

Method for regulating people flow entering and exiting an enclosure, associated signaling system and car of rail vehicle equipped with such a system

The present invention relates to the field of regulating the flow of people entering and exiting an enclosure.

More specifically, the present invention relates to a method for regulating a flow of people entering and exiting an enclosure through an opening, said method comprising the following steps implemented by an electronic signaling system:

- commanding the implementation of a first signaling mode on a set of signaling device(s) positioned at least at the opening;
- triggering the switching from the first signaling mode to a second signaling mode on the set of signaling devices, the second mode being different from the first mode.

Such methods are implemented in particular in rail transport.

For example, for subway doors including interfaces (joined edges) made from rubber at which they close, it is known to position these interfaces of the lines with LEDs (Light-Emitting Diodes) turning green when the doors open, next turning white during the time when the doors are open and idle, then red shortly before they close, the red starting to blink when the closing of the doors becomes imminent.

A need remains, however, to further optimize the regulation of the entering and exiting flows in rail transport in particular, and more generally in enclosures including an opening allowing individual flows to enter and exit.

To that end, according to a first aspect, the invention proposes a method for regulating a flow of people entering and exiting an enclosure through an opening, of the aforementioned type and characterized in that it comprises a step, carried out by the electronic signaling system, of:

- measuring the flow of people exiting the enclosure through the opening;
- and in that during the step for triggering the switch from the first signaling mode to the second signaling mode, the switch from the first signaling mode to the second mode is triggered based at least on measurements taken of the flows of exiting people.

The invention thus makes it possible to control the signaling and to trigger the signaling switch in a manner adapted to the current flows, which results in better regulation of the traffic and its fluidification.

In embodiments, the method for regulating flows of people entering and exiting according to the invention further includes one or more of the following features:

- the set of signaling device(s) includes at least a first subset of signaling device(s) positioned such that the signal of said first subset is delivered across from the exiting flow of people and a second subset of signaling device(s) positioned such that the signal of said second subset is delivered across from the entering flow of people, and according to which, for at least one of the first and second signaling modes, the implementation of said mode comprises implementing a signal of a first type on the first subset and implementing a signal of a second type, different from the first type, on the second subset;
- the implementation of the first signaling mode comprises implementing the first type of signal on the first subset and implementing the second type of signal on the second subset and the implementation of the second signaling mode comprises implementing the second type of signal on the first subset and implementing the first type of signal on the second subset;
- the switch from the first signaling mode to the second is triggered based on at least one parameter determined based on said measurements from among the set of parameters comprising: a number of people exiting or entering the enclosure, their speed, their flow rate, a total number of people present in the enclosure, the proportion between exiting individuals and those beginning to enter;
- the movable enclosure is a rail vehicle car and the command implementing the first signaling mode is triggered during the opening of the doors following the arrival in the station to signal that the people wishing to exit and/or the people wishing to enter should wait; and the switch to the second signaling mode is triggered, before the closing of the doors preceding the departure from the station, the signal that the people wishing to enter should enter and/or that the people wishing to exit should wait;
- the second signaling mode comprises the display of light signals suitable for guiding individuals from their entry into the enclosure through the opening to a zone further inside the enclosure than the opening zone, in order to free the access to the enclosure.

According to a second aspect, the present invention proposes an electronic signaling system including a set of signaling device(s) positioned at least at the opening of an enclosure, said system being suitable for commanding the implementation of a first signaling mode on the set of signaling device(s) positioned at least at the opening, in order to trigger the switching from the first signaling mode to a second signaling mode on the set of signaling devices, the second mode being different from the first mode;

said system being characterized in that it is suitable for measuring the flow of people exiting the enclosure through the opening;

and for, during the step for triggering the switch from the first signaling mode to the second signaling mode, triggering said switch from the first signaling mode to the second mode based at least on measurements taken of the flows of exiting people.

In embodiments, the electronic signaling system according to the invention further includes one or more of the following features:

- the set of signaling device(s) includes at least a first subset of signaling device(s) positioned such that the signal of said first subset is delivered across from the exiting flow of people and a second subset of signaling device(s) positioned such that the signal of said second subset is delivered across from the entering flow of people, and suitable for implementing at least one of the first and second signaling modes by implementing a signal of a first type on the first subset and a signal of a second type, different from the first type, on the second subset;
- the electronic signaling system is suitable, during the implementation of the first signaling mode, for implementing the first type of signal on the first subset and implementing the second type of signal on the second subset, and suitable, during the implementation of the second signaling mode, for implementing the second type of signal on the first subset and implementing the first type of signal on the second subset;

According to a third aspect, the present invention proposes a rail vehicle car defining a movable enclosure including an opening for the entry and exit of a flow of people, said car including an electronic signaling system according to the second aspect of the invention, including a set of signaling device(s) positioned at least at the opening of the movable enclosure.

