

## Multifunctional Safety Pedal for Rail Transit

Yujun Pan<sup>1,a</sup>, Ningkang Zhao<sup>1</sup>, Xinjun Ying<sup>1</sup>, Zeqi Fang<sup>1</sup>, Jun Xia<sup>1</sup>, Ning Wang<sup>1</sup>,  
Jiani Pan<sup>1</sup>

<sup>1</sup>Ryan College, Wenzhou Polytechnic, Wenzhou 325035, China.

<sup>a</sup>panyujun0713@126.com

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### Abstract

The intelligent rail transit safety pedal is a pedal device used for getting on and off passengers on a rail transit platform. When the train arrives at the station, the pedal will automatically extend before the train door is opened, and will cover the gap between the train door and the platform door in a short time, which can prevent people and objects from falling. Among them, the sloping board extended by the pedals is convenient for passengers in wheelchairs, pushing strollers, and carrying luggage. It prevents passengers from accidentally jamming wheels into the gap between the door and the platform door, and also prevents passengers from taking valuables Fall into orbit. In addition to the automatic control of the central system program, the device is also equipped with a driver's local control authority and a pedal manual operation device inside the train. The pedal has platform extension angle, evacuation channel extension angle and maintenance extension angle. It is suitable for different environments. It is easy to operate and retract, which can meet market demand and is suitable for promotion.

### Keywords

Rail Transit; Multifunctional Safety Pedal; Passengers.

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### 1. Introduction

In recent years, my country's railway transportation industry has developed rapidly. According to the "Thirteenth Five-Year Development Plan for Railways", it is estimated that the national railway operating mileage will reach 150,000 kilometers in 2020, of which high-speed railway operating mileage will be 30,000 kilometers. However, with the rapid development of rail transit, many potential problems have also emerged. On May 31, 2021, a two-month-old baby in Wuhan accidentally slipped off the track when getting off because his mother did not buckle the child's stroller seat belt; October 24, 2019, Shanghai Line 8 Dashijie Station When a female passenger was riding on the platform, because she didn't pay attention to her feet on the phone, she stepped on her feet and slipped into the gap between the train and the platform... It can be seen that the gap between the platform door and the car door caused a person to be caught There is a certain safety hazard with inclusions [1]. According to the survey, the distance between the platform edge of the Shanghai Metro and the contour line of the vehicle is greater than the designed clearance requirement, and some curved station sections even reach 220mm. [2] The main problems that this gap may bring are:

- (1) Passengers stepped into the gap due to accidentally stepping on their feet when getting on and off the vehicle, causing injuries to the passengers and affecting the operation of the vehicle.
- (2) Items are stuck in the gap. When luggage, trolleys, and baby carriages get on and off, the wheels may be stuck in the gap, which may cause damage to passengers and affect the operation of the vehicle.

(3) The item falls into the track. Valuable or small items in your hand, such as mobile phones, wallets, keys, etc., may fall into the track due to squeezing and collision. It will not only bring economic losses to passengers, but also affect the normal operation of trains.

The lighter ones of the above problems cause the passengers' property loss, the more serious ones cause the passengers to be injured and affect the operation of the train. This seemingly insignificant gap hides huge hidden dangers. In order to solve this problem, an intelligent safety pedal device for passengers on and off rail transit platforms has been invented. The invention can effectively reduce the risk of people falling through the gap, and to a certain extent can ensure the personal and property safety of passengers.

## 2. Design Ideas

### 2.1 Basic ideas

The smart pedal (Figure 1) can block the track gap, so that after the train stops at the platform, it can automatically extend from the bottom of the train to fill the gap between the platform and the train, which not only ensures the gap between the vehicle boundary and the equipment boundary, It also meets the safety needs and convenience needs of passengers getting on and off the train (such as passengers pushing strollers or wheelchairs).

