Research on energy-saving lighting control system of tram station based on traffic and passenger flow information

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Abstract. In order to meet the needs of passengers waiting for the trams, an energy-saving lighting control system of tram station is proposed based on the detection of illumination information, driving in and out of the station information, station passenger flow information. The system can change the lighting control module according to the different conditions of the station, so as to control the opening and brightness of the lighting source and reduce the energy waste caused by the using of the lighting source in the non-necessary period. The system realizes fully automatic lighting energy-saving control of the tram station by making full use of traffic and passenger flow information. The lighting control system can automatically switch according to its internal preset mode, reducing the operation cost of the station.

1. Introduction
In recent years, modern trams have developed rapidly in China and have been put into operation in more than ten cities. Because trams are mostly set along main roads, most of them have no separate lighting, but with the help of street lamps[1,2,4]. The tram platform has certain particularity: sometimes there will be more people waiting for the train at the platform, or even more crowded; there may be very few people waiting for the last bus. If the platforms are not installed energy-saving lighting control system, it may affect the safety of waiting passengers and will cause unnecessary waste when there are few or no people waiting for the bus. Therefore, it is urgent to propose a special lighting energy saving control system, which can automatically adjust the lighting mode according to the situation of waiting passengers and the information of the tram entering and leaving the station. The lighting control system for the tram station can give the balance of lighting and energy efficiency requirements[3–8].

2. Energy-saving lighting control system for tram stations
The energy-saving lighting control system for tram station based on traffic and passenger flow information includes information acquisition module(Tram entering and leaving detection equipment and activity personnel detection equipment ), information transmission module, lighting control module, remote lighting control module and communication module set in the control center(See figure 1). The information acquisition module is used to collect the information of passengers entering and leaving the station, illumination information and the information of trams entering and leaving the station. The information transmission module is used to transmit the information collected by the
The lighting control module controls the brightness of the lighting source according to the station illumination information transmitted by the communication module, the information of tram entering and leaving the station and the information of passengers entering and leaving the station. The illumination control module can be controlled according to the different conditions of the station, so as to control the opening and brightness of the lighting source and reduce the waste of energy caused by the opening of the lighting source in non-essential periods. And the automatic control mode further saves human resources and reduces the operation cost of the station.

3. System solutions

The energy-saving lighting control system for tram station based on traffic and passenger flow information is a kind of lighting control system for tram station that can automatically adjust the lighting mode according to the situation of passengers in the tram station and the information of tram driving (entering and leaving the station) and take into account the lighting and energy saving requirements at the same time. In order to achieve the above purposes, the system uses the information acquisition module, information transmission module and lighting control module to collect and transmit the station illumination information, tram entering and leaving station information and passenger entering and leaving station information; and controls the brightness of the lighting source according to the illumination information received, the information of entering and leaving stations of trams and the information of passengers entering and leaving stations; The system also includes a remote lighting control module and a communication module. In case of abnormal situation in the station, the normal transmission between the information transmission module and the lighting control module is interrupted. The remote lighting control module directly controls the lighting control module through the central communication module, and controls the brightness of the lighting source through the lighting control module. The fault information of the lighting source is uploaded to the remote lighting control module through the communication module.

The information acquisition module includes the illumination detector used to detect the illumination information of the station and the detection equipment used to detect the entering and leaving information of the tram. The illumination detector transmits the detected station illumination information to the illumination control module through the station illumination communication module. The information acquisition module also includes a personnel activity detection device for detecting the information of passengers entering and leaving the station. If the lighting control module
is in the closed state, the lighting source will be closed. If the lighting control module is opened, the lighting control module controls the brightness of the lighting source according to the information received from passengers entering and leaving the station.

4. Lighting control method and process based on traffic and passenger flow information

The energy-saving lighting control method for tram stations includes the following steps:

Step 1: The illumination detector is used to detect the illumination information of the station and transmitted to the lighting control module through the station illumination communication module. When the station illumination information is in the daytime mode, the lighting control module is closed. The lighting control module controls the brightness of the lighting source based on the information of tram entering and leaving the station. This control mode can ensure the automatic closing of the lighting source in the case of sufficient illumination, which saves energy and labour cost without manually control the opening and closing of the lighting source.

