Application and Design of Guiding Equipment Based on Man-machine Interaction and the Internet of Things

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Abstract. This paper introduced basic concept of man-machine interaction, the internet of things and the medical theory, such as pathology and physiology, basis of its application in guiding equipment. Based on the analysis of demands of blind people and comparing the strongpoint and shortcoming among the common types of the guiding equipment, the design for novel intelligent guiding equipment based on man-machine interaction and multi-sensor technique was proposed. This method used multiple sense information mainly by infrared sensor and impacted sensor etc to detect obstruction and control the advancing direction of whole guiding equipment through the intellectualized judgment and processing by microprocessor to guide the blind. In addition, the principle and process of detecting method, control function, command definition, program design and debugging improvement of the guiding equipment were introduced. The practice proves the application of this intelligent guiding equipment can deal with various requirements, and the prospect of it was discussed finally.

Keywords: Internet of things, guiding equipment, man-machine interaction, detect.

1. Introduction

The blind is a special group people in our society, need the more solicitude to make them can enjoy independent living. In the daily life, safety walk is one of the important problems to the blind, so many types of blind guiding equipment based on the new technique were designed. This paper will introduce the design of novel intelligent guiding equipment based on man-machine interaction and multi-sensor technique. Man-machine interaction is a technique to study the interaction of man and computer. The user interface was always used as the medium of transferring and exchanging message between man and computer [1].

2. Medical Theory of Blind Guiding

It is necessary to apply man-machine interaction concept in designing the blind guiding equipment. Traditional man-machine interaction and figure interface depend on visual pathway, which lacks in the blind. But their trans-sensory pathway reconstruction provides a helpful theoretical evidence for this thought. After the loss of vision, the function of the blind will transfer to other senses including audition, tactile sensation or olfactory sensation to better obtain surrounding information [2]. Generally, the other senses except vision of the blind are more sensitive [3]. The infrared detecting intelligent guiding equipment was designed based on man-machine interaction to communicate with the blind by obtaining the signal of obstacles and receiving commands, especially the sense of audibility, because this sense is the most direct and efficient information for the blind.

3. Types of Blind Guiding Equipment

3.1. Electronic Guiding Equipment

It is early developed and equipped with mini electronic device and sensor. It can send information from the sensor to the blind and allow them to move safely and rapidly. However, it can only avoid local disturbance.

3.2. Mobile Robot.

It has various sensors and is equipped with control computer with high intelligentification. It can provide self-contained navigation in complex environment. With design and improvement of man-machine interface module, the mobile robot has been used to guide the blind.

3.3. Guiding Stick.

Beside a specific sensor, a microcomputer is installed in the holder of the stick, and a mobile device is added below the stick. It retains the detection sensor and control but remove the power system of the mobile robot

3.4. Wearable Guiding Equipment.

The obstruction avoidance device is worn on the blind to send avoidance command to the blind, and make the blind moves more flexibly than mobile robot [4]

3.5. Voice Guiding Equipment.

It is a novel guiding equipment to inform city direction. The mobile phone, or other mobile terminal, should support WAP. It cannot provide real-time blind guiding and is expensive [5].

Of the above-mentioned guiding equipment, some has limited function and cannot meet the requirement of the blind, some are not convenient to take along, and some are expensive and not afforded by some people [6]. Therefore, to design practical and feasible blind guiding equipment is necessary for the blind.

4. Guiding Equipment Based on Internet of Things

4.1. General Thoughts.

The multi-sensor technique was used in this intelligent guiding equipment through integrating various sensor information such as apply infrared sensor, photosensitive sensor, sound sensor, impact sensor and photoelectric encoder. The actuator used in various environment includes DC motor, buzzer, and LCD, and DC motor has a professional drive chip and sends a sound through the buzzer.

