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Smart Shoe Rack with Face Recognition

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Abstract

The Smart Shoe Rack with face recognition is most likely one of the newest projects to have been introduced of its kind. In a Hindu country, temples are almost everywhere, inside the valley as well as outside, where one has to take off his footwear before entering. One of the most common yet overlooked problems is shoe misplacement in crowded temple areas. Therefore, to sort out this major problem, the idea of a Smart Shoe Keeping with face recognition has been proposed in this paper. By the use of microcontrollers, raspberry pi captures face encoding of a person and along with adjusting stepper motors, the shoe can be stacked at one of the sixteen different locations. The use of a clock helps in determining the stepper position at every instance. With face recognition technology, the shoes can be fetched. Once the face is recognized, it is matched with the previously captured person, and the system checks for the available shoe. The position of the stepper is then identified, and the shoe is fetched through the shortest path possible by the step anti/clockwise rotation of the stepper motor. The total time of storage of the footwear displayed in the LCD is then used for charging the amount of money accordingly.

Keywords: Recognition, microcontrollers, stepper motors, LCD, raspberry pi

1. Introduction

The idea of the Smart Shoe keeping with face recognition is to help minimise the risk of getting one's shoe misplaced while in a temple, as this has been one of the most overlooked and unresolved issues faced by most of the people in Nepal. In this project, the shoes are collected by the system using face recognition technology and are kept safely. The developed prototype is able to hold and store a total of 16 pairs of shoes. They will be stored and locked inside the system and can be fetched upon the system recognizing the client's face. With the help of RTC, the time when the shoe is placed shall be noted down which will

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be subtracted from the time when the shoe is fetched back, so that the time will be recorded accordingly, and the generated amount will be shown in the LCD display which the person can pay.

2. Related Work

There are several approaches found in the literature study and that have been discussed in this section. Smart shoe keeping system is related to the door unlock system with face recognition were proposed in papers [1-4]. The attendance system using a face recognition project in python were illustrated in articles [5-8]. Door unlock system with face recognition involves three phases. In the first phase, the samples of images that are authorised to open the door are collected and in second phase, the collected face samples are trained and at the final phase, the trainer data is considered to recognize the faces. When raspberry pi identifies a face, it allows the door lock to open. Face recognition system technology is developing rapidly and is widely used in many aspects [9-11]. A facial recognition system is a technique used to identify a human face from a video or image by comparting it over the closeness of the given database [12, 13]. Applying a face recognition system in the smart shoe keeping makes the systematic way of managing the shoes.

3. Material and Methods

3.1 Hardware and software requirement

The raspberry pi board is the main module of the whole embedded system that includes image capturing and processing system. Other hardware components used are Arduino uno, stepper motor, DC motor, motor driver, LCD, IR sensor. For software IDE, Arduino IDE, Virtual Network Computing, and Raspberry Pi OS are used.

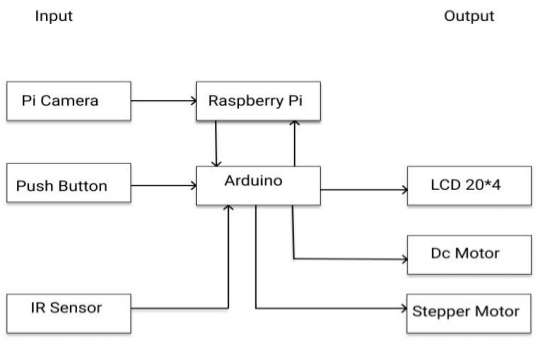

Figure 1. Block diagram of the system

Pi camera captures the image of a person and stores face encoding in raspberry pi storage. Raspberry pi and Arduino are synchronised so that data transfer takes place. Push button is clicked for keeping and taking shoes. The IR sensor detects the empty slot for keeping shoes. DC motor is used for opening and closing doors for fetching shoes. Stepper motor rotates based on the location of the shoes. LCD displays interactive messages about the working of the system.