Step 2: start up the detection equipment of tram which is used to detect the information of tram entering and leaving station. The detected information of trams is transmitted to the lighting control module through the detection communication module. When the station illuminance information is in night mode, the lighting control module opens. The lighting control module controls the brightness of the lighting source according to the information of tram entering and leaving the station. If the communication module receives the signal from the trams to the station, the on-board and off-board lighting mode will be turned on, and the lighting source will work at full load to provide 100% illumination, so as to meet passengers' on-board and off-board requirements. When the communication module receives the signal that the tram has left the station, the station illumination is the waiting light mode, providing 30% illumination. In this process, the equipment used to detect the entrance of trams can be based on the current common tram positioning and signal control equipment, as well as a variety of detection equipment such as reading information signs, ring coil detection.

Step 3. start to detect station waiting passengers to the activities of the personnel activity detection device, lighting control module according to the information received 30% of illuminance for waiting passengers. In this detection process, the personnel activity detection equipment used to detect the information of passengers entering and leaving the station can be infrared detection equipment, camera or other equipment.

The remote lighting control module communicate with the center of the communication module in the abnormal situation of the station, such as fire, earthquake, or train fault occurs, because the normal transmission between the information transmission module and the lighting control module is interrupted. The control center directly commands the lighting control module and controls the brightness of the lighting source, for example, turn on the light source and provide 100% illumination. When the lighting source fails, the fault information of the lighting source is uploaded to the remote lighting control module through the central communication module. When the tram is not in operation, the lighting source can also be directly turned off by remote control of the lighting module.

The fault information of lighting source can be uploaded to the remote lighting control module set in the control center through the communication module for information transmission module, so as to timely discover and maintain the fault of lighting source. The brightness of the light source in the waiting mode can be 30%-60%, while the illumination in the boarding mode can be 70%-100%.

The illumination control module can be controlled according to the different conditions of the station due to the illumination detection instrument, the detection equipment for trams entering and leaving the station and the personnel activity detection device. The illumination detection equipment sets day and night modes based on the detection results. The daylight mode is defined as the mode in which natural light can meet the lighting requirements of the station. Under this mode, the lighting source in the station lighting control system is closed. Night mode is defined as a mode in which natural light cannot meet the lighting requirements of the station. In this mode, the lighting source needs to be provided by the station lighting system. In order to further save energy, according to the actual brightness of the lighting source required by the station, the night mode is divided into waiting
mode or inbound and outbound mode. Among them, the brightness of the light source in the waiting mode can be 30%, while the lighting mode of getting on and off the bus can be 100%, to avoid accidents caused by insufficient light in the process of getting on and off the bus. In this way, the opening and brightness of the lighting source can be controlled and the waste of energy caused by the opening of the lighting source in non-essential periods can be reduced.

The flowchart of specific lighting control methods for tram stations is shown in figure 2.

![Flowchart of lighting control methods for tram stations](image)

**Figure 2.** Flowchart of lighting control methods for tram stations

The mentioned above is the cooperation between modules when the lighting control system works normally. Since the lighting control mode of the station is automatic control mode, the lighting control system can automatically switch according to its internal preset mode without manual operation, which saves human costs and reduces the operation cost of the station. The remote lighting control module set in the control center can directly control the lighting control module through the center communication module, adjust the opening and brightness of the lighting source, and provide the ability to control the lighting system of the station in case of emergency. In addition, the fault information of the lighting source can be uploaded to the remote lighting control module through the communication module, so as to avoid the occurrence of the failure of the lighting source.
5. conclusion
The energy-saving lighting control system of tram station can control lighting module based on illumination information, driving in and out of the station information, station passenger flow information. It reduces the unnecessary time lighting source opening by adjusting the brightness or switch the light according to the different situation of the station. The lighting control mode of the station is an automatic control mode by making full use of traffic and passenger flow information, and the lighting control system can automatically switch according to its internal preset mode.

Acknowledgments
This paper are supported by Shanghai talent training and development fund (project number 201324) and Innovation action plan of Shanghai science and technology commission (15DZ1204300).

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