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Smart Access to a Smart Home

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Abstract: ***Smart home security control system has become indispensable in daily life. Since physical presence may not be possible in all cases, remote access of the home environment proves to be vital. In this paper, a smart home lock system is proposed which allows access to known members of the family. In case of the unknown members, their image is forwarded to the admin who then may decide if the visitor must be allowed access to the house. This system makes use of facial recognition algorithm RANSAC implemented using OpenCV, an android application which the admin uses to access the lock remotely and an arduino based locking system that is controlled by the app. The android application is developed using GCM to enable push notifications and further simplify the control process.***

Keywords: Face Recognition, OpenCV, RANSAC, Android, GCM

1. Introduction

Internet of Things (IoT) has revolutionized the modern day technology. IoT is basically an interconnected web of physical objects, mostly unprogrammable. These objects are embedded with sensors or other electronics in order to retrieve data in real time. The embedded sensors and electronics also allow for remote access of appliances that previously demanded physical presence for operation. All these features make IoT the next big thing in the field of technology.

IoT has vast applications such as smart city grids, smart parkings and even smart healthcare. A major application of iot lies in home automation. With the increasing working population, remote access of home appliances is vital to the society. Temperature sensors in thermostats, gas leak sensing systems and smart lighting options have been already implemented in many homes. Some appliances have no external sensors and they do not interact, such as a programmable light switch, while others are part of the network and accessed for remote control and also data transfer.

Hardware devices can include sensors, light sensitive diodes, controllers, actuators, and communication systems. The control unit which allows remote access maybe any handheld or portable device that is connected to the Internet of things. Remote control can range from a simple remote control to a smart phone with Bluetooth, to a computer on the other side of the world connected by internet. Home automation systems are available which consist of a suite of products designed to work together.

Facial recognition along with Internet of things opens up to a wide range of smart home appliances that can be put to intelligent use. Facial recognition is technique that makes use of biometric software and image processing, and can identify and recognize a specific individual (face) in an image. This is carried out by analysis of face patterns and matching them against a sample dataset. Facial recognition systems are commonly used for security purposes but are increasingly being used in a variety of other applications.

By making use of android apps the controlling of such home appliances is greatly simplified. Since a major part of the population today, own android mobile phones, apps may be installed on a wide range of devices thereby reducing the need for an additional remote controller.

2. Literature survey

Reference paper [1] describes about the smart home lock system that restricts access into a home to authorized people only. The wireless control system is built on Raspberry Pi and the inter device communication is carried out by ZigBee. The facial recognition part of the system is carried out by PCA which performs image processing and thus helps in determining the authenticity of the member allowed access. ZigBee module and electromagnetic door lock module combined operate the door accessibility, has been designed and developed. The Raspberry Pi system as well as the image processing face recognition algorithms are used to detect and recognize visitors and send an email and/or an alert message about the current home environment status via GSM network automatically to the home owner's mobile phone or any communication device. This ensures two aspects: firstly, accessibility in to a home environment for authenticated people only, and secondly, application in areas where physical presence is not possible all the time

Reference Paper [2] proposes two new methods to effectively solve the problem of weakly labeled images by learning two discriminative affinity matrices from these weakly labeled images. The paper describes two main methods called normalized low-rank depiction by efficiently utilizing weakly supervised information to learn a low-rank reconstruction coefficient matrix while exploring multiple subspace

structures of the data. Specifically, by introducing a specially designed regularizer to the low-rank representation method, the corresponding reconstruction coefficients is penalized related to the situations where a face is reconstructed by using face images from other subjects or by using itself.

Reference paper [3] describes a system using the current technology that will be valuable to the lives of others and is a vital part in the human community. The system is an implementation of an inexpensive yet customizable mechanism using a smartphone based home automation system. With the rapid development of the Internet, the remote accesses of the home appliances have tripled. But not all can afford expensive electronics.

3. Existing System

The exiting Smart Lock Solutions make use of Fingerprint based scanning based on which the authentication is allowed. When user passes by the door, the door unlocks using his mobile device as the key.
There are several disadvantages of these systems such as: physical Presence may be required, incorrect response to mobile key is encountered. Multiple cases of residents locked inside their own house are reported.