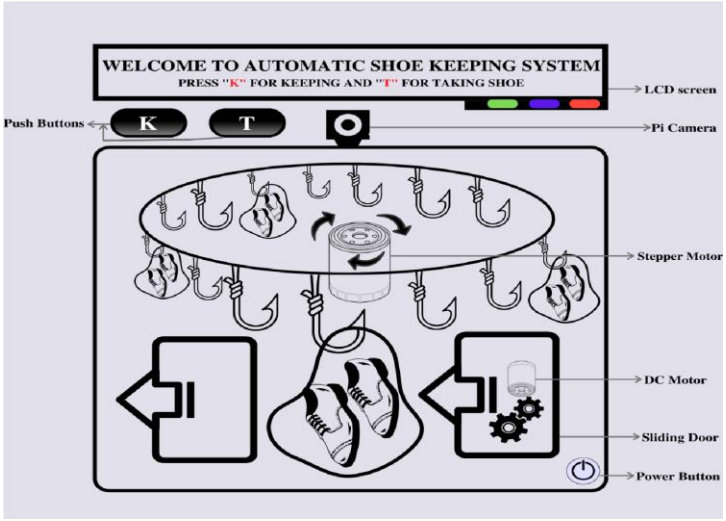

Figure 2. Overview of the system working

3.2 Methodology

Firstly, a person walks by and presses the “K” button to keep his shoe into the system. The system then shifts to the shoe keeping menu where he will again have to press the “K” button after placing his shoe onto the hook. Then, the pi camera captures the owner’s image and stores it to compare during the process of shoe fetching. Along with that, the stepper motor is also rotated by 22.5 degree. Now to get back his shoe, he/she must face towards the camera after pressing the “T” button. If any of the stored image matches with the current input face, the stepper rotates and delivers the shoe taken from the same slot by rotating along the shortest direction possible. All the interactive messages are displayed on the LCD screen. Time of storing the shoes is stored on the system and accordingly the amount to be paid is calculated.

3.2.1 Face Detection

Face detection technology is applied over different application that recognizes the human faces from a given digital image. However, the face detection algorithm works same

as that of the object detection in a few steps. The system detects the location of most of the places for a given input image in object detection method, whereas it detects only the frontal areas on human face for the face detection application. Hence, the face detection method is analogous where a person image is matched by the existing one. The image features are compared over the images stored in the database. The matching process will be invalidated when there is a change in facial feature observed with the dataset image. Haar Cascade algorithm is one of the reliable technique widely employed for the face recognition. In that, the possible human eye regions are identified by analyzing all the valley regions in a grey-level image and the algorithm generates all the possible face regions which include the eyebrows, the nostril, the iris, and the mouth corners. After capturing the image, the motor rotates to the empty slot towards the person for him to place his footwear.

3.2.2 Face Recognition

A facial recognition method compares the matching areas of the human face with the digital image against a database of faces, typically utilized to authenticate users through face recognition by measuring the facial features against the given image. Identifying the face is based on multiple factors such as height/width of the face parts like lips, nose etc. After recognizing the image of a person, the stepper motor rotates to the location of shoes and the door opens so that the person can get his shoes back.

