in particular as a line scan camera, by means of which a position of the optical marking can be detected.

The specified leading door travel curve can be determined in advance - for example, empirically and/or by a manufacturer of the elevator system. The specified leading door travel curve can, for example, be stored on a memory unit of the leading control unit. If the hoistway door 11 is the leading door, the specified leading door travel curve is a hoistway door travel curve. If car door 7 is the leading door, the specified leading door travel curve is a car door travel curve.

Optionally, the follower control unit can be designed to generate the follower control signal depending upon a specified follower door travel curve, at least roughly. The follower control signal can therefore be generated depending upon the received position signal and depending upon the specified follower door travel curve. For example, the

specified follower door travel curve can be corrected depending upon the position signal, and the follower control signal can be generated based upon the corrected follower door travel curve. In other words, the specified follower door travel curve can be a kind of reference curve that roughly specifies the movement of the follower door and that is corrected based upon the position signal. The specified leading door travel curve can correspond to the follower door travel curve. Alternatively, the specified leading door travel curve can differ from the specified follower door travel curve.

Fig. 2 shows a sectional plan view of the car door 7 and the hoistway door 11 of the elevator system 1 according to Figure 1, according to an embodiment of the present invention. In this exemplary embodiment, the elevator car 5 has two car doors 7 and the elevator shaft 3 has two hoistway doors 11 on each floor 10. In this case, the car doors 7 and the hoistway doors 11 of one of the floors 10, which are arranged directly next to each other, i.e., on the same side of the car door opening 6 or the hoistway door opening 9, each form a pair, wherein the doors of a pair are assigned to each other. For reasons of simplicity of illustration, the features and functions of the car doors 7 and the hoistway doors 11 and the corresponding door drives and control units mentioned in this description always refer to a pair of these doors, i.e., to one of the car doors 7 and the hoistway door 11 assigned thereto. In an alternative embodiment, the elevator car 5 can have only one of the car doors 7 and the elevator shaft 3 can have only one of the hoistway doors 11 on each floor 10 (not shown), wherein the features and functions of the car doors 7 and the hoistway doors 11 mentioned in this description can be readily transferred to this alternative embodiment.

The two car doors 7 move towards each other when the car doors 7 are closed and away from each other when the car doors 7 are opened. The two hoistway doors 11 move towards each other when the hoistway doors 11 are closed and away from each other when the hoistway doors 11 are opened. If the doors are opened, the end positions of the doors refer to the opening positions of the corresponding doors, i.e., the positions of the doors in which they are maximally open as intended. If the doors are closed, the end positions of the doors refer to the closing positions of the corresponding doors, i.e., the positions of the doors in which they are maximally closed as intended.

If the car door 7 is closed, vertical outer edges 21 of the car door 7 touch each other. If the car door 7 is opened to its maximum, the outer edges 21 of the car door 7 are at a

maximum distance from each other. If the hoistway door 11 is closed, vertical outer edges 23 of the hoistway door 11 touch each other. If the hoistway door 11 is fully open, the outer edges 21 of the hoistway door 11 are at a maximum distance from each other.

5 When opening and/or closing the doors, the doors are moved in different directions of movement. The direction of movement of the follower door is parallel to the direction of movement of the leading door. When the elevator car 5 is arranged as intended, both directions of movement are aligned horizontally - in other words, level. The directions of movement refer, for example, to closing directions 25 of the two doors or to opening
10 directions (not shown) of the two doors, wherein the closing directions are parallel to each other and parallel to the opening directions, wherein the opening directions are parallel to each other, and wherein the closing directions are opposite to the corresponding opening directions.

15 The displacement between the two doors refers to the relative positions of the two doors to each other. The displacement refers, for example, to a distance S of the movable vertical outer edge of the leading door, e.g., the outer edge 23 of the hoistway door 11, from a movable vertical outer edge of the follower door - for example, the outer edge 21 of the car door 7. In this case, the distance S is measured parallel to the direction of movement. In this
20 connection, the transmitter 15 can be arranged in the horizontal direction at the same distance from the corresponding outer edge of the leading door as the receiver 17 is arranged in the horizontal direction from the corresponding outer edge of the follower door. In this arrangement, the distance from the transmitter to the receiver is minimal when the displacement, i.e., the distance S , is minimal, and, when the displacement is minimal, the
25 signal strength of the position signal is maximal. In an ideal case, the displacement is so minimal that it cannot be detected by a person who uses the elevator system without aid and/or that the opening and closing of the two doors is perceived by the person as synchronous and/or simultaneous. In the vertical direction, the transmitters 15 and the receivers 17, in particular one of the pairs, can be arranged at the same height.

