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Study of Optical Speed Gates for Railway Transportation

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Abstract: **As the backbone of the metro transport system in large cities, the passenger flow is huge, such as the Shanghai Metro, Beijing Metro daily average passenger flow in more than ten million people. Gate as a human-machine system equipment in and out of the station, switching gate frequency is high, especially during the peak period of passenger flow, the gate's operation pressure is greater, for the rapid passage of passenger flow has a certain pressure. Through the reverse thinking, it is proposed that the default state of the gate is open, and the corresponding passage signal is projected through the projection lamp to indicate whether the passengers can pass or not. By making this optimisation method into a practical demonstration model to prove the practical operability of the idea and test the ideal effect to a certain extent. This can greatly improve the passage efficiency and passenger experience, reduce the wear and tear of the equipment, prolong the life of the equipment, and at the same time, reduce energy consumption.**

Keywords: **rail transit; reverse thinking; gates; high efficiency; energy saving; humanization.**

1. INTRODUCTION

In the national call for green travel, under the impetus of technological development, driven by people's environmental awareness, convenient, fast and comfortable underground has become the first choice of many people travelling. The underground is a number of stations connected to the line as a running route, the personnel ride is also in the station, in and out of the station is dependent on the subway gate.

There are three main types of existing metro gates, namely, swing gates, wing gates and triple stick gates. These three types of gates have their own merits, but I found that they all have the same can be optimised point, due to its principle of limitation which affects the efficiency of its work.

With the increasing number of metro lines, more and more people are choosing convenient and efficient metro travel. During peak hours, the existing gates in the stations are often congested due to the limitations of the efficiency of the existing gates, if this phenomenon can be improved, it will greatly improve the efficiency of passenger traffic.

2. RAILWAY GATES

Gate, is a channel blocking device (channel management equipment), used to manage the flow of people and regulate pedestrian access, mainly used in the metro gate system, toll gate system. Its most basic and core function is to achieve only one person at a time, can be used for a variety of charges, access control occasions at the entrance channel.

The main function of the metro gate is to realise automatic ticket checking and access control, highly reflecting the quality of service and management level, which can make the management of ticketing and accounting system become more rapid and accurate, and put an end to the omission of manual ticket checking, the metro gate is used in conjunction with the AFC system, and it can realise the speedy management system aiming at the joint operation and management of the ticketing and service.

According to the different ways of controlling the movement, the gates are generally divided into three broad categories: mechanical, semi-automatic and fully automatic.

Mechanical is through the human control block body (connected with the movement) operation, mechanical limit control movement stop; semi-automatic is through the electromagnet to control the movement of the operation and stop; relative to mechanical gate, semi-automatic gate to be a little more stable, the cost of full-automatic than to be lower. Full-automatic type is through the motor to control the movement of the operation and stop; wing gate, swing gate, translation gate and so on belong to the full-automatic type gate.

Fig. 1 Mechanical

Fig. 2 Semi-automatic

Fig. 3 Fully automatic

At the entrance of the underground station are automatic ticket gate, the role is to automatically check whether the passenger's ticket is valid, divided into inbound gate and outbound gate, by the electronic recognition system to automatically identify the ticket in the relevant information is consistent with the current ride information, when the ticket surface is damaged or the ticket is expired, and the current use of the relevant information is inconsistent with the train, the gate will automatically stop the passenger out of the station, can not enter the station or exit, when the electronic recognition system found its ticket information does not match, the role and purpose is to effectively prevent passengers from evading the ticket to ride. When the electronic identification system finds that the ticket information does not match, it will immediately and automatically drop the gate, the role and purpose is to effectively prevent passengers from evading the ticket.

3. RAILWAY PHOTOELECTRIC SPEED PASS GATE MACHINE

3.1 Idea generation and programme development

Most of today's metro gates work principle is: the default state of the gate in the closed state, the passenger swipes the card, if in line with the conditions of passage, that is, the gate opens, the passenger passes, complete the passage of the gate needs to be done "a open a close" two actions. Because the gate fan door open, close each for a complete release action, the action of the implementation of the time needed, in the place of the larger passenger flow will cause congestion. And in the current underground because of the advantages of fast and convenient, become a lot of people travelling first choice, high traffic, gate opening and closing times also become more, a large number of opening and closing action will cause high intensity use of the gate, the service life of the gate will be reduced, the cost of energy consumption and maintenance frequency will be increased, no matter from the point of view of energy-saving or mechanical durability is not a small challenge.