Figure 3. Haar cascade algorithm

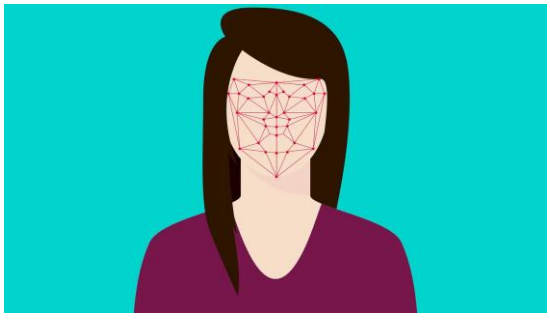

Figure 4. Working of face recognition

3.3 Flowcharts of the methodology

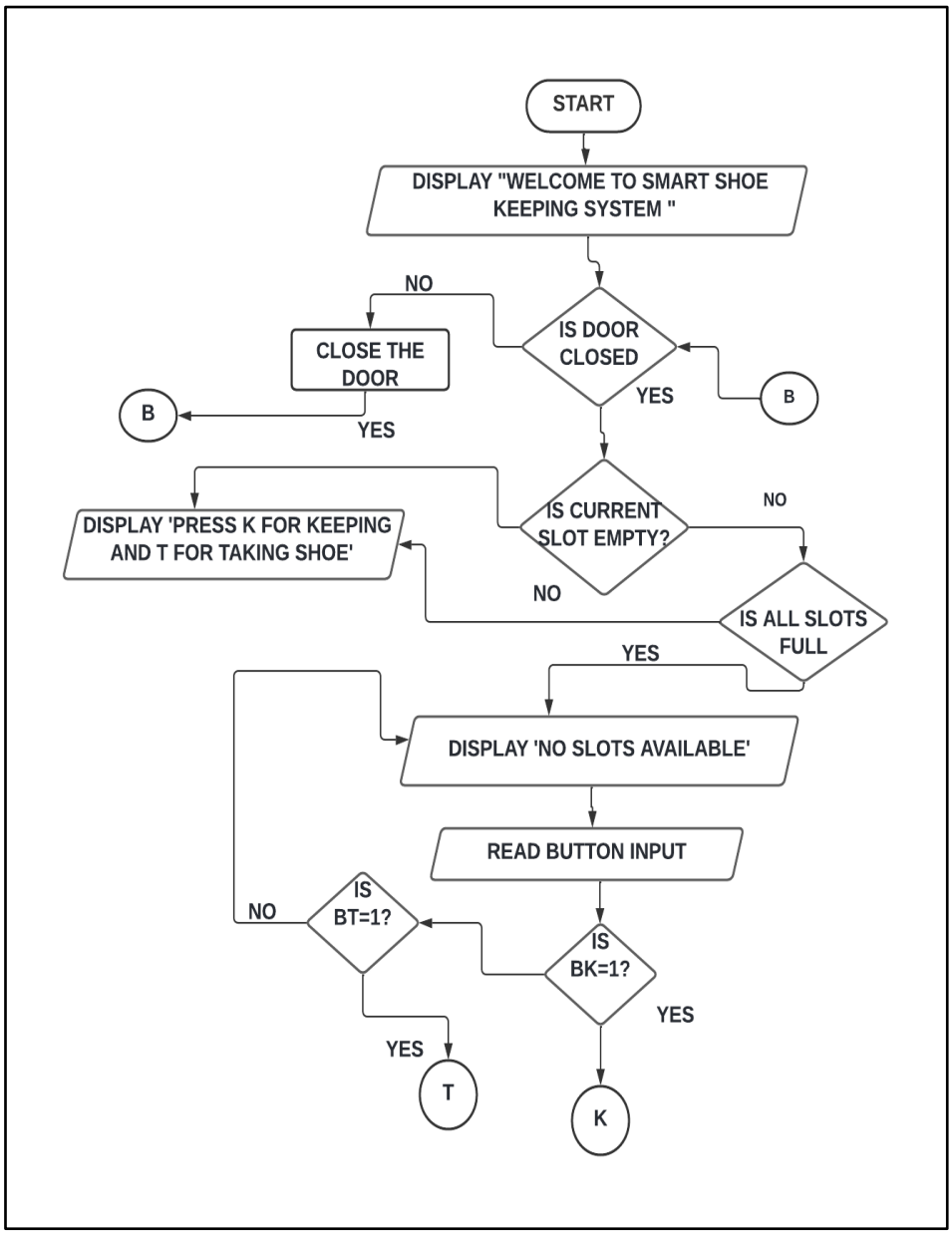

Figure 5. Flowchart 1

where,

BK: Button for keeping shoes

BT: Button for taking shoes

LCD displays welcome to the smart shoe keeping system. After that, the state of the door is checked; if the door is closed. then the system is terminated, otherwise the door is closed and then terminated. The state of the slot is checked; if the slot is empty then it shows

button K for keeping and T for taking off the shoes, otherwise it shows that all slots are full. Then for reading the button input, if BK is pressed then go to the button for keeping shoes otherwise go to the taking off shoes (BT).

