January-February 2020
ISSN: 0193-4120 Page No. 6463 - 6467

Design and Implementation of the Smart Door Lock System

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Abstract
Security and Privacy are both common benefits in addition to make sure that in our lifestyle we are safe, lot of analysis goes on in the area of residence safety measures, and Internet of Things is the new development, where we attach daily things to contribute information for our improvement. Face identification may be a developed process during which the image recognized out of the picture. The theme is to make a sensible entry, which protects the doorway. We would like to develop this technique supported Rasp.pi 3, to form the home only opened when facial image is predicted by the popularity methods from OpenCV library and until you're permissible in by the residence owner, who could watch doorway privately. As a result of the system is a smaller amount possible to be defrauded: since the owner can confirm each guest within the isolated console, getting predicted by the camera. If employing a camera won't work, we added new feature pass code function for doorway.

Keyword*: Rasb.Pi, Facial Recognition, Home safety, IoT.*

1. Introduction

Smart devices there's a vital got to transform our present daily things and make them elegant. To vary and renovate any object we'd like to get rid of its extant defects, and include additional features. The major problems throughout an ordinary entry lock are that everybody can unlock a typical door lock by duplicating or robbery the key. To overcome these problems easily by converting conventional entry lock into a sensible lock, which may unlock the entry at any time when anyone in front of the door or once we would like to unlock for somebody else without being actually there, we'd like to switch the entry. With an approach where devices can communicate with its clients and at an equivalent instance provide their security and remain inventing them. Users could operate a touch screen to pick entering the house by recognizing the face and/or by connecting a digital numeral screen pad to allow the instructions from the user or adding Infra-Red or Bluetooth modules to work these equipments. For face recognition, a picture is going to be captured by a pi camera and pre-processed by Raspberry pi like converting, re-sizing and cropping. Next image recognition be achieved. Once the image is recognized by the classifier supported a pre- stored image library, the image are going to be sent to a foreign console expecting house owner's decision. For the passcode half, users may enter or reset pass code through a computer keyboard.

2. Existing Model

Implementing Smart Door Locks with the assistance of GSM mobiles and stepper motors are studied. The drawback in existing approach may be a difficulty of a structure and without need of counting on extra components. The industry has seen working in the field of AI, Machine Learning, Internet of Things, Big Data Analytic all with a standard aim to form things simple, self-inspecting and to communicate with all types of equipments by making daily things controlled and interoperable. A requirement has been explored within the area of digitalizing traditional safety measure tools and as a result lots of effort has been formed on

January-February 2020
ISSN: 0193-4120 Page No. 6463 - 6467

making lifestyle locks sensible by suggesting locks changeable with the assistance of stepper.

3. Proposed Model

Our model is exclusive through its one among a sort grouping of different features offered. The main difference is within the operating cost reduction by the domestic device because it identifies the face from the picture and transmits it on to appliance connected with our application. We introduced new methods of face detection as an approach scheme with a mixture of relay unit with a solenoid switch to unlock the entry and connecting interface. Moreover instead of employing a less-quality Rasp.Pi interfaced Camera we've used USB attachable HD Web Camera to try to to capable and consistent face detection.

System Architecture

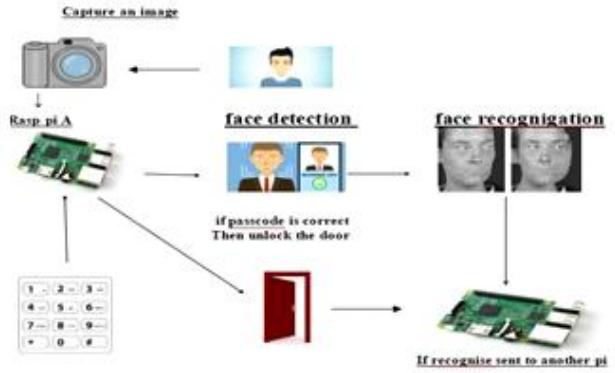

Figure 1: Block diagram

To develop above model the following equipments are required. Which are mentioned below:

Raspberry Pi: Rasp. Pi is an ARM-based single board computer. The Rasp.Pi 3 Model B is that the 3rd generation Rasp.Pi. It has Broadcom BCM2837 64bit ARM Cortex-A53 Quad Core Processor SoC running at 1.2GHz and 1GB RAM. The OS used for Raspberry Pi is Raspbian because it is open source anyone can use. It is 40 pins during which 24 are GPIO pins these pins are used for general purpose, 8 ground pins, two of every 5V and 3V power pin. Its four USB-2 ports and a Micro USB power source. It runs on the 5V power supply.

