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Automatic Multiple Door Opening and Closing System

S. Sindhu[1], M. Suganya[2], V. Megala[3], R. Niranjana[4], A. Sathish Kumar[5]
[1,2,3,4]*UG Scholar, Dept. of Electronics and Communication Engg., The Kavery Engg. College, Salem, India*
[4]*Associate Professor, Dept. of Electronics and Communication Engg., The Kavery Engg. College, Salem, India*

***Abstract*: Conventional automatic door systems use fixed settings for different door parameters like opening widths, opening times, opening and closing speeds, etc. These settings generally cannot be altered by end user. If the door settings need to be changed, the end user has to call a technician to fix it. This paper proposes a new approach that allows end user to make the changes on their own through a handled device. To make the necessary changes, this device communicates with the door system, thus avoiding the needed to reprogram the entire system. This paper also introduces security mechanism to the door system using access control via RFID smart cards, and security for door user using multiple presence sensors combined. It is possible to achieve cost and energy savings during operation by minimizing the unnecessary cycles of opening due to false detections.**

***Keywords*: Automatic door system, access control, RFID, PWM, GPRS**

1. Introduction

In many places such as shopping malls, airports, office places etc., Automatic door system are installed typical automatic sliding door is as shown in Fig. 1. When one or many people are detected. These doors open automatically. If the door is installed in public spaces, the door opens for all, and if it is installed in private spaces with limited access, some form of access control mechanism is employed.

Fig. 1. Target environment

Usually, the presence sensors are placed at the top of the doors, which scans the detection region continuously.

When the system is installed at the user's space, various settings of the door such as door opening width, opening time, opening and closing speeds are fixed. If the user door settings are to be changed by the user must call a technician to make the necessary changes. Problem with this is that the user has to bear

The expenses of technician's visit, every time the door settings need to be altered.

This paper presents a smart automatic door system where users can make the changes on their own. This can be achieved by means of a handheld device which can be operated by the user, and the handheld device communicates with the automatic door system to do the necessary changes.

The rest of the paper is organized as follows. Section 2 describes overview of the system. Sections 3 and 4 describe the hardware design of the system and the software design of the system. Section 5 concludes the paper.

2. System overview

As explained in the previous section, the user can be benefitted by using a handheld device which can communicate with the door system in wireless manner.

Access control mechanism can be implemented. This can be accomplished by different techniques such as voice recognition, face recognition, iris recognition [3], password-based systems, smart cards [4], etc. We used NFC smart card based approach because it provides much less computational access control then system type recognition of voice and iris [1]. Only the users can pass through with valid and authorized cards. This is useful to keep a track of employee's attendance record within an institution [5]. The designed system is able to operate both as a public Place door (without authentication) and door (with authentication) as a private place.

Some of the conventional door systems use infrared sensors to detect a human presence, while other use Doppler Effect sensor to detect movement. Infrared sensors are unable to detect motion [2], while Doppler Effect sensor is unable to detect a person standing still. We have combined these two sensors in the designed system so that even if a person walks to a door and its right under the door frame door will not collide. Thus user's safety can be increased by combining multiple sensors together.

Power can be saved by minimizing false door opening cycles. A Doppler Effect sensor is a directional sensor, so it can detect if a person walks to walks away to a door. If the door gets less frequently opened for false detections, less frequent maintenance will be required for the drive mechanism and rollers in the door frame. Thus maintenance costs get reduced.

If the door gets frequently opened, the air conditioning facilities inside a building will be heavily burdened. So cost saving can also be achieved through cheaper electricity bills.

3. Hardware design of the system

The detailed block diagram of the system is as shown in Fig. 2.

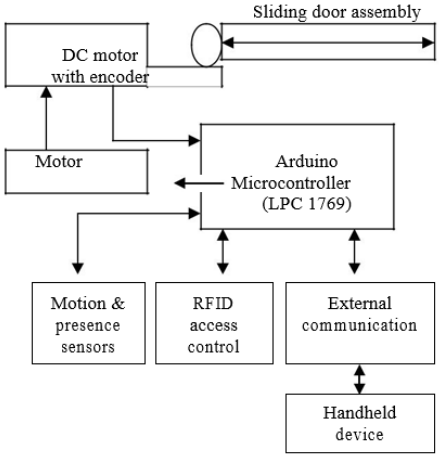

Fig. 2. Block diagram

The sliding door assembly is connected by a belt drive to the DC motor shaft. As the motor rotates, the motor shaft's circular motion is converted into linear sliding door movement. The door system positioning is detected by means of limit switches.

