Face First: Facial Lock Recognition System

Preeti Priyam
Computer Science
SUNY Binghamton
Binghamton, NY USA
ppriyam1@binghamton.edu

Ramandeep Kaur
Computer Science
SUNY Binghamton
Binghamton, NY USA
rkaur21@binghamton.edu

1. INTRODUCTION

The key idea of the proposed system is to provide a better security for authentication of an authorized user over other identification system such as pass code or RFID cards to unlock the door which seems less intrusive now a days as people have to carry physical device such as RFID tags or keys with them or remember pass-codes, but with increasing research in IOT technologies and Convolution neural networks we can eliminate such problems by developing a simple face authentication based door lock system. The system consists of various specific software and hardware components which adds a great advantage to the overall system such as the Proximity sensor is used to detect presence of any closure object which activates the camera module. This process saves a lot of computation power and in-turn saves energy consumption compared to other traditional cameras based system for door lock which remains on all the time for authentication purpose of an authorized object and as a result consumes more computational power and more energy. Moreover, use of other models such as Servo motor, Raspberry pi and software components such as Raspbian OS (Linux based) and Tensor-flow based CNN model makes an overall efficient system for authentication and security.

2. SYSTEM DESIGN

The Proximity sensor and camera module is connected to the raspberry pi module and attached in front of the door for better input signals and improved accuracy of the authentication process. The input signals were sent to the Raspbian based Operating System which collectively sends to Tensor flow-based Convolution neural network which undergoes Face recognition algorithm based on the data-set available to the system and further, authenticates the request. Moreover, the operating systems sends a pulse signal to servo motor which in-turns opens the door.

developing environment contains python environment, datasets and our face classification algorithm. The servo motor is connected to the raspberry pi and according to the output of the algorithm the servo motor is switched on or off.

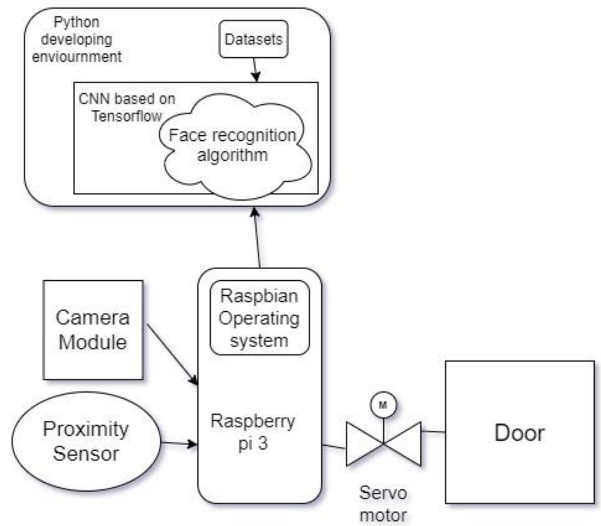

Figure 1: System Design

3. IMPLEMENTATION

3.1 HARDWARE COMPONENT

3.1.1 Raspberry Pi 3

Figure 2: Raspberry Pi 3 Microprocessor

Raspberry Pi is portable single board microprocessor which runs on Linux based operating system (In this project, we have used Raspbian operating system). We have used the 3rd generation Raspberry pi which provides a set of 28 general purpose input/output pins, VCC and Ground to control other electronic components in order to build a system.

3.1.2 PIR Motion Sensor

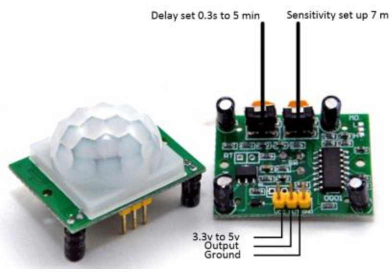

Figure 3: PIR Motion Sensor

PIR(Passive Infrared Sensor) sensor is responsible to detect the motion of nearby object and subsequently sends the signal to raspberry GPIO pin in terms of digital data. PIR sensor works on Infrared light radiating from the Object in the field of view. The effective range of PIR sensor is up to 20 feet. It has 3 output pins one for VCC(electric supply) and GND(ground) and a digital out pin (0 and 1). PIR sensor takes 5 volts as input supply. Here, The PIR sensor would send digital output signal as 1 when there is an moving Object in front of the sensor otherwise, It would indicate as digital Output 0. According to the Output signal from PIR sensor to the GPIO (General purpose Input/Output) pins the Operating system would perform the task associated with it.

3.1.3 Camera Module

Figure 4: Camera Module

We use a Raspberry pi compatible Camera Module which is a 5 mega pixel lens camera. This camera captures all the Visible light and infrared signals to capture the image of the object came across the PIR sensor. Raspberry pi has a dedicated slot for the Camera module. The data is transferred through a parallel bus (white strip) connected to the raspberry pi and camera for faster data transfer. Based on the Output received from PIR sensor, camera module gets activated to capture the image.

1.1.4 Servo Motor

Figure 5: Servo Motor

Servo motor is a Analog based sensor which is controlled by PWM (pulse width modulation) signals. Generally, the Servo motor works on 50hz pulse width. Every different pulse send from the operating system has a different output over the servo motor's angle of movement. The pulse signal can vary from 0 being the Initial calibration to 14 being the angle at 180 degree from the initial calibration point. Servo motor has 3 pins VCC, GND and input signal where it takes input from the GPIO pin of Raspberry Pi and move to a certain angle based on the pulse rate. When the Software component detects the right person then the servo motor is set to pulse 7 which is at 90 degrees and opens the gate.