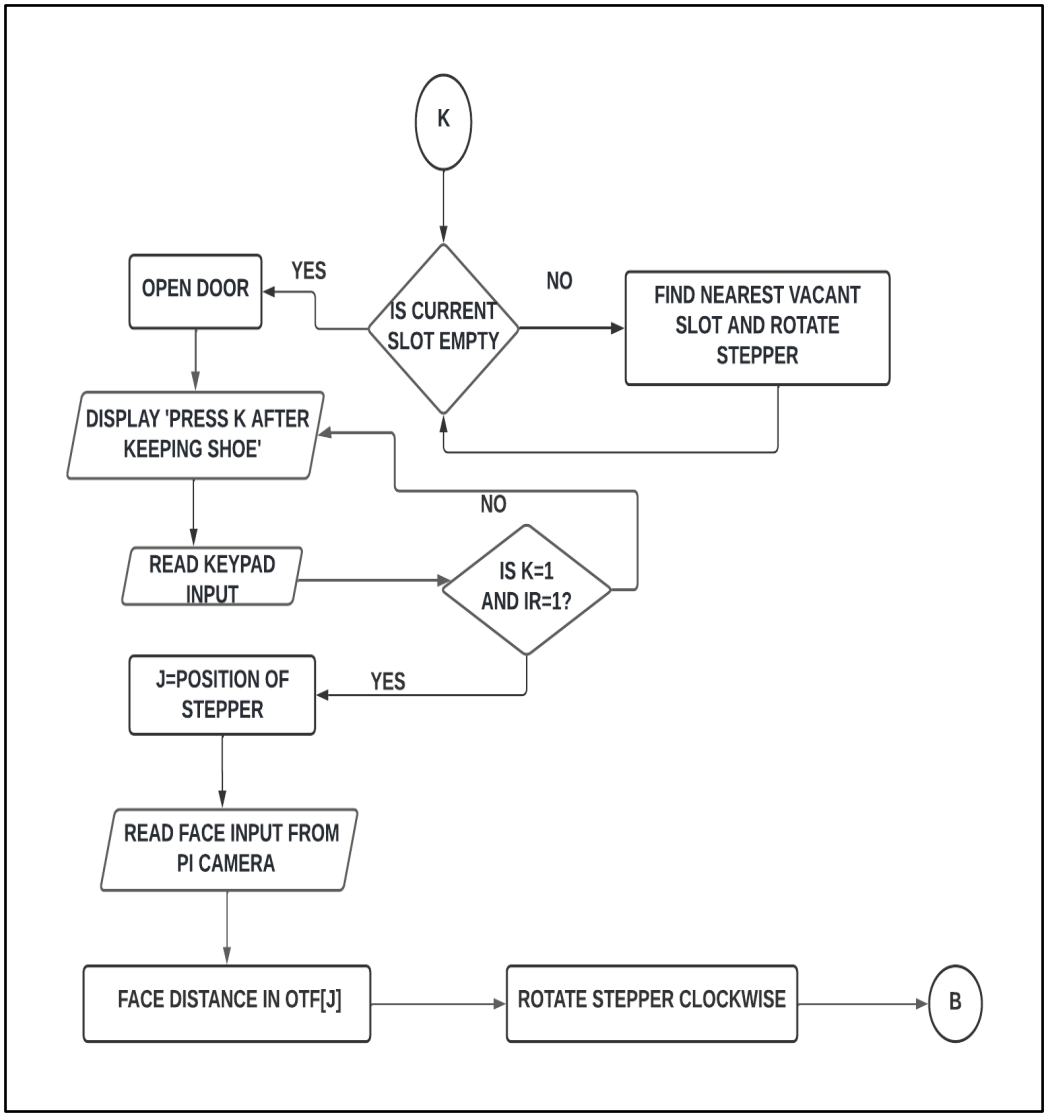

Figure 6. Flowchart 2

where,

IR:IR sensor

OTF: One time face reading

After pressing the BK button, whether the slots are empty or not is checked by the IR sensor. If the slot is empty, the stepper motor rotates to the empty slot otherwise it waits till the slot becomes empty. After pressing button K, the pi camera captures the image of person and stores face encoding in pi database.