This led to the idea of whether it was possible to achieve an optimised solution that could significantly shorten the entry and exit times, but also extend the service life and reduce energy consumption. The optimised solution was obtained through field observations and a thorough understanding of the existing gates, as well as through continuous innovation and testing.

Based on the original operating principle of the gate, through reverse thinking, it is proposed that the gate is open in the default state, and the gate is closed only when the personnel do not have the conditions for passage. And through the projection lamp cast "green arrow", "red fork" and "yellow square map" to prompt the personnel whether they have the conditions of passage, which can be the original mechanised release into electronic release. This can transform the original mechanised release into electronic release.

3.2 Significance of the programme

The successful realization of this optimization scheme can greatly shorten the time for passengers to enter and exit the station, and theoretically can improve the congestion phenomenon of the metro station during peak hours to a certain extent; due to the transformation of the mechanized release into electronic release not only improves the speed but also reduces the mechanical loss, which can greatly prolong the service life of the gate, and then indirectly reduce the maintenance cost; the

default state of the normally open with the indication of green arrows, which gives a psychological sense of welcome to the passengers. The default state of normally open with the green arrow instructions, giving people from the psychological sense of welcome, can give passengers a better sense of passage experience, conducive to the development of rail transport, service quality improvement.

4. RAILWAY PHOTOELECTRIC SPEED PASS GATE MACHINE PRINCIPLE

In order to illustrate the optimisation scheme more visually, it is illustrated by a logic schematic and a diagram of the desired effect.