4. Software design of the system

The door system initially undergoes a learning procedure when powered up to analyze the length of the total track it must cover. Workflow of the learning procedure is as shown in Fig. 3. For pre decided number of iterations. The learning procedure is performed at very low door speeds. If the door does not move, by increasing the width of the PWM signal, additional power is applied to the motor drive. The encoder's feedback is observed and stored in memory.

Feedback signal received from the motor. The engine is equipped with an optical quadrature encoder mounted on its shaft to generate a feedback signal. as the motor rotates, to identical square wave signals generate a signal that is shifted by 90 degrees in phase. these two signals can be used to deduce the motors rotation direction, depending on which of the two signals leads over the other.

The microcontroller LPC 1769 has a special peripheral known as Quadrature Encoder Interface (QEI). This block can decode the quadrature encoded feedback signal from the motor, and derive the direction of rotation of the motor. The motor driver used is L298 capable of operating at 4 ampere current. The maximum DC voltage to be applied to the DC motor depends e.g. on the derived shafts total load. The motor speed control is achieved through the microcontroller – generated PWM signal.it is necessary to set the acceleration and deceleration aerates properly.as the door panels used in sliding doors are very fragile and can be broken if the door does not stop at the right time. A Doppler effect sensor and an infrared light sensor are used as a to detect a person's movement and presence. The combination of sensors makes the overall system safer.

Access control is provided through NFC smart cards. The readers at the door emit an electromagnetic radiation to read nearby NFC cards. The NFC smart cards are protected by special passwords so that only authorized card holder will be granted an entry.

A separate handheld device is designed to change the door current settings. This device communicates with the door system via GSM. A message is sent through the handheld device in a predefined format containing the desired new door settings. This handheld device is designed using 8-bit CPU 89V51RD2 microcontroller. The handheld device can also communicate through any wired protocols like I2C, SPI, etc. The device is equipped with an LCD display, matrix keypad, GPRS module, battery, and notification LEDs.

Other facilities include daily tracking of records, displaying current door status, etc. The total number of people passing through the door (in either directions), a particular person's entry and exit times (in the case of NFC smart card entry) can be stored and uploaded via GPRS to a database. This is useful to keeping a record of attendance reports at a specific institution.

The door system is also equipped with an LCD display, which is used to display the current status of the door. This includes current count of people paper through the door, time, error warnings, maintenance schedule warnings, etc.

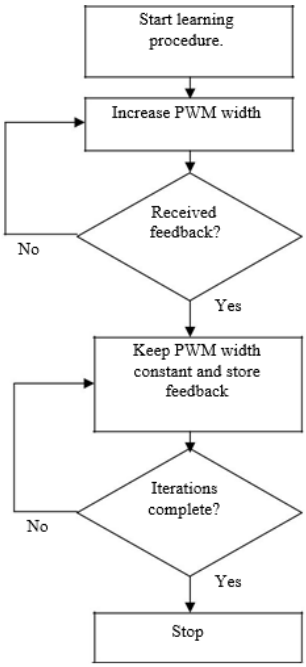

Fig. 3. Workflow of learning procedure

The system now enters a normal operation mode when the learning process is complete.

Now enters a normal operation mode. Depending on the access control status, the door opens and closes automatically after a certain time. The door will only open when a valid identify is displayed to the reader if the access control is switched on.

Control is switched off; the door will open for everyone as though it were up in a public place.

When settings of the door need to be changed, the data received through GSM module is used. The received message, in a predefined format, contains new settings of the door.

5. Conclusion

The system designed is safer, efficient and easy to be adjusted. The main advantage is that the end user can do the settings by himself. This saves large amounts of time and money. The new settings can be sent via GSM that is not restricted by the distance of the handheld device from the door system. The conventional system is made safer by combining multiple sensors together. This overcomes the possible danger of colliding of door with a person standing beneath the door frame. Energy and maintenance costs can be saved by minimizing false opening cycles.

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