International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 06 | June 2018 www.irjet.net p-ISSN: 2395-0072

Embedded System for Automatic Door Access using Face Recognition Technique and Cloud Based Services

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Abstract - *In today's digital world, it is important to have safety measures for the property. Security is a significant perspective or feature within the smart home applications in modern times. Home automation is one among the multiple areas where Internet of Things(IoT) technology can be applied. IoT methods helps in collaboration of different devices and ultimately achieving efficient home automation as one application. It also helps in monitoring and accessing things remotely. A typical home automation construction workflow consists of certain stages such as execution and updating of workflow, triggering the workflow and finally making the system interact with the humans as well as other systems. This paper is an attempt to construct a smart security door system for home automation using interdisciplinary approach by applying image processing, implicit human-computer interaction and cloud-based services that ensures less human intervention and more automation.*

Key Words: **Home Automation, Access Control, Automatic Door Lock, IoT, Raspberry Pi, OpenCV libraries, Dlib libraries, Security System, Android, Firebase Services**.

1. INTRODUCTION

1.1 Project Idea

Property protection is a vital feature within the smart home applications. The major part of any door security systems is to distinguish the persons entering through the door correctly. Authentication between human beings can be easily done using face identification mechanism. An efficient and correct home security and entry control to the doors system that is based on face identification is important for wide selection of security application. In the facial recognition approach, a given face is compared with the faces stored in the database in order to identify the person. The purpose is to find a face in the database, which has the highest similarity with the given face. Detection of face in an image is more exigent because of some unstable features such as glasses and beard impacting the detecting effectiveness.

In addition to this, the different kind and angles of lighting generates uneven brightness on the face, which has influence on the detection process. To prevail over the above problems, the existing system used Ada Boost (Adaptive Boosting) algorithm, implemented using HAAR classifiers for face detection, ORB for 3D object recognition and Principal Component Analysis for face recognition implementation.

While these implementations we producing better results than their predecessors, the accuracy was not upto the expectation, and not fast enough to run on cheap camera, required for home security purposes. Machine Learning played an important role in finding a better solution. The analysis of various datasets and information provided in better techniques for implementation of Face Detection and Recognition.

In our proposed model, finding of face is implemented using Histogram of Oriented Gradients (HOG), isolation of facial features using Face Landmark Estimation and facial recognition by implementing a SVM classifier.

Finally, using Android and Cloud Services the whole system is designed as one unit for data storage and real time notification services.

1.2 Motivation

The motivation behind this project are:

- Most doors are controlled by persons with the use of keys and security cards, which required caring and security for itself.
- Replication of key and security card required for allowing multiple user access making the system less secure.
- Password or pattern to open the door were alternatives but in this digital era it would be additional burden to human memory.
- Providing a way for the owner of the house to provide access to multiple users without compromising the security as well as getting updated about the activities.

1.3 Goals and Objectives

- To minimize the shortcoming of existing system and integrate remotely controlled system with cloud-based services.
- Automatic opening and closing of door to authorized person without human intervention.

- Centralized storage of data over the cloud to overcome disk space issues and data integrity.
- Allow the system to be used around with various mobile platforms.
- Real-time notification to the user using mobile and cloud services platform.
- Lastly, a cost-effective system in order to justify its application in home automation.

2. SYSTEM SPECIFICATION

Sr. No	Parameter	Specification
Raspberry Pi 3 Model B		
1.	CPU	1.2 GHZ quad-core ARM Cortex A53
2.	Memory	1 GB LPDDR2-900 SDRAM
3.	Operating System	RaspbianOS Jessie
4.	GPU	Broadcom Video Core IV @ 400 MHz
5.	USB 2.0 Ports	4
6.	SOC	Broadcom BCM2837(roughly 50% fast than Pi 2)
7.	Network	10/100 MBPS Ethernet, Wireless LAN, Bluetooth
8.	Power Source	5V DC
9.	GPIO	40 pins
Digital Camera		
10.	Sensor	CMOS
11.	Megapixel	20
12.	Frame Rate	30 fps
13.	Focal Length	3.85 mm
14.	Connector	USB 2.0
Servo Motor		
15.	Rated Output	50 W
16.	Rated Torque	0.16 Nm
17.	Rated Speed	3000
18.	Max Speed	5000

Table - 1: Hardware Specification

Sr. No	Parameter
Platform	
1.	Raspbian Jessie
2.	Android Nougat and above
3.	Firebase
Libraries	
4.	OpenCV 3.1.0
5.	Dlib
6.	Face_recognition
7.	Pyrebase 3.0.27
8.	Rpi.GPIO
9.	Schedule 0.2.0
10.	PyFCM
11.	Firebase for android SDK 15.0 and above
12.	Glide v4

Table - 2: Software Specifications

3. PROPOSED SYSTEM

The proposed model is a system accessible over cloud. It makes use of raspberry pi over microcontrollers providing many advantages and features. The proposed system supports more elasticity, comfort, easily accessible and remotely controllable. The system also attempts to provide every possible benefit of automation, computer vision, cloud computing and embedded systems.