Pi Camera: Pi This interface uses the dedicated CSI interface, which was designed especially for interfacing to cameras. The CSI bus is ability of extremely high data rates, and it exclusively carries pixel data. The sensor itself features a native resolution of 5 megapixels and features a fixed focus lens on board.

Keypad: Attach matrix 7-pin interfaces to 7 free GPIO pins, 3 column pins are set as output which are directly connected with GPIO, while 4 row pins are set as input with pull-up resistor.

Servo: Attach the servo to a GPIO (we selected GPIO 17 here) of the Raspberry pi-A and control its rotation utilizing pulse-width modulation. The servo is powered by a 6V-battery pack.

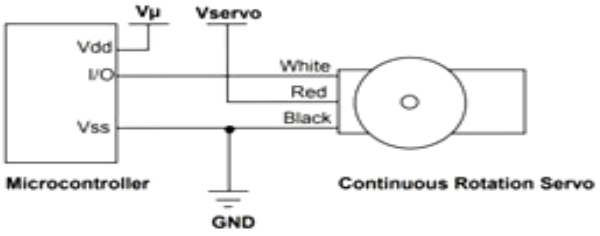

Figure 2: Servo

Software

OpenCV: OpenCV is an open source software library. The library features a lot of improvising algorithms, which may be utilized in many Internet of Things related sectors together with face detection and recognition. We used the Haar classifier, Lower Binary Pattern histogram face recognizer.

Algorithm: Image processing may be a mathematically intensive operation & one among the most important areas of research for an enormous data field. It's a process on the image to convert it into desired trying to find which the input is a picture and therefore the output could also be a picture or set of characters associated with the particular image. It refers to a spread of techniques that are wont to maximize the knowledge yield from an image.

Haar Cascade Classifier: A Haar Cascade classifier which is employed to detect the thing that it's been trained for, from the source.

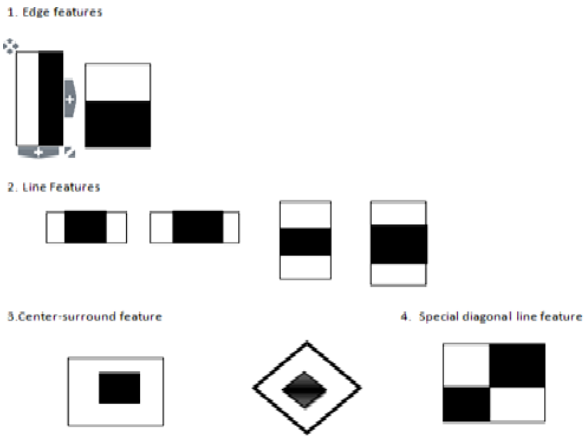

Figure 3: cascade classifier

This proposed system uses Haar Cascades classifier as a face detection algorithm. Firstly, the algorithm wants a lot of images of faces and images without faces to prepare the classifier. Image Processing Integral image may be an arrangement which may be a summed area table and algorithm for quickly and efficiently generating sum of values during a rectangular grid subset. Integral image springs by using following equation,

January-February 2020
ISSN: 0193-4120 Page No. 6463 - 6467

$$I_{\Sigma}(x,y) = \sum_{x' <x} i\,(x' + y')$$

To avoid the complexity of calculation we use Adaboost algorithm, which is inbuilt in OpenCV library that's cascade classifier, it is the procedure to combine a set of weak classifiers to form a strong classifier. Classification takes place gradually, if the selected region fails within the first stage, we reject it. The region which clears all the stages i.e. all strong classifiers is evaluated as the identified face. Identified Faces are sending to the Face recognizing phase LBPH algorithm has been used for face recognition, which labels the pixels of an image by thresholding the region of each pixel and provides the outcome as a binary number. The identified total image is exact to the LBPH. We used histogram equalization for face preprocessing. For effectiveness we used to divide preprocessing for left and right face. So histogram equalization is finished in 3 ways, initially for the whole face and additional two for side faces.

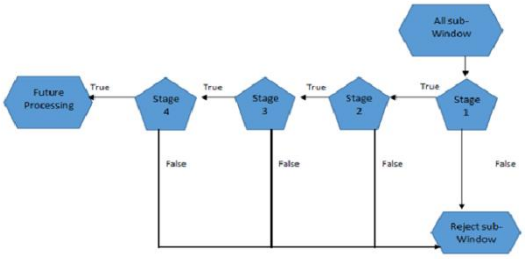

Figure 4: cascade classifier stages

4. Methodology

User Interfaces: For user interfaces, we utilized python library 'pygame' to design the aesthetics of PiTFT touch screen and detect any user input.