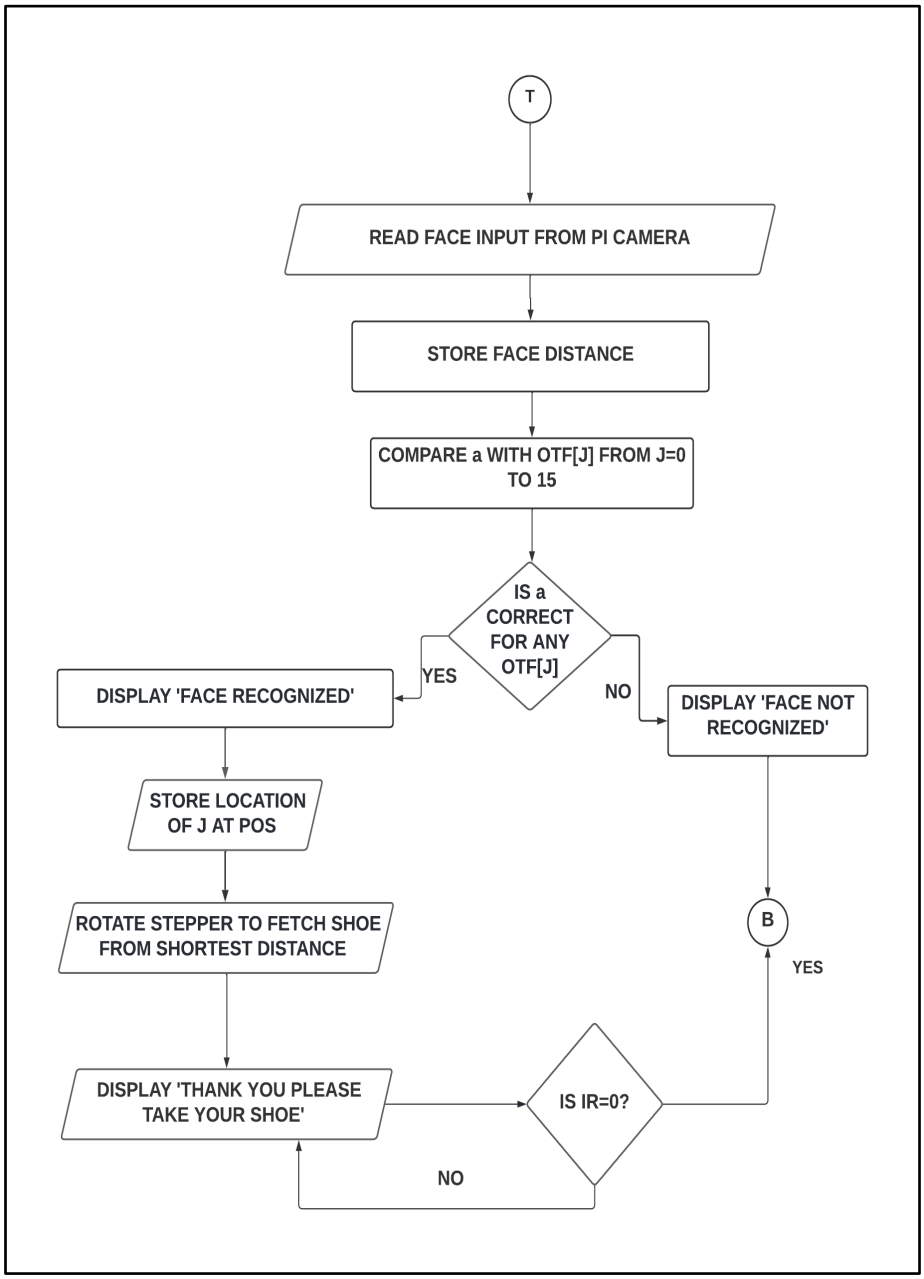

Figure 7. Flowchart 3

where,

POS is the variable for storing the location of shoes.

After pressing the BT button, the pi camera again captures an image of the person and stores face distance in the database. Then it compares the image of person with the previously stored image in pi database, and when image gets recognized it displays the message “face is recognized” and stepper motor rotates to fetch shoe using shortest distance algorithm and then finally displays “thank you” message. If the captured face does not match, it displays “face is not recognized” and terminates the system.

4. Results and Discussion

The results are obtained successfully by recognizing the image which was previously stored in the datasets. After recognizing the face encoding, the stepper motor rotates to the location of the shoe to get their shoes back. Limitations of the proposed work are that the same person should come back to take their shoes and sometimes due to lack of visibility, the camera cannot accurately recognize the face.

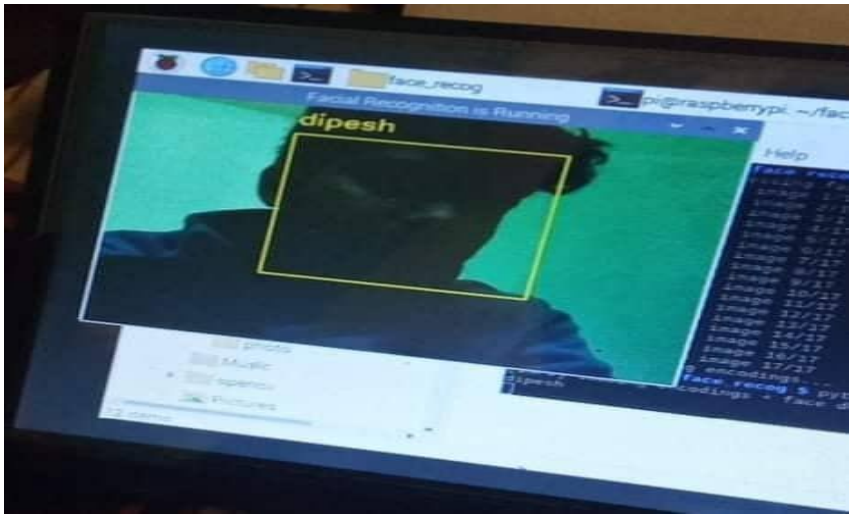

Figure 8. Image of recognized person

5. Conclusion

In this research project, the basics of Computer Vision and raspberry pi to detect and recognize the images of people have been implemented. When the button is pressed, the pi camera turns on and captures the image of the person and stores the captured face encoding in the raspberry pi datasets. When the face encoding gets matched with the stored face encoding, then the servo motor rotates to the location of the shoe so that the person can take his shoes back. The number of shoes can further be increased from 16 pairs to 32 pairs and to 64 pairs based on our requirements. As the result obtained is satisfactory, the proposed project can be implemented in the real field.

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