The shown system architecture shows the interconnection and the relationships between the software components and the hardware components which helps in implementing the entire system.

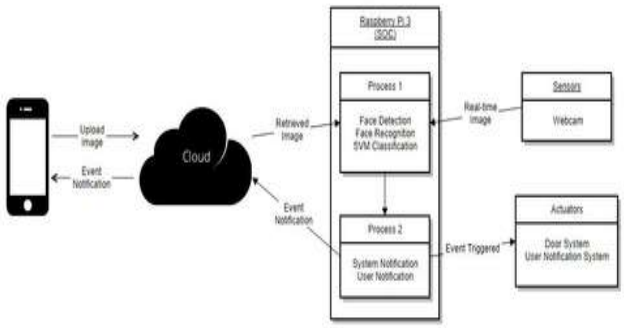

Fig - 1: System Architecture

4. IMPLEMENTATION:

1. Import necessary libraries and packages
2. Set GPIO mode for Raspberry Pi
3. Set Output Pin as 7
4. Set pulse width modulation Frequency to pin 7
5. Initialize variables for video capture using OpenCV libraries
6. Initialize arrays for face image locations (face_locations) and face image encodings(face_encodings)
7. Initialize frame count <- 0
8. If video capture available:
   Continue
   else:
   Abort
   endif

9. while true:
    a. read captured image frame
    b. resize the frame of video to ¼ size for faster face recognition
    c. store face location found in frame in array(face_locations)
    d. store face encoding (from Image Processing: HOG, Face landmark estimation) found in frame in array(face_encodings)
    e. Repeat step c and d for all the images stored in internal storage for face matching.
    f. Match the face image found in the frame with all the face encodings of all the images stored in internal storage using SVM Classification.
    g. Monitor few number for frame to check whether video frame image is stable
    h. if image is stable:
        I. scale back the face location frame to normal size
        II. display the recognized user by surrounding the face with a rectangle
        III. display the name of the recognized user by fetching from (face_locations) array.
        IV. Perform tasks for:
            - Responses
            - Notification
            - Door opening and closing operations

    else:
        continue to monitor the frame for face detection

    end if

end while

10. Clean up GPIO
11. Clean captured frames

4. RESULTS

Fig - 2: Uploading image to Firebase

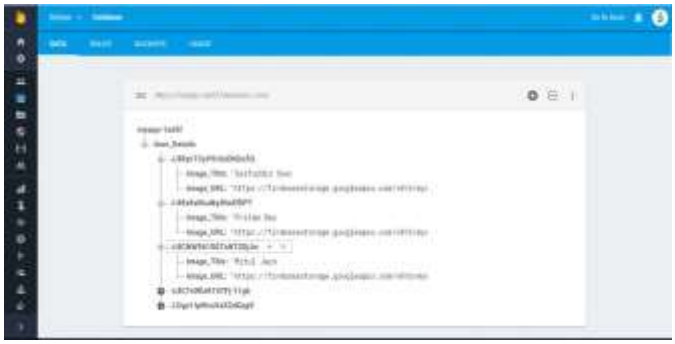

Fig - 3: Firebase Database

Fig - 4: Firebase Storage

Fig - 5: Face Recognition results from different angles

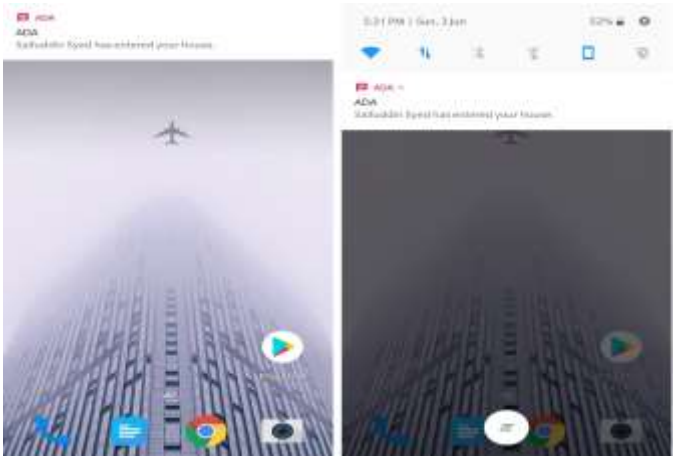

Fig - 6: Mobile Notification

5. CONCLUSIONS

However, face detection is more challenging because of some unstable characteristics, thus it very much possible that there will be many improvements to this current system and rather can also be replaced with better options currently under research (eg. DNA Verification). Also, Convolutional Neutral Networks and Deep Learning approaches can be used for improving the performance of face recognition process.

Moreover, the integration of systems and communication between them can also be synchronized and functioned smoothly by implementing future advancement in cloud computing services.

The system can also be integrated with other home devices and appliances with energy controller enabling Home Automation.

The boon of IoT, Automation and Machine Learning gives this subject many more implementation, modifications and advancement to be taken forward with such future generation technologies.

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