These features and advantages of the invention will appear upon reading the following description, provided solely as an example, and done in reference to the appended drawings, in which:

- figure 1 is a schematic view of a signaling system in a first embodiment of the invention;
- figure 2 is a partial view of a subway car equipped with a signaling system in one embodiment of the invention, in a signaling state during stopping in a station;
- figure 3 is a partial view of the subway car of figure 2 in another signaling state during stopping in the station;
- figure 4 schematically shows the car of figure 2 in top view;

- figure 5 shows a signaling cycle implemented during stopping in the station by a subway car in one embodiment of the invention;
- figure 6 is a flowchart of steps implemented in one embodiment of the invention.

Figure 1 shows a view of an electronic signaling system 10 in one embodiment of the invention. This signaling system 10 is suitable for controlling the signaling intended for individuals entering and exiting an enclosure through an opening.

The signaling system 10 includes a set of electronic signaling device(s) 11, an electronic control unit 12 and an electronic unit 13 for measuring flows of people.

The set of signaling device(s) 11 includes one or several signaling devices positioned at least at the opening of the enclosure whereof one wishes to regulate the entering and exiting flows, so as to be visible by the entering and/or exiting individuals.

Such signaling devices 11 are suitable for delivering a signal intended for the individuals entering and/or exiting the enclosure, using visual signals displayed on electronic display screens and/or by emitting lights of variable color and intensity and/or using sound signals emitted using speakers, etc. In the specific example described in more detail below in reference to figures 2 to 5, the signaling devices are of the light-based signal emission type.

The set of signaling device(s) 11 is suitable for operating according to several signaling modes, based on commands received from the control unit 12.

The unit for measuring flows of people 13 is suitable for detecting the people exiting the enclosure and/or for detecting the people entering the enclosure and for sending the detection information to the control unit 12 in real-time.

The control unit 12 is suitable for receiving the detection information from the measuring unit 13, processing it and extracting one or more parameters therefrom determined based on this information, to select a signaling mode from among those which can be implemented by the set of signaling device(s) 11, based on defined criteria and conditions and sending the command corresponding to the selected mode to the set of signaling device(s) 11.

The signaling device(s) 11, control unit 12 and people flow measuring unit 13 are suitable for exchanging data with one another via wired or wireless, for example radio, telecommunication links. They therefore include the corresponding telecommunication modules.

The invention will now be described in one particular embodiment applying to a subway train including cars transporting travelers.

Each of these cars 1 as shown partially in figure 2 delimits an enclosure within which the travelers are transported between the subway stations. Each car 1 includes, in a known

manner, a roof, a floor, stationary side walls and sliding doors. The doors 3, once open, delimit an opening 2 by which the people inside the car can exit the car 1 and the people on the platform outside the car 1 can enter the car 1.

The control unit 12, not shown in figure 2, is for example positioned below the floor.

5 The measuring unit 13 for example includes a set of sensor(s) suitable for detecting the passage of people. In the present case, a set 13 of two ultrasonic sensor systems is positioned in the upper part of the opening 2, so as to detect the passage of people crossing the opening 2 below the sensors, and positioned offset relative to one another along an axis Y (i.e., their orthogonal projection along the axis Y is not combined at a same point), which
10 is perpendicular to the plane of the doors. They are suitable for emitting ultrasounds every period with duration T (for example T having a value equal to the values used in the ultrasonic vehicle backup sensors) and capturing the ultrasounds in return coming from the reflection of the emitted ultrasounds, and sending the control unit 12 information relative to the emitted and captured data, in particular the times and intensities of emission and
15 capture). The control unit 12 is suitable, based on information thus received, for estimating a parameter relative to the flows of entering and/or exiting people based on this information, for example the number of people exiting the car 1. Indeed, the arrangement offset along Y of the ultrasonic sensor systems allows the control unit 12 to determine whether a person is detected as crossing the opening, and whether he is entering or exiting: if he is detected
20 first by the closest sensor system (along the axis Y) outside the car, then next by the furthest sensor system (along the axis Y) outside the car, this means that the person is entering; and on the contrary if he is detected first by the furthest sensor (along the axis Y) outside the car, then next by the closest sensor system (along the axis Y) outside the car, this means that the person is exiting. In embodiments, the control unit 12 is suitable for
25 determining, based on the received ultrasonic measurements, other parameters relative to the flow of entering people and/or the flow of exiting people: the exit speed of the people (for example averaged out of the values from the last opening of the doors), and/or the exit speed of the people (for example averaged out of the values from the last opening of the doors), the exit rate (i.e., value of the people exiting per second), a total number of people
30 located in the car (calculated based on the number of successive entries and exits over the course of the stops in the stations), and/or a number of people entering the car 1 and/or the entry speed of the people and/or the entry rate (i.e., value of people entering per second), etc.