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Fig. 3 shows a flowchart of an exemplary embodiment of a method for opening and/or closing the car door 7 and the hoistway door 11, according to an embodiment of the present invention. The method can, for example, be processed by the control system.

In a step S2, the leading control signal for opening or closing the leading door is generated, depending upon the specified leading door travel curve, after the elevator car 5 has arrived at one of the floors 10.

5 In a step S4, a position signal is generated by means of the transmitter 15, which is arranged on the leading door.

In a step S6, the position signal is received by the receiver 17, which is arranged on the follower door.

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In a step S8, for example, the follower control unit generates the follower control signal for opening or closing the follower door depending upon the received position signal, so that, when the leading door moves, the follower door follows the leading door. For example, the follower control signal can be generated in such a way that the displacement of the follower door relative to the leading door in the direction of movement of the two doors, i.e., the distance S , is minimized. For example, the follower control unit can have a control that influences the follower control signal such that the signal strength of the received position signal is maximal and that, consequently, the displacement is minimal. For example, the follower control signal can be generated in such a way that the signal strength of the received position signal is maximal at any time during the opening and/or closing of the two doors. In this regard, ideally, the displacement is so minimal that it cannot be detected by a person who uses the elevator system without aid and/or that the opening and closing of the two doors is perceived by the person as synchronous and/or simultaneous.

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25 Optionally, the follower control signal can be generated depending upon the specified follower door travel curve. The follower control signal can therefore be generated depending upon the received position signal and depending upon the specified follower door travel curve. For example, the predefined follower door travel curve can be adapted depending upon the position signal, and the follower control signal can be generated based upon the adapted follower door travel curve. For example, the specified follower door travel curve can be dynamically adapted depending upon the position signal, and the follower control signal can be generated depending upon the dynamically adapted follower door travel curve. Alternatively thereto, the specified follower door travel curve can be permanently adapted based upon the position signal and saved in an adapted form such that

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the follower door travel curve needs to be adapted less with each new opening and/or closing process, and, in the case of the control, the corresponding control effort is reduced.

5 Furthermore, a separate travel curve can be provided for each floor, in particular for each of the hoistway doors, since the hoistway doors exhibit slightly different behavior due to usual tolerances when the corresponding hoistway door drives are controlled in the same way - for example, due to different friction values of the corresponding guide rails. In particular, in the case of hoistway doors as leading doors, a separate leading door travel curve can be specified for each floor, in particular for each hoistway door. Alternatively
10 thereto, in the case of hoistway doors as follower doors, a separate follower door travel curve can be specified for each floor, in particular for each hoistway door. In the latter case, the different follower door travel curves can be adapted independently of each other.

15 Finally, it should be noted that terms such as “having,” “comprising,” etc., do not exclude other elements or steps, and terms such as “a” or “an” do not exclude a plurality. Furthermore, it should be noted that features or steps which have been described with reference to one of the above exemplary embodiments may also be used in combination with other features or steps of other exemplary embodiments described above. Reference signs in the claims should not be considered to be limiting.

Claims

1. A method for opening and/or closing a car door (7) of an elevator car (5) and a hoistway door (11) of an elevator system (1), wherein the elevator car (5) is arranged to be vertically displaceable in an elevator shaft (3) of a building, and has a car door opening (6) for entering or exiting the elevator car (5) and a car door (7) for opening or closing the car door opening (6), wherein the hoistway door (11) is arranged on a floor (10) of the building at a hoistway door opening (9) of the elevator shaft (3) and is designed to open or close the hoistway door opening (9), and wherein the car door (7) or the hoistway door (11) is designed as a leading door, and the other of the two doors is designed as a follower door, the method involving:
- generating a leading control signal for opening or closing the leading door, depending upon a specified leading door travel curve, after the elevator car (5) has arrived at the floor (10);
- generating a position signal by means of a transmitter (15) which is arranged on the leading door;
- receiving the position signal by means of a receiver (17) which is arranged on the follower door; and
- generating a follower control signal to open or close the follower door depending upon the received position signal, so that, when the leading door moves, the follower door follows the leading door.
2. The method according to claim 1, wherein the follower control signal is generated in such a way that a displacement of the follower door relative to the leading door in the direction of movement (25) of the two doors is minimized.
3. The method according to any of claims 1 or 2, wherein the follower control signal is generated in such a way that the signal strength of the received position signal is maximized.
4. The method according to any of claims 1 to 3, wherein the follower control signal is generated depending upon a specified follower door travel curve.
5. The method according to claim 4, wherein

the specified follower door travel curve is adapted depending upon the received position signal.