Rasp. Pi A: The way we linked touch screen buttons with system functions on Pi A is displayed in fig.5. Initially, on the PiTFT screen, there are 3 buttons within the 'main' level: 'Lock', 'Recognize Face' and 'Enter Pass code'. The 'Lock' button is meant for homeowners to understand whether the door is locked and lock the door manually. When the door is unlocked, the house owner could press the 'Lock' button to lock the door. If the door is already locked, nothing will happen. When the 'Lock' button is pressed. Once the 'Face Recognize' button is pressed, you'll preview pi camera on the screen and therefore the image are going to be captured in 5 seconds. After a series of image processing steps, if the face can't be recognized, a message 'Could not recognize, please try again' will appear on the screen for 3 seconds before screen return to 'main' level. Otherwise, the recognized images are going to be displayed until remote confirmation is formed. If Pi A receives a positive response from Pi B, that is, the one is allowed in by the house owner, the door are going to be unlocked by the servo and 'The door is unlocked' will show abreast of the screen. If Pi A receives a negative response from Pi B, you'll be told that 'Entrance not allowed by the house owner'.

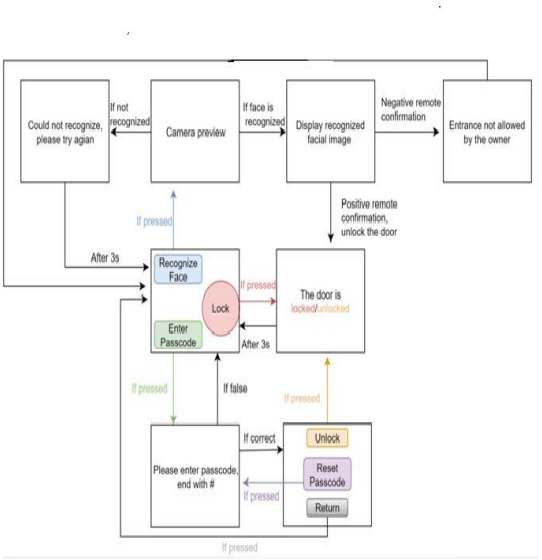

Figure 5: System algorithm

At last, after 3 seconds, the system will return to its 'main' level. When a user presses the 'Enter Passcode' button on the screen, the text 'Please enter the passcode, end with #' are often seen on the touchscreen and therefore the user must enter the passcode using the 3x4 matrix keypad. Each pressed number on the keypad are going to be displayed on the screen then be covered by a star if subsequent key has been pressed.

If the passcode entered is wrong, then we've the PiTFT display a message, 'Password doesn't match, please try again', which can last for 3 seconds before going back to 'main' level. On the opposite hand, if the passcode entered is correct, the system will get into the second-level buttons: 'Unlock', 'Reset Passcode' and 'Return'. Users could unlock the door by pressing 'Unlock' button and therefore the servo is going to be driven to open the door. The password might be reset by pressing the 'Reset Passcode' button. The new passcode must be entered through the keyboard too and can become next time. The 'Return' button is meant to return to the previous level. For security reason, we set the upper limit for times of entering the incorrect passcode. If the upper constraint is reached, the entire system are going to be locked for a specific amount of your time, like quarter-hour and screen will tell the user that 'Maximum failed passcode attempts in restriction. Please try again after 5 minutes.

Rasp Pi B

January-February 2020
ISSN: 0193-4120 Page No. 6463 - 6467

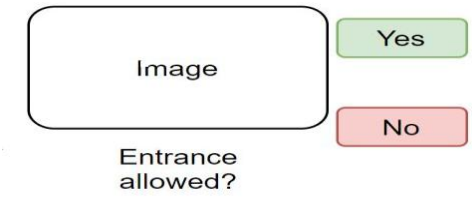

Figure 6: User interface of Pi B

Pi B works because the server expecting the connection from Pi A and its user interfaces only show up when Pi B receives a picture. The image are going to be displayed on its PiTFT screen plus 2 buttons 'Yes' or 'No', by pressing which the corresponding response are going to be sent to Pi A.

Face Detection: Face Detection and Haar Cascade Classifier After preprocessing, like resizing and cropping, the image are going to be used as input of Haar Cascade Classifier to detect whether there's one face detected during this image. Face detection may be a process of checking out the face area within the image. Within the project, we use Haar Cascade to detect faces. Haar cascade with edge, line and center-surround features are used and that they are inputs of classifiers. Cascade classifiers test the image by cascade features. Since the quantity of features is large, rather than applying all features on the window, the features are divided into different stages. The image window which successfully clears all the levels is taken into account to be face image. Haar cascade classifiers have a plus of its fast detection speed compared to other classifier.