In the embodiment considered in figure 2, the set of signaling device(s) 11 includes:

- a system of LEDs 4.1, here in the form of a ribbon, positioned on the inner face of the perimeter of the opening 2 (here the perimeter of the inner walls of the car 1 surrounding the opening inside the car 1);
- a system of LEDs 4.2, here in the form of a ribbon, positioned on the outer face

The lighted ribbons are therefore positioned, in the considered specific example, so as to surround the doors on at least three of their sides, or even four. Other embodiments are of course possible.

We will now describe the steps of the method 100 implemented by the signaling system 10 includes a set of electronic signaling device(s) 11, an electronic control unit 12 and an electronic unit for measuring flows of people 13 in reference to figure 6, as well as figures 2, 3, 4 and 5.

In a step 101, the subway train enters the station and stops. People 5 wish either to enter the car 1, or to exit the car 1.

Just before the doors of the car 1 begin to open or when they begin to open, the control unit 12 commands a first signal to all of the electronic signaling devices 11.

This first signal, intended to draw the attention of the people 5, is for example as follows: blinking (for example with a blinking frequency in a range of 1 to 2 seconds of the LEDs of the system of LEDs 4.1 and 4.2, the light emitted by the system of LEDs 4.1 being green, that of the system of LEDs 4.2 being red, as shown in figures 2 and 4 (when one is in the "illuminated" period of the blinking). In the figures, the green color is shown with dots, the red color with dashes.

The green, respectively red color, is conventionally associated with road or pedestrian signaling in particular, due to the fact that forward movement is possible, respectively prohibited, and for that reason is also used here. Other colors or signals can, however, be used, for example blue, respectively orange.

The people 5 in the car 1 see the green blinking, which tells them that it is possible to exit.

The people 5 on the platform see the red blinking, which therefore tells them that they are not allowed to enter.

The measuring unit 13 sends the collection unit 12, in real time, the information relative to the ultrasonic data sent and captured from the beginning of opening of the doors. Based on this information, the collection unit 12 updates the values of one or several parameters describing the flow of people exiting or entering the train as it goes, as previously seen: the number of people having exited the train since the doors were opened and/or the exit speed of the people (for example averaged out of the values since the last

opening of the doors), the exit rate (i.e., value of people exiting per second) and/or a number of people entering the car 1, and/or the entry speed of the people and/or entry rate.

As of complete opening of the doors of the car, the control unit 12 commands a second signal for all of the electronic signaling devices 11 (the first signal will therefore have the length of time T1 necessary for complete opening of the doors). This second signal is for example the continuous illumination of the LEDs of the LED systems 4.1 and 4.2, the light emitted by the LED system 4.1 being green, that of the LED system 4.2 being red, as shown in figures 2 and 4.

The people 5 on board the car 1 wishing to exit, who therefore have the green light from the LED system 4.1 across from them, then exit. The people 5 on the platform 6 wishing to board the car then see the red light from the LED system 4.2 across from them, and wait.

The collection unit 2 continues to update the values of the calculated parameter(s) based on ultrasonic information sent by the measuring unit 13.

This or these updated value(s) is or are further used by the collection unit 12 to verify a signal switching condition.

As long as this signal switching condition is not verified, the second signal remains implemented.

In a step 102, once the signal switching condition is verified, the collection unit 12 commands a third signal for the set of electronic signaling devices 11 (the second signal will therefore have lasted for the time T2a). This third signal is for example the continuous illumination of the LEDs of the LED systems 4.1 and 4.2, the light emitted by the LED system 4.1 being red, that of the LED system 4.2 being green, as shown in figure 3.

The people 5 on board the car 1 see the red light from the LED system 4.1: the exit is therefore indicated as henceforth not being allowed. The people 5 on the platform 6 wishing to board the car then see the green light from the LED system 4.2, which indicates that entering the vehicle is allowed.