When the guiding equipment detects the obstruction, it will send the signals to the microcomputer system, and the system will send a command to stop the equipment with sound from the buzzer so as to tell the blind that there is obstruction. Through manual control designed by simulating mouse such as left and right keys or buttons or a roller, the blind can control the motion such as turning left, right, or around, accelerating, slowing down, or stopping. This design fully presents the concept of man-machine interaction and exhibits excellent practicability. The structure of this guiding equipment was shown as Fig 1.

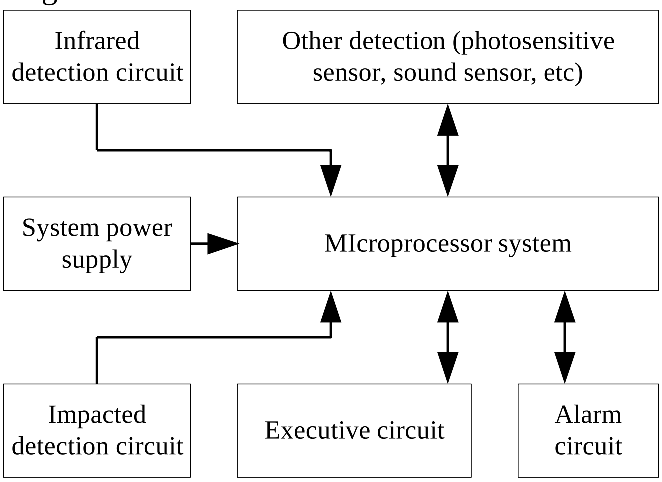

Fig 1 Structure of guiding equipment

4.2. Detection Modes.

When the blind is walking, the guiding equipment detects obstruction in front, upward, left-upward and right-upward through the infrared sensor, if there is no obstruction, it will continue to detect the front, upward, left-upward and right-upward through three impact sensors. The double-sensor detection considers various obstructions to avoid negligence of the infrared sensor due to thin, deep colored, or smooth appearance [7]. With the improvement of infrared detection technique, detector with high performance is increasingly developed, and ratio of performance and price is decreased, allowing less negligent detections; however, considering the safety of the blind, the components of impact sensor should be retain [8].

Obstructions signals detected by infrared sensor and impacted sensor is detecting an obstruction, the infrared sensor can immediately stop advancing and the buzzer sends a warning to the blind [8]. When detecting an obstruction, the impact sensor should draw back and stop, and the buzzer sends a warning to the blind. Because at that time, the guiding equipment has touched the obstruction, and the distance between the blind and the obstruction is very close, it is difficult to change direction. Considering noise may disturb the blind, a decibel detector is installed. When the sound is over 60 dB, the warning sound will be sent accompanied by trembling of the manual control [9]. This paper introduced guiding equipment with infrared sensor to detect obstruction assisted by impact sensor and detector.

4.3. Command Definition.

Command definition is very important for the whole design of the guiding equipment. Firstly, the equipment should have the performance to send enough commands to meet the demands of the blind; on the other hand, it is necessary to consider the cost, because command increase will improve the performance of control and drive chip, and the price and cost are increased. Thus, it is essential to find the balance of price and performance.

Based on the design of two keys and one roller, command definition is coded as follows. The codes of initial condition, i.e. the manual control component are not under use, are 0000; the left key is 0001, and the right key is 0110. Other primary command codes are listed in table 1. Switching set up is important with and without obstruction [10]. When the infrared sensor does not detect any obstruction, the codes can be retained, but when the infrared sensor detects obstructions, the stop command is sent and the guiding equipment is stopped.

Table 1 Coding of Command System

Object	Resting	Click	Double click	Push forward	Push backward
Left key	0000	0001	0101	/	/
Right key	0000	0010	0110	/	/
Roll	0000	0011	0111	1001	1010

Control Function.

Manual control is used to control the guiding equipment, and its design is based on the mouse, including two keys and one roller. When clicking the left key, the equipment will rotate certain degrees according to clicking times (once clicking, 15°). The least rotation degree can be adjusted by the blind, but the degree must be integer multiples of 15°, otherwise the performance requirement of the control unit will be increased and the cost is improved. Double click of the left key will result in a right angle rotation to the left, and the right key will induce a right angle rotation to the right. The roller eases the operation of forward and backward movement. In addition, downward pressure of the roller can stop, start or examine the system.