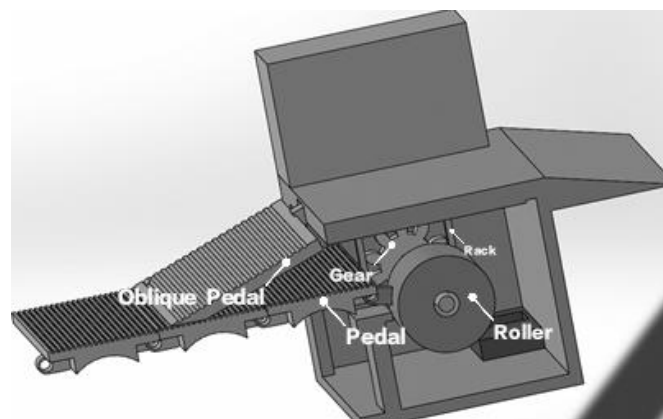


Figure 1. Schematic diagram of smart pedal device

In addition, the product also uses ultrasonic imaging to monitor the real-time status of the equipment itself, equipped with emergency power supply, remote control of the Internet of things, and precise Internet work. It is a multifunctional safety pedal that guarantees quality, safety and efficiency.

### 2.2 Principle of operation and its feasibility

Under normal conditions, after the train enters the station and stops, the train door is opened with a delay of 1-2s. At this time, the motor in the device box installed under the door starts to operate. The motor drives the round roller, and the pedal rolled up on the round roller rotates on the roller. Unfold downwards and extend to the outside of the box. The pedals are extended to the inside of the screen door. The inclined plate covering the box body is unfolded during the extension of the pedals. The inclination of the inclined plate is about  $15^{\circ} \pm 0.3^{\circ}$  (Figure 3) After the screen door is closed, the device can be rotated by the motor before the train door is closed to quickly retract the pedal to the inside of the box, and the inclined plate supported by the pedal will fall when the pedal is extended (Figure 2). The whole process is completed before the door is opened or the door is closed [4] can effectively prevent passengers from accidents caused by grabbing or grabbing.

In emergency situations, such as the loss of power to the catenary and the forced stop of the train, if the emergency power supply is available, the driver activates the emergency power supply to enable the pedal device to realize the automatic telescopic function. If the emergency power supply is not available, the pedal device cannot be automatically extended or retracted by the motor. Passengers

can deploy the pedal device by operating the hand crank device next to the door under relevant instructions. When the passenger operates the hand crank device, the roller connected by the gear rotates under the drive of the rack connected with the hand crank, so that the pedal is deployed, and the swash plate is also deployed under the extension of the pedal to realize the manual operation of the pedal device. After use, the pedal and the inclined plate can be retracted by operating the hand crank. The existence of manual operation mode can improve the utilization rate of the pedals, and can also speed up the evacuation of passengers in emergency situations to a certain extent.

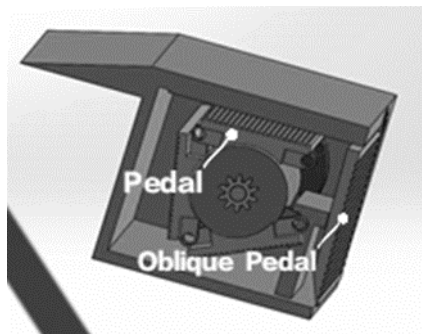


Figure 2. Pedal retracted state

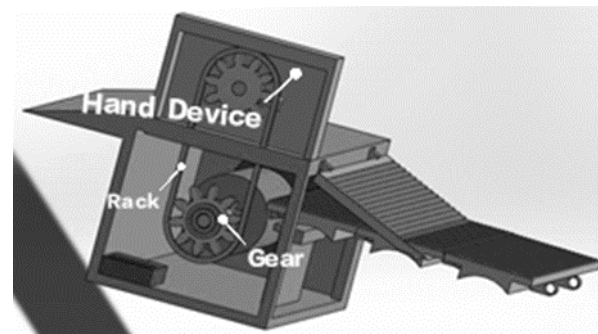


Figure 3. Pedal extended state

### 2.3 Multifunctional pedal material and processing technology

Using aluminum honeycomb panel material, using hot-press forming technology, due to the high thermal conductivity between the aluminum skin and the honeycomb, the thermal expansion and contraction of the inner and outer aluminum skins are synchronized; the honeycomb aluminum skin has small holes so that the gas in the plate can flow freely; The sliding mounting buckle system will not cause structural deformation during thermal expansion and contraction.