At the end of a duration T2b, in a step 103, the collection unit 12 commands a fourth signal for the set of electronic signaling devices 11 (the third signal will therefore have lasted for the time T2b). This fourth signal, intended to draw the attention of the people 5, is for example as follows: blinking of the LEDs of the system of LEDs 4.1 and 4.2, the light emitted by the system of LEDs 4.1 and 4.2 being red, to indicate that neither entering nor exiting are henceforth allowed, and to indicate the imminent closing of the doors.

The doors close. Once the doors close, the collection unit 12 commands the stopping of the fourth signal, which will have lasted for a time T3. The train then starts again.

The durations T1 and T3 are for example fixed.

The durations T2a and T2b are variable and depend on the entering and/or exiting flows. T2a must be greater than a minimum value T2a_min and less than a maximum value T2a_max that are both set beforehand.

The sum of T2a and T2b is equal to the duration T2, which can also vary between a lower bound and an upper bound that are set by the operating rules of the subway train, and which can also depend on the time and the supposed inflow.

The signal switching condition can also depend on the parameter(s) updated by the collection unit 12 based on ultrasonic measuring information, lower and upper bounds of T2, proportions between exiting people and those beginning to enter.

In one embodiment, this switching condition is defined as follows:

- as long as the second signal duration is less than T2a_min, stay on the second signal;
- ➔ if the current second signal duration is between T2a_min and T2a_max, switch to the third signal once the rate of exiting people stays below D0 for a duration t0 (D0 and t0 being threshold values set beforehand); and
 - o once the second signal duration exceeds T2a_max, switch to the third signal if the second signal is still applied.

Another switching condition, cumulative or alternative, is for example that the switching is triggered once the ratio between people finishing exiting and those beginning to enter is low enough (i.e., drops below a predetermined threshold).

The present invention thus makes it possible to regulate the traffic by adapting the signal to the characteristics of the flow entering or exiting the car 1 to gain fluidity.

It further makes it possible to regulate traffic through separate signals intended on the one hand for people in the car, and on the other hand for people on the platform, in order to pace the entries and exits.

In one embodiment, an additional or alternative type of signal commanded by the collection unit 12 can be positioned on the ground, on the floor of the car or on the ground of the platform (such as the arrows on the ground shown in figure 4 in the direction of disembarkation so as to be able to provide a lighted image for example showing one or several arrows in one direction, for example that of exiting the car, and alternatively one or several arrows in the other direction, when entering), on the ceiling or on the side walls of the car 1, on the seats. In one embodiment, the lighted signals, for example in wave form, can further accompany the people entering the car, from the opening of the car, then draw a path in the car, to accompany them and guide them from their entry into the car to an area somewhat close to the opening (so as to reduce the bulk at the entrance of the car 1 and facilitate exchanges).

In the present case, the control unit 12 (not shown in figure 2) is on board the car. Depending on the embodiments, the set of control units for the cars of the train will be grouped together in a single module performing the functions of these control units. The module will be on board the train or located in the station depending on the embodiments.

5 In one embodiment, the control unit 12 includes a memory and a processor. The memory includes software instructions of a computer program. The processor is suitable for executing this program and executing the program implements the steps indicated above for which the control unit 12 is responsible.

10 In another embodiment, the control unit 12 is made in the form of a programmable logic component, such as an FPGA (Field Programmable Gate Array), or in the form of a dedicated integrated circuit, such as an ASIC (Application Specific Integrated Circuit).

15 In another embodiment, the ultrasonic sensors are positioned not on the upper part of the opening, but on the sides at the opening. In one embodiment, the unit for measuring the flow of people is based not on ultrasonic measurements, but on other technologies, alone or in combination, such as infrared detection, thermography or video image capture and analysis of the captured images, etc.

20 It will be noted that the switching between signaling according to the invention can be implemented based on measurements of the exiting flow, or of the entering flow, and can also be applied in embodiments where the signal in the first and/or second mode is unique and does not include one signal for the entering flow and another for the exiting flow.

25 It will be noted that the switching from the first signaling mode to the second mode, each of the two modes including a signal intended for the exiting flow different from that intended for the entering flow, can be implemented after a given time delay, without accounting for measurements of the individual flows of people entering or exiting the enclosure.

The invention has been described in an embodiment relative to a subway car. It is of course applicable to any type of rail transport car. It is also applicable to the regulation of other enclosures, movable or not, for example a bus, an elevator, cable car, carousel, monument, etc. cab.