4.1 Basic Logic Principles

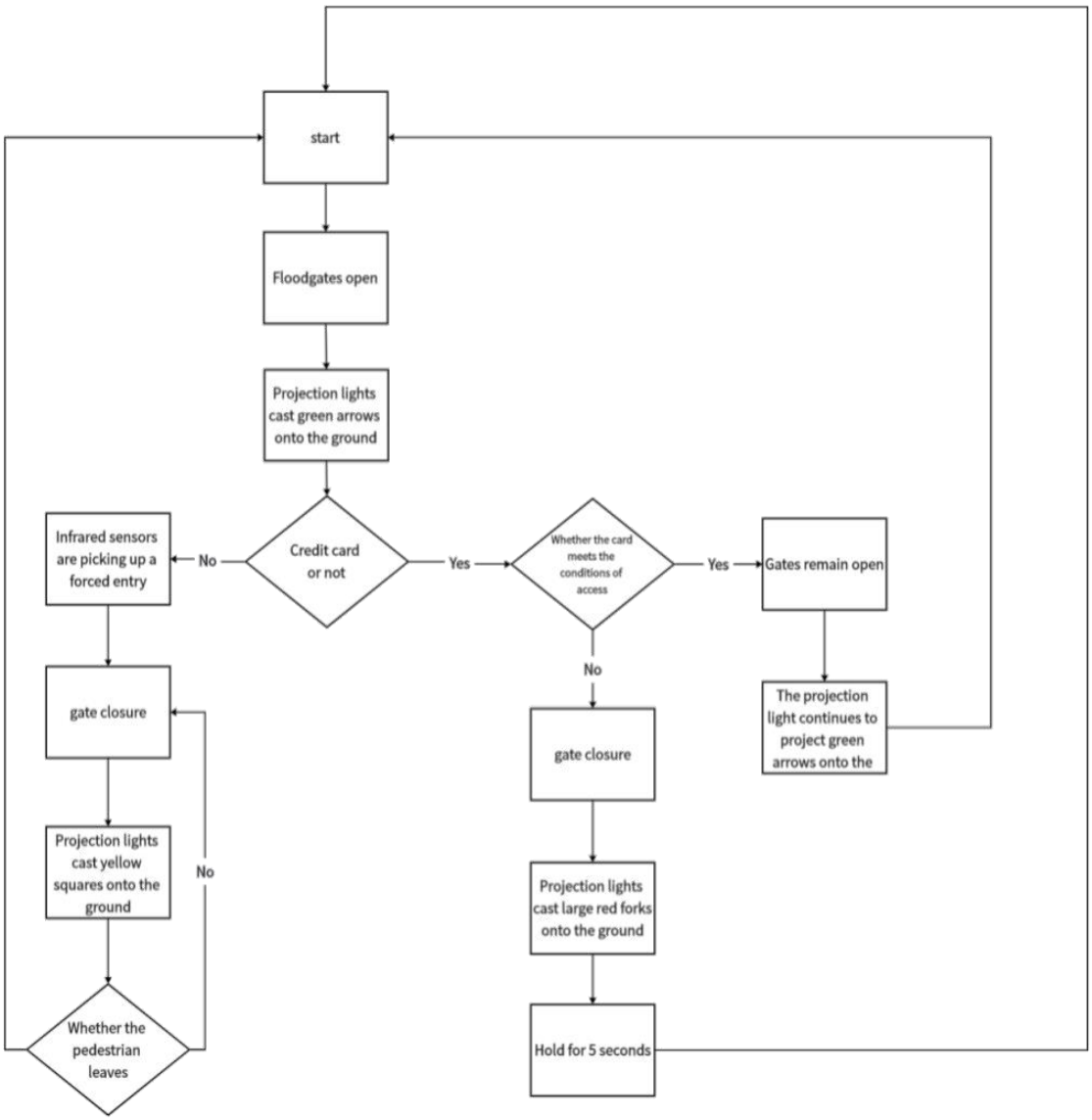

Fig. 4 Basic working logic schematic of the gate

4.2 Desirable effects

4.2.1 Accessibility

The default state of the new gate in this project is open, the projection lamp projects the green arrow pattern onto the ground inside the gate channel, if the passenger swipes the card to meet the requirements, it will continue to remain open and the projection lamp will continue to project the green arrow to signify that the passenger can pass;

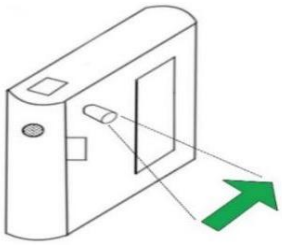

Fig. 5 Schematic diagram of gate operation in default/passable state

4.2.2 First impassable state

If the passenger's card does not meet the requirements, the gate will be closed, the projection lamp will project the red big cross pattern onto the ground inside the gate channel, and the passenger is not allowed to pass, and the default state will be restored after 5 seconds;

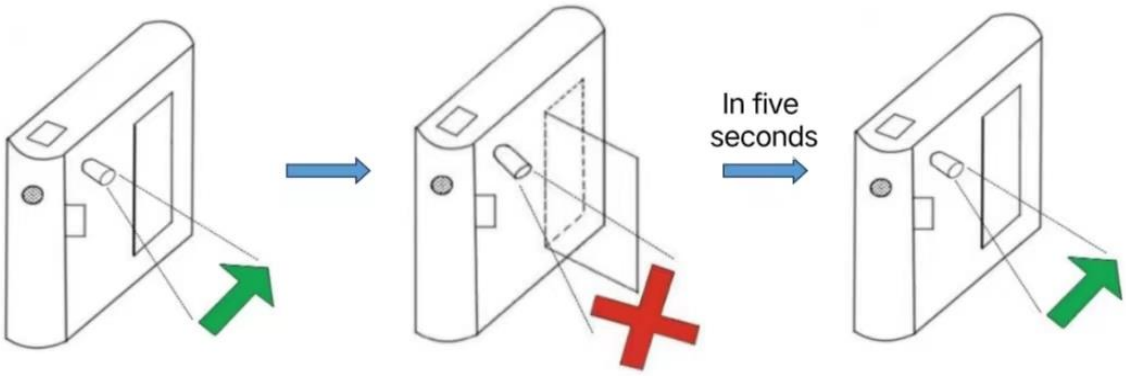

Fig. 6 Schematic diagram of the operation of the gate for passengers who swipe their cards and do not meet the conditions for access.

4.2.3 Second impassable state

If a passenger does not swipe the card and the infrared sensor senses that a person is forcing his way through, the gate closes, the projection lamp projects a yellow square pattern onto the ground inside the gate channel, and the passenger is not allowed to pass until no one is detected forcing his way through, and the gate opens to restore the default state. The action is completed by the sensor receiving information to convey the control signal.