### 2.4 Main functions

- (1) After the train has stopped, the pedals are automatically set up between the train and the platform to allow some special people (such as pregnant women, strollers, the elderly, and disabled persons in wheelchairs) to get on/off the train safely, to a certain extent It can effectively prevent people from being caught in the gap between the train door and the platform, and prevent people from being caught in the gap from affecting the train's operation and causing train delays.
- (2) Prevent items from falling into the gap. If passengers carry valuable items, such as mobile phones, wallets, rings, watches, etc. and fall into the gap, the train operation is likely to cause some damage to these items, and at the same time, it will also cause excitement of the passengers, which will not only cause damage to the passengers' property, but also It may also affect train operation. The application of pedals solves this problem.
- (3) In an emergency state, the driver or passenger can manually deploy or extend the pedal by operating it, and it can also be used to connect the evacuation platform during evacuation within the section. If the car is forced to park in the section under an emergency situation, passengers are prone to panic and passenger pushing events are prone to occur. At this time, passengers can manually operate the pedals, which are connected to the evacuation platform, which is more conducive to the rapid and effective evacuation of passengers. It can also prevent passengers from falling into the track area due to pushing.
- (4) After the train operation ends, the vehicle is driven into the vehicle base. When washing the vehicle, the driver manually deploys the safety pedal for cleaning. The original cleaning equipment can be used for cleaning without adding additional cleaning equipment.
- (5) The pedal can be self-tested in the retracted state to detect whether its parts are aging. If it is aging, the result will be directly transmitted to the driver, and the alarm will be repaired.

### 3. Key technology and working status

#### 3.1 Technical points

(1) We use Digital ultrasonic inspection and Imaging processing system is used PC microcomputer. Real-time detection system with high-speed real-time acquisition and storage and digital imaging as the main technology. Use ultrasonic technology to detect defects in the device itself and the track. Digital ultrasonic flaw detectors usually emit ultrasound to the object to be tested. Then use its reflection, Doppler effect [3], transmission and other principles to obtain the measured object information and process it to finally form an image. Due to the difference in reflection of ultrasound when it comes into contact with different media. According to the order and amplitude of the reflected ultrasonic waves, we can determine the size and distribution of various media contained in this device, as well as the degree of contrast between the media and other information, so as to determine whether the measured object is abnormal [4].