CLAIMS

1.- A method for regulating a flow of people (5) entering and exiting an enclosure through an opening, said method comprising the following steps implemented by an electronic signaling system (10):

- commanding the implementation of a first signaling mode on a set of signaling device(s) (11) positioned at least at the opening;

- triggering the switching from the first signaling mode to a second signaling mode on the set of signaling devices, the second mode being different from the first mode;

said method being characterized in that it comprises a step, carried out by the electronic signaling system (10), of:

- measuring the flow of people exiting the enclosure through the opening;

and in that during the step for triggering the switch from the first signaling mode to the second signaling mode, the switch from the first signaling mode to the second mode is triggered based at least on measurements taken of the flows of exiting people; and according to which

the first signaling mode signals that entering is not allowed and that exiting is allowed, while the second signaling mode signals at least that entering is allowed.

2.- The method for regulating the flowing of entering and/or exiting people according to claim 1, according to which the set of signaling device(s) (11) includes at least a first subset of signaling device(s) (4.1) positioned such that the signal of said first subset is delivered across from the exiting flow of people and a second subset of signaling device(s) (4.2) positioned such that the signal of said second subset is delivered across from the entering flow of people, and according to which, for at least one of the first and second signaling modes, the implementation of said mode includes implementing a signal of a first type on the first subset and implementing a signal of a second type, different from the first type, on the second subset.

3.- The method for regulating flows of entering and exiting people according to claim 2, according to which the implementation of the first signaling mode includes implementing the first type of signal on the first subset (4.1) and implementing the second type of signal on the second subset (4.2) and the implementation of the second signaling mode includes implementing the second type of signal on the first subset and implementing the first type of signal on the second subset.

4.- The method for regulating the flow of entering and exiting people according to one of claims 1 to 3, wherein the switch from the first signaling mode to the second is triggered based on at least one parameter determined based on said measurements from among the set of parameters including: a number of people exiting or entering the enclosure, their speed, their flow rate, a total number of people present in the enclosure, the proportion between exiting individuals and those beginning to enter.

5.- The method for regulating the flow of entering and exiting people according to one of claims 1 to 4, according to which:

- the movable enclosure is a rail vehicle car (1),
- the command implementing the first signaling mode is triggered during the opening of the doors (3) following the arrival of the rail vehicle in a passenger exchange station to signal that the people wishing to exit and/or the people wishing to enter should wait; and
- the switch to the second signaling mode is triggered, before the closing of the doors preceding the departure of the rail vehicle from the passenger exchange station, the signal that the people wishing to enter should enter and/or that the people wishing to exit should wait.

6.- The method for regulating the flow of entering and exiting people according to one of claims 1 to 5, wherein the second signaling mode includes the display of light signals suitable for guiding individuals from their entry into the enclosure through the opening to a zone further inside the enclosure than a zone including the opening, in order to free the access to the enclosure.

7.- An electronic signaling system (10) including a set of signaling device(s) positioned at least at the opening of an enclosure, said system including a control unit suitable for commanding the implementation of a first signaling mode on the set of signaling device(s) (11) positioned at least at the opening, in order to trigger the switching from the first signaling mode to a second signaling mode on the set of signaling devices, the second mode being different from the first mode;

said system being characterized in that it includes means for measuring the flow of people exiting the enclosure through the opening;

and the control unit being configured for, during the step for triggering the switch from the first signaling mode to the second signaling mode, triggering said switch from the first signaling mode to the second mode based at least on measurements taken of the flows of

exiting people, the first signaling mode signaling that entering is not allowed and that exiting is allowed, while the second signaling mode signals at least that entering is allowed.

8.- The electronic signaling system (10) according to claim 7, wherein the set of signaling device(s) (11) includes at least a first subset of signaling device(s) (4.1) positioned such that the signal of said first subset is delivered across from the exiting flow of people and a second subset of signaling device(s) (4.2) positioned such that the signal of said second subset is delivered across from the entering flow of people, and wherein the control unit is configured for implementing at least one of the first and second signaling modes by implementing a signal of a first type on the first subset and a signal of a second type, different from the first type, on the second subset.

9.- The electronic signaling system (10) according to claim 8, the control unit being configured, during the implementation of the first signaling mode, for implementing the first type of signal on the first subset (4.1) and implementing the second type of signal on the second subset (4.2), and suitable, during the implementation of the second signaling mode, for implementing the second type of signal on the first subset and implementing the first type of signal on the second subset.

10. A rail vehicle car (1) defining a movable enclosure including an opening for the entry and exit of a flow of people, said car including an electronic signaling system (10) according to one of claims 7 to 9 including a set of signaling device(s) (11) positioned at least at the opening of the movable enclosure.