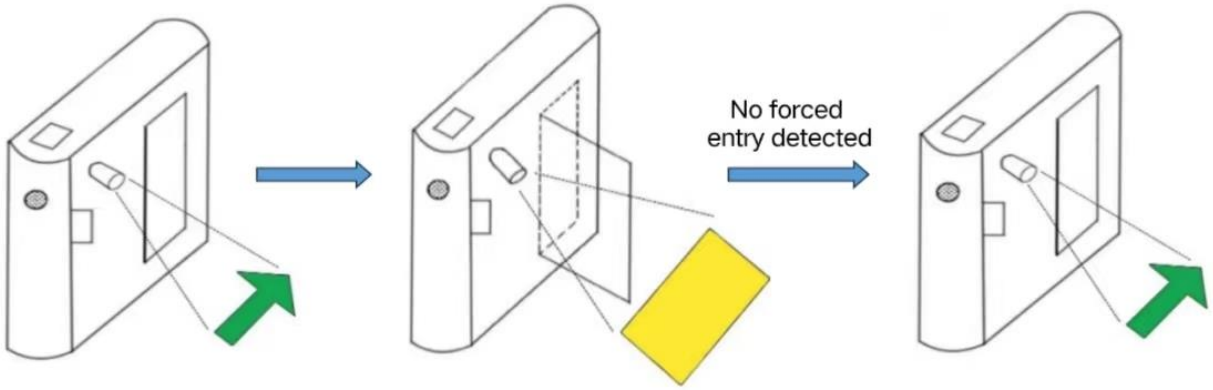

Fig. 7 Schematic diagram of the operation of the gate for passengers who have not swiped their cards.

5. DESIGN AND SIMULATION IMPLEMENTATION

The principle of optimising the gates has been described above and is now demonstrated more visually by means of a simulation implementation. This process is accomplished through modelling, and the following are the results of my design and production of the model:

5.1 Model design drawings

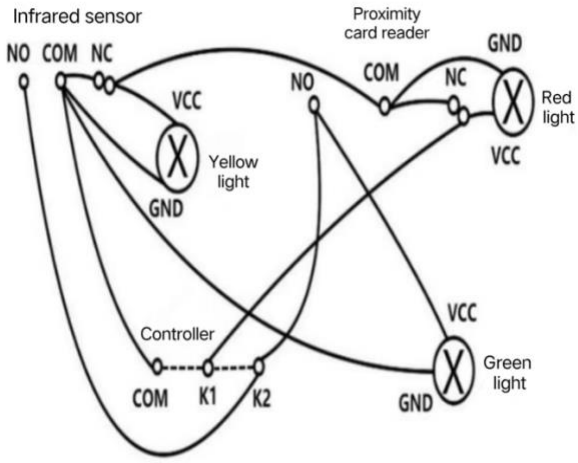

Fig. 8 Physical Wiring Diagram

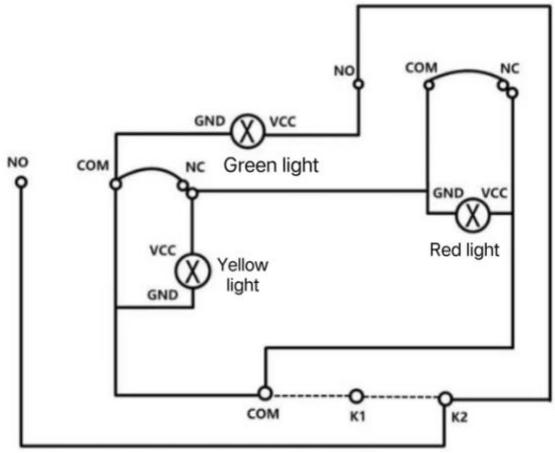

Fig. 9 Circuit Diagram

5.2 Demonstration and presentation of physical effects

By default the gate stays open and the projector lamp projects a green arrow, if the person swipes the card to meet the access requirements, the gate stays open and the projector lamp continues to project a green arrow.

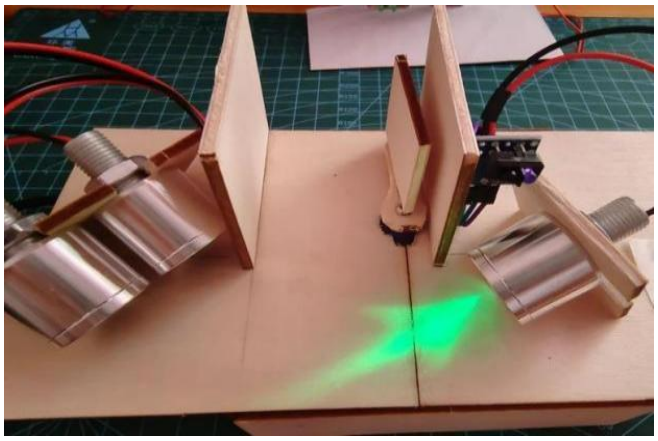

Fig. 10 Default state/compliance with access conditions effect diagram

If the passer swipes a card that does not meet the passing conditions, the gate closes, the projection lamp projects a big red cross, the passer is prohibited from passing, and the default state is restored after 5 seconds.