After one command is finished, the buzzer will inform the blind through the sound. Forward pressing the roller can keep advancing until detecting obstruction again. Under normal and safe advances, the blind can change direction through manual control operation. In addition, the equipment has three adjustable speed grades: slow, moderate, and rapid. People can change the speed by pressing the left and right keys simultaneously [11].

Program Design.

The program of the guiding equipment includes two parts: obstruction detection and command sending, shown as fig 2. Firstly, the program designs each variable according to command codes; then, the infrared sensor is used to detect obstruction, if no obstruction is detected, the impact sensor is used, stops and sends warning when detecting obstruction. The impact sensor is used to detect obstruction, if no obstruction is detected; the infrared sensor is used again, moves backward and sends warning when detecting obstruction. After warning, the detection can continue as above-mentioned if the blind does not send a command through the manual control component. When the command is finished, the system will be back to infrared detection. Command is finished by click pattern (click, double click, pressing) and click times.

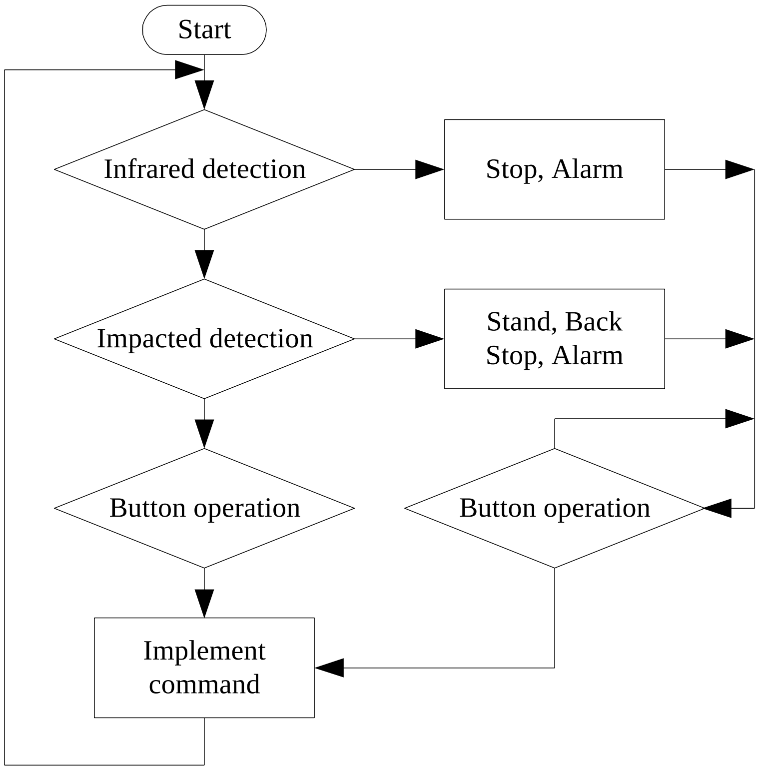

Fig 2 Flowchart of main program

5. Debugging and Improvement

There are possible some trouble during practical application. For example, the equipment may not clearly identify twice click or double click, or the equipment stops when the infrared sensor detects obstruction, but the buzzer does not send warning [12]. Most of the troubles are caused by detection of computer control over the sensor. Hardware unit and software program are two aspects to solve these trouble [13]. Prior to production in quantity, a series of trials should be carried out to simulate the troubles and avoid problems for the blind.

6. Conclusion

Based on man-machine interaction, the guiding equipment is designed with various sensors information based on the Internet of things, mainly the infrared sensor, to detect obstruction, and integrates modern computer control technique. Although there are some drawbacks and renovation, human-oriented principle and man-machine interaction will provide some useful thoughts for designing equipment for the blind or other disabled. With the development and improvement of artificial cochlea, visual prosthesis [14], and other products, the disabled person can better enjoy the life with modern technique and social support.

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