Test: The Eigen face classifier with different confidence threshold to urge the simplest recognition accuracy. After the system could recognize one face successfully, we also considered making the system recognize multiple faces by fixing several classifiers and allow them to do recognition add turns or in multi-thread way.

Pass code Implementation: In the implementation of the keypad, the approach for deciding the pressed button is firstly setting outputs (column pins) and inputs (row pins) as high. When a button is pressed, it'll produce a small signal. Then each column is scanned during a 'for' loop. If the low signal is detected, we could know which button is pressed.

Communication over TCP Sockets: The two Raspberry is within the project are set to speak using TCP sockets via wifi modular and a wifi router. The Raspberry Pi A, which displays main buttons, is that the client and therefore the other Raspberry Pi B, for remote confirmation, is that the server. With specific IP addresses, the client could hook up with the server and send files like images over TCP socket. Then the server will send a response back to the client and once the response received, the client goes to shut the connection.

5. Result

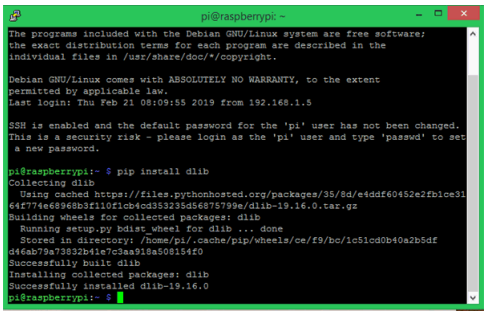

Figure 7: driver Installation

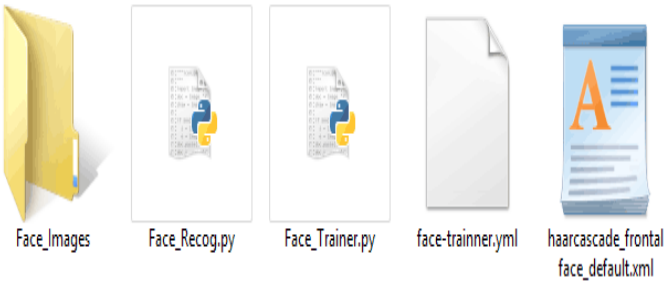

Figure 8: Folder of face recognition system

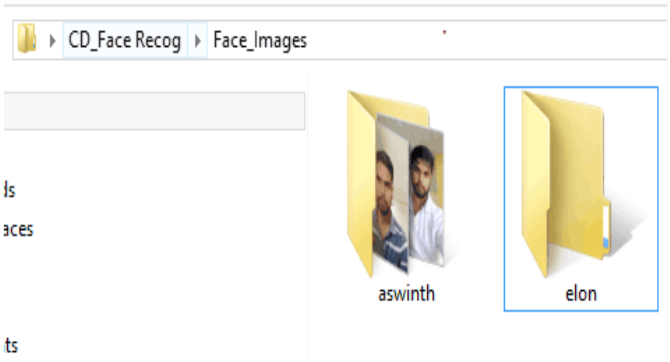

Figure 9: sampled images

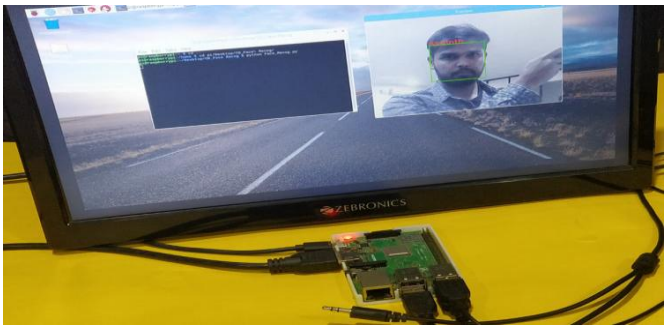

Figure 10: Face recognized output

The trained data is ready; we use it to recognize faces. In the Face Recognizer program we will get a live video feed from a USB webcam and then convert it to image. Then we have to use our face detection technique to detect for faces in those photos and then compare it with all the Face ID that we have created earlier. If a face is recognized in the video feed you will find a box around it and if your program could recognize the face it will also

display the name of the person.

6. Conclusion

High precision in predicting residence owner faces and it transfer the corresponding face picture to a different Raspberry Pi within time and provides a direct output. This proposed face detection entry lock safety method has been realized to avoid robbery in extremely protected areas like home surroundings with lower power utilization and more reliable security gadget for both Intruder discovery and for entry security.

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