6. A control system for opening and/or closing a car door (7) of an elevator car (5) and a hoistway door (11) of an elevator system (1), wherein the elevator car (5) is arranged to be vertically displaceable in an elevator shaft (3) of a building and has a car door opening (6) for entering or exiting the elevator car (5) and a car door (7) for opening or closing the car door opening (6), and wherein the hoistway door (11) is arranged on a floor (10) of the building at a hoistway door opening (9) of the elevator shaft (3) and is designed to open or close the hoistway door opening (9), the control system having:

- a car door control unit (14) for controlling a car door drive (8) for opening or closing the car door (7), wherein the car door drive (8) is mechanically coupled to the car door (7); and

- a hoistway door control unit (19) for controlling a hoistway door drive (13) for opening or closing the hoistway door (11), wherein the hoistway door drive (13) is mechanically coupled to the hoistway door (11), wherein

the car door (7) or the hoistway door (11) is designed as a leading door, and the other of the two doors as a follower door, and, accordingly, the car door control unit (14) or the hoistway door control unit (19) is designed as a leading control unit, and the other of the two control units as a follower control unit,

the leading control unit is designed to generate a leading control signal for opening or closing the leading door, depending upon a specified leading door travel curve, after the elevator car (5) has arrived at the floor (10), and

the follower control unit is designed to generate a follower control signal for the follower door drive for opening or closing the follower door, depending upon a position signal which is generated by a transmitter (15) to be arranged on the leading door and is received by a receiver (17) which is communicatively coupled to the follower control unit and which is to be arranged on the follower door, in such a way that, when the leading door moves, the follower door follows the leading door.

7. The control system shaft according to claim 6, wherein the follower control signal is generated in such a way that a displacement of the follower door relative to the leading door in the direction of movement (25) of the two doors is minimized.

8. The control system according to any of claims 6 or 7, wherein the follower control signal is generated in such a way that the signal strength of the received position signal is maximized.

5 9. The control system according to any of claims 6 to 8, wherein the follower control unit is designed to generate the follower control signal depending upon a specified follower door travel curve, and/or to adapt the specified follower door travel curve depending upon the received position signal.

10 10. An elevator system (1), having:

- a control system according to any of claims 6 to 9,
- the elevator car (5) which is arranged to be vertically displaceable in the elevator shaft (3) of the building, which has the car door opening (6) for entering or exiting the elevator car (5) and which has the car door (7) for opening or closing the car door opening (6);
- 15 - the car door drive (8) which is mechanically coupled to the car door (7);
- the hoistway door (11) which is arranged on a floor (10) of the building at a hoistway door opening (9) of the elevator shaft (3) and which is designed to open or close the hoistway door opening (9);
- a hoistway door drive (13) which is mechanically coupled to the hoistway door (11);
- 20 wherein the car door control unit (14) is communicatively coupled to the car door drive (8);
- and
- the hoistway door control unit (19) is communicatively coupled to the hoistway door drive (13), and
- wherein the car door (7) or the hoistway door (11) is designed as a leading door, the
- 25 corresponding control unit as a leading control unit, and the corresponding door drive as a leading door drive, and wherein the other of the two doors is designed as a follower door, the other of the two control units as a follower control unit, and the other of the two door drives as a follower door drive;
- the transmitter (15) for generating a position signal, which is arranged on the
- 30 leading door and faces the follower door;
- the receiver (17) for receiving the position signal, which is arranged on the follower door, which faces the leading door and which is communicatively coupled to the follower control unit.

11. The elevator system (1) according to claim 10, wherein
the transmitter (15) is arranged on the leading door, and the receiver (17) is arranged on
the follower door in such a way that a signal strength of the received position signal is
maximal when a displacement of the follower door relative to the leading door in the
direction of movement (25) of the follower door is minimal.

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12. The elevator system (1) according to claim 10, wherein
the follower control unit is designed to generate the follower control signal in such a way that
a displacement of the follower door relative to the leading door in the direction of movement
(25) of the two doors is minimized.

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13. The elevator system (1) according to claims 11 and 12, wherein
the follower control unit is designed to generate the follower control signal in such a way
that the signal strength of the received position signal is maximized.

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14. The elevator system (1) according to claims 10 and 13, wherein
the follower control unit is designed to generate the follower control signal depending
upon a specified follower door travel curve.

15. The elevator system (1) according to claim 14, wherein
the follower control unit is designed to adapt the specified follower door travel curve
depending upon the received position signal.

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