3.2 SOFTWARE COMPONENT

3.2.1 Raspbian Operating System

It is a Linux based Operating System that is embedded on Raspberry pi.

3.2.2 Tensor Flow

Tensor-flow is an open library used for deep learning to construct each layer in convolution neural network. It offers multiple level of abstraction to allow the user to choose right facial features to determine the person. We need to train the model using tensor-flow retrain which captures the essential differentiating features between the classes of images. The differentiating features is saved in the form of graph. It is trained once and reused to classify the input images into categories for which it is trained. Later, this trained graph is used by the Image classification algorithm for authentication.

3.2.3 Image Classification

To perform Image classification first we need to convert the input image into tensors. Tensors are basically a set of n x n matrix which is obtained by creating a window size of n which captures n x n pixels into a matrix. Each color of the pixel is represented as the mixture of Red, Blue and Green color. Each pixel has a numerical value and it is compared by the graph formed by tensor-flow algorithm based on the features. To compare the Tensors, we use different activation Function such as ReLU, Sigmoid and various other functions. After the comparison result it provides with a probability match with each class of features which helps in classifying the input image into a class with highest probability.

3.3 SYSTEM FLOW

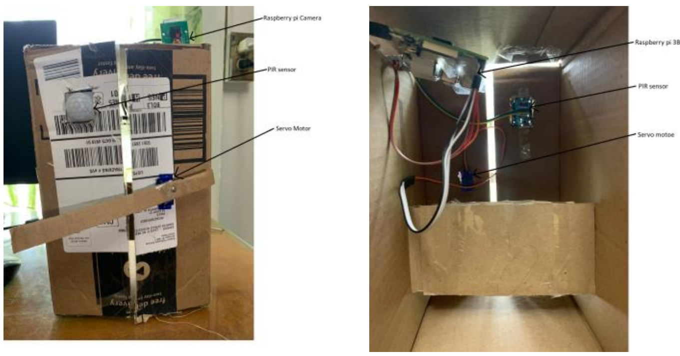

Figure 6: System Architecture

The system working starts with the Input signal of PIR motion sensors. Whenever the PIR sensor detect an object in its field of view, it sends signal to the Raspbian Operating system in Raspberry Pi and based on the input signal, camera module would activate and capture the image of the object, The camera module would store the image into the "jpg" file. Once the data is stored, it would then send data to the Testing environment which undergoes a Tensor-flow based image classification. The image classification predicts its results. The results contain the probability match of the input image to each class. The response of the algorithm decides whether the door should remain closed or it should open. Based on the image classification, if the probability of a authenticated class is more than 90%, then the Operation system would send a pulse signal to servomotor, and then it would open the door. However, if the result is negative, the door remains closed.

4. EVALUATION

To evaluate the project, we started everything up together and let it run on various inputs while monitoring the outputs for correctness.

4.1 Face detection and recognition

To evaluate our tensor-flow based image recognition on the Raspberry Pi, we trained our model on one of our team member's faces. Using the camera on Raspberry pi, we captured each of our faces into the camera. We found that the detection algorithm was nearly perfect with an accuracy of 94% at authenticating. We found that false negatives were more frequent than false positives which in return improves security as an unauthorized person could never be able to open the door.

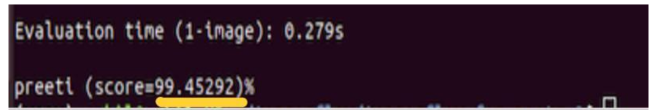

Figure 7: Evaluation of image recognition

4.2 Motion sensors

To evaluate the motion sensors, we conducted several try and error on our PIR sensor. It gives the results 90% accurate if there is no sleep time. But if we have a sleep time of a second it would give us 100 % accurate results.

4.3 Camera module

The 5-megapixel raspberry pi-based camera module captures the image which is enough as an input to classification algorithm.

5. Conclusion

In this Project, we have successfully implemented a prototype of a Secure and accurate Face detection-based door lock system. Which would give a same level of functionality with a convenience over traditional methods which makes you carry a physical device or remember a passcode. With the Hardware and Software requirements fulfilled Face First is compatible with any Door lock system replacing the traditional systems. We found that the motion sensors work perfectly fine for gathering the information we need such as field of view and the image and would be ideal for real-world applications but we can improve the accuracy of the image classification model by adding more hidden layers and delimiting the false positives which would use more computational power which raspberry pi 3rd generation specifications cannot fulfill, we would either use cloud based service to determine the image or use an upgraded hardware to perform such task. In conclusion, Face first is a complete solution to the new generation door lock systems which can replace traditional systems which have been used for years.

6. REFERENCES

[1] En.wikipedia.org. 2020. Raspberry Pi. [online] Available at: <https://en.wikipedia.org/wiki/Raspberry_Pi>.
[2] En.wikipedia.org. 2020. Passive infrared sensor. [online] Available at: <https://en.wikipedia.org/wiki/Passive_infrared_sensor>.
[3] En.wikipedia.org. 2020. Servo motor. [online] Available at: < https://en.wikipedia.org/wiki/Servomotor>.
[4] En.wikipedia.org. 2020.Raspbian OS. [online] Available at: < https://en.wikipedia.org/wiki/Raspbian>