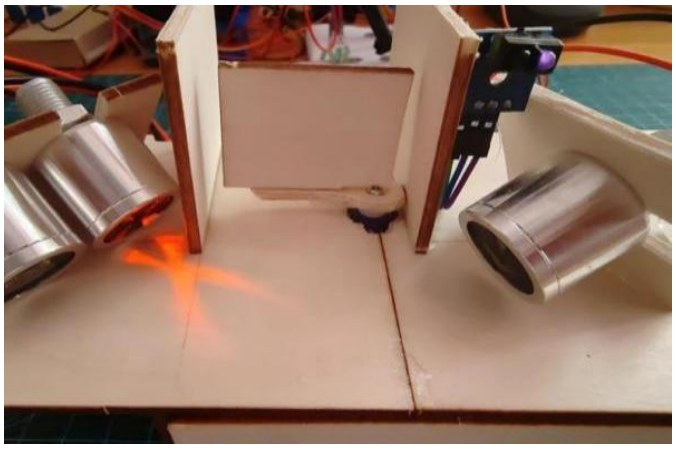

Fig. 11 Effect of non-compliance with access conditions

Passers trying to force their way through without swiping their cards will be recognised by the infrared sensors, the gate will close, the projection light will project a yellow square onto the ground, and the default state will be restored if no pedestrians are detected forcing their way through.

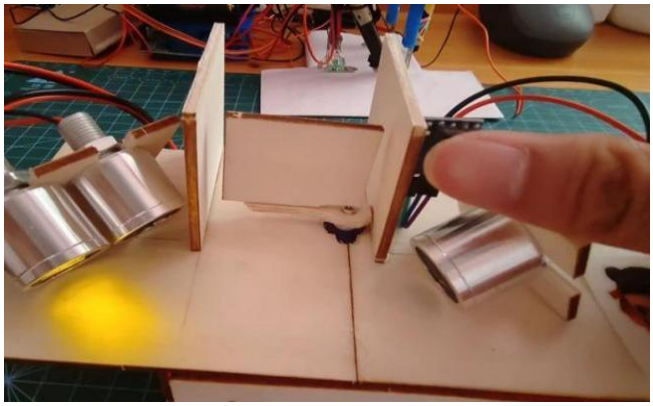

Fig. 12 Effect of not swiping the card

6. ANALYSIS AND ARGUMENTATION

Firstly, the usual process of entering the station is to swipe the card, wait for the gate to open, pass through, and the gate closes. If it is always open, passengers do not have to wait for the gate to open and can pass directly, eliminating the time of the gate opening and closing mechanical action, passengers travel more efficient. In addition, the "green arrows", "red crosses" and "yellow squares" projected by the projector lamps also provide a more intuitive visual indication of the situation.

From the aspect of equipment loss and energy consumption, because the vast majority of passengers are in line with the passage conditions, so the photoelectric gate will greatly reduce the number of times the fan door opens and closes, from the original almost non-stop open and close, into almost no open and close, can effectively reduce the loss of equipment, prolong the service life of the equipment, and increase the social benefits.

From the perspective of passenger experience, this new type of gate can give passengers a better travelling experience. The photoelectric gate is always open by default, giving people a psychological sense of welcome, meet, can pass the psychological implication, but also to a certain extent to enhance the travelling experience of passengers.

Shanghai Metro has four lines of interchange, the average daily passenger flow of 450,000 people of the Century Avenue station as an example. Assuming that the gate every pass a person open and close once then the station gate will need to open a total of 450,000 times off 450,000 times, which will have a very loss of gate, and the new gate in the opposite direction, the original gate default status closed, the new gate for the normal open, which can greatly reduce the original gate open and close the action, greatly reducing the loss of the gate. It is understood that the existing gate can pass about 35 people per minute. The new gate through a person's time is almost only consumed with the system response time and pedestrian through time, almost no mechanical action time consumption, only to calculate the average no one due to mechanical action wasted time for 0.5 seconds, then the new gate compared to the original gate can be more than an average of 14 people per minute. For the average daily passenger flow of 450,000 Century Avenue, the new gate can be released 18 million more people, the traffic efficiency will be greatly improved. Travelling efficiency is conducive to improving the quality of service, enhance the passenger experience.

7. SUMMARY AND OUTLOOK

The proposed optimisation scheme is a new type of photoelectric gate launched on the basis of the basic working principle of the original gate, mainly for the swing gate to make the optimisation, not only has the advantages of the existing swing gate, but also the photoelectric gate can make the passage more efficient, for the loss of equipment is smaller, in terms of energy saving and humane will also have a more positive contribution.

The original intention of this programme is to better solve some of the problems around the research and development, due to knowledge and technology there are still many shortcomings, in the knowledge and technology will gradually improve and optimise to make it more perfect, more practical significance.

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