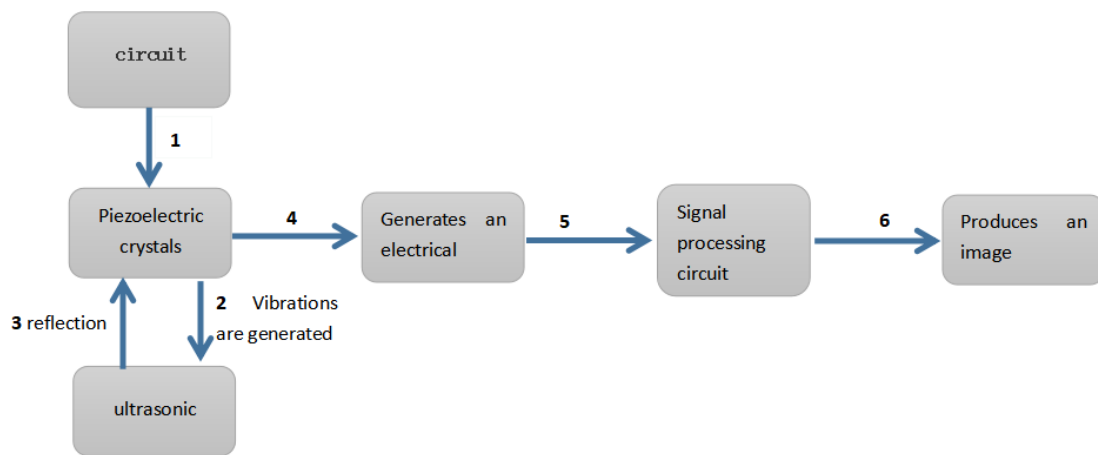


Figure 4. Principle of Ultrasonic Flaw Detection Imaging

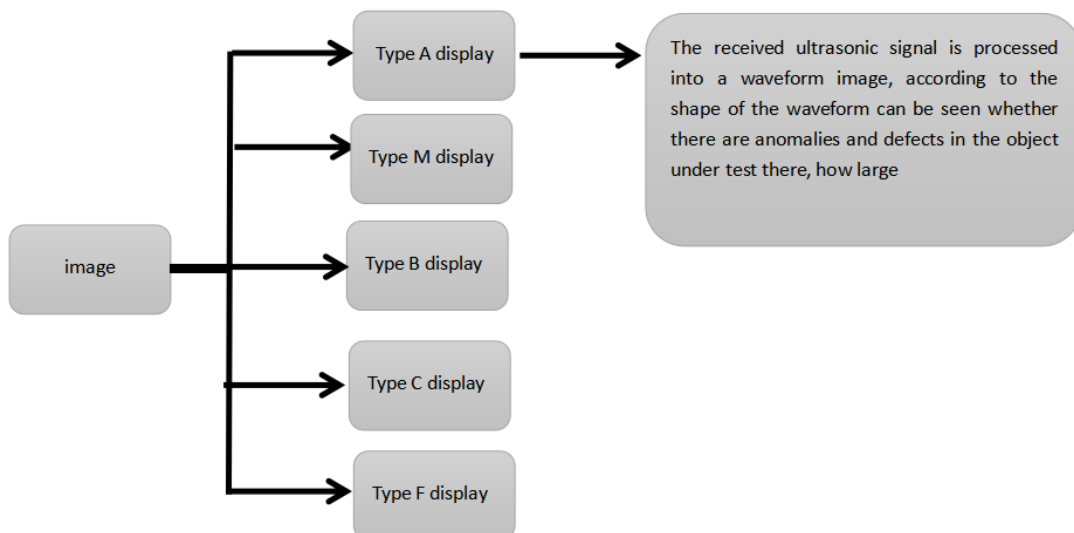


Figure 5. Ultrasound imaging classification

(2) The pedal uses high temperature resistant materials: withstand more than 120 °C

(3) The pedal structure adopts aluminum honeycomb version hot press molding technology: The panel mainly uses high-quality 3003H24 alloy aluminum plate or 5052AH14 high manganese alloy aluminum plate as the base material, The panel thickness is 0.8~1.5mm fluorocarbon roll-coated sheet

or color-resistant baking varnish. The color-resistant baking varnish is stronger than PVDF in scratch resistance, acid rain resistance and discoloration, and self-cleaning. The thickness of the bottom plate is 0.6~1.0mm, and the total thickness is 25mm.

(4) The recycling pedal uses round roller folding technology to save space.

### **3.2 Working status**

#### **3.2.1 Normal status**

When the train enters the station and stops steadily, the pedals will automatically unfold before the screen door is opened. After the screen door is closed, the pedal automatically retracts.

#### **3.2.2 Power outage**

When the train stops in the section, the driver can open the pedals by button operation, or the passengers can operate the hand-cranked device to open the pedals under the instruction of the slogan, allowing the passengers to go directly from the train to the evacuation platform. When the train stops at the platform, the driver manually opens/retracts the pedals to facilitate passengers getting on and off.

#### **3.2.3 Special situation**

If the multifunctional pedal cannot be extended or retracted in time after stopping at the platform, an alarm will be issued in time to remind the driver. The driver will extend or retract the safety pedal through a manual device in the cab, or the driver will direct the passengers to follow the prompt slogan through the broadcast Operate the manual device located at each door to deal with such emergencies in time.

## **4. Prospect Analysis**

### **4.1 Economic benefit**

First of all, starting from a lower price (or promoting the development of the urban rail industry through public welfare), we signed agreements with the most promising cities and put them into use to shorten the marketing front. After getting satisfactory feedback from passengers and rail transit staff, And then sell it to major urban rail transit companies in China, and even promote it abroad. After the product is fully mature, it can be marketed through the Internet, media promotion, and advertising.

### **4.2 Social benefit**

The multi-functional safety pedal device realizes the electrical automatic control between the retractable pedal and the platform door system, the station signal system, and the train door, which better solves the problem of the intrusion of the traditional anti-stepping measures into the boundary, and improves the operational safety and passengers. Personal safety and passenger comfort have also greatly improved the overall shape of the urban subway, accumulated rich experience for future engineering practices, and made positive contributions to the development of the rail transit industry in China and the world.

## **5. Conclusion**

The pedal can effectively prevent the problem of falling people and objects, and provide more convenient and safer services for passengers pushing wheelchairs and strollers. The communication between the equipment and the Internet terminal has a much higher operating speed than ordinary people, and it can be analyzed and performed in time. Maintenance can solve problems with quality and quantity. Compared with the ordinary pedals on the market, the multifunctional pedal has complete functions, which is convenient for passengers and relieves the work pressure of the station staff.

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