4. Proposed System

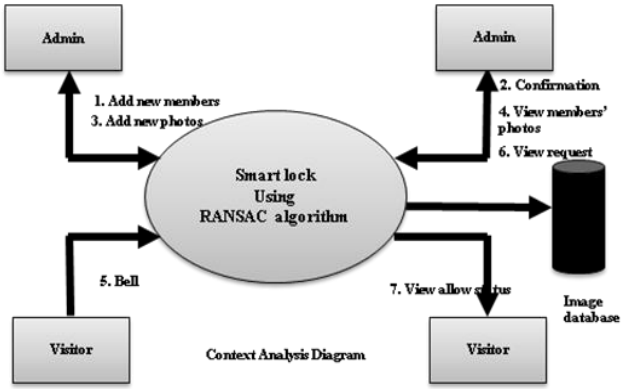

Figure 4.1: System Architecture

In our proposed system, when the guest rings the doorbell, his image is captured using an IP camera. In this system, face recognition algorithm, RANSAC is implemented in OpenCV based on which the access to home is allowed. If a person's face matches with the face patterns stored in the database, access is automatically granted and door unlocks. In case of intruder, image of the person is captured and the same is sent to the owner's Android App using GCM. Owner may decide if access is supposed to be granted or not. Usage of Wi-Fi [instead of Bluetooth] will enable worldwide access to the system.

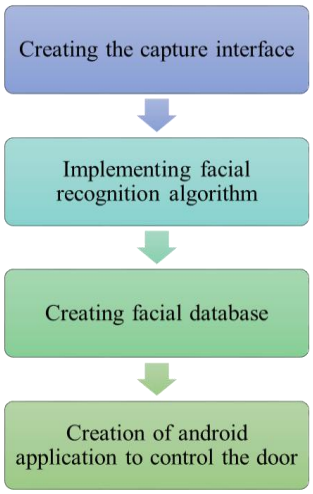

Figure 4.2: Modules of the proposed system

The advantages of this system are: (1) User need not be physically present in the vicinity to allow access to the guest. (2) User may be inside the house and yet not approach the main door to allow access. (3) In case of closely known persons, the user need not grant access. The door automatically opens in case of authenticated persons. (4) Remote access to the lock is possible from anywhere around the world.

4.1 OpenCV

OpenCV (Open Source Computer Vision) is a library of programming functions that are largely intended at real-time computer vision. OpenCV is a product of Intel's research center in Nizhny Novgorod (Russia), later sustained by Willow Garage and now maintained by Itseez. This is an open source library under the open-source BSD license which is the main motive behind using this technique. Since OpenCV is written in C++ the compilation times are optimal and also the library is cross-platform. In the proposed system, we use OpenCV libraries to perform face recognition algorithm RANSAC.

4.2Ransac algorithm

Random sample consensus (RANSAC) is an iterative technique to approximate factors of a mathematical model from a set of observed data which contains outliers. Therefore, it also can be construed as an outlier detection method. RANSAC is a non-deterministic algorithm and hence produces a realistic outcome only with a definite probability which is directly proportional to the iterations performed. The algorithm was first published by Fischler and Bolles at SRI International in 1981. They used RANSAC to solve the Location Determination Problem (LDP), where the goal is to determine the points in the space that project onto an image into a set of landmarks with known locations. In the proposed system we use RANSAC to perform face recognition.

4.3 Global Cloud Messaging (GCM)

Google Cloud Messaging is a mobile application service that was developed by Google. GCM facilitates third-party

application developers to launch notifications information servers maintained by developers to applications that mark the Google Android OS and also extensions developed for the Google Chrome internet browser. We use GCM to develop our application in the proposed system to enable push notifications.

4.4Arduino

Arduino is a software company, project, and user community that designs and manufactures computer hardware, open, and microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices. In the proposed system, we use arduino to control the door remotely. The app communicates with arduino uno fitted with a Wi-Fi shield. The decision taken by the admin directs the arduino to either allow or disallow the visitor.

A J2EE web application is developed to enable the admin to manage the smart lock system. The web application allows an admin to maintain a profile which ensures safety and authorized access into the database.

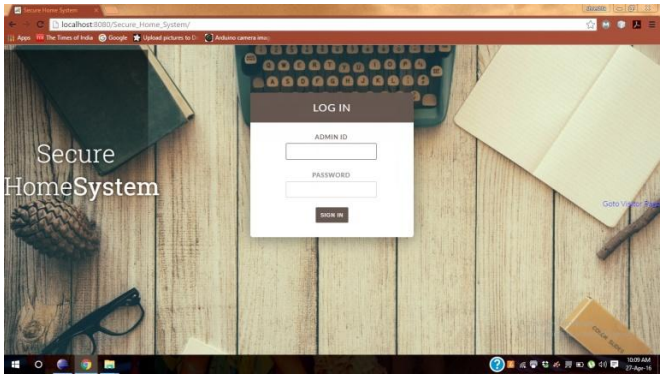

Figure 4.3: Login Page

Only the authorized admin can access the web application by entering his valid credentials in the login page. Once this is completed, the admin is redirected to the home page where he may perform various activities to manage the Smart lock system.

In the home page, there are several options that allow the admin to add members, change the password, upload member photos, view profile and delete members. Only the admin is allowed to add photos of the known members into the database.

From the login page, visitor page may be accessed. Here, the visitor may capture his image and wait for the request to be accepted or rejected. If the visitor's image exists in the database, the request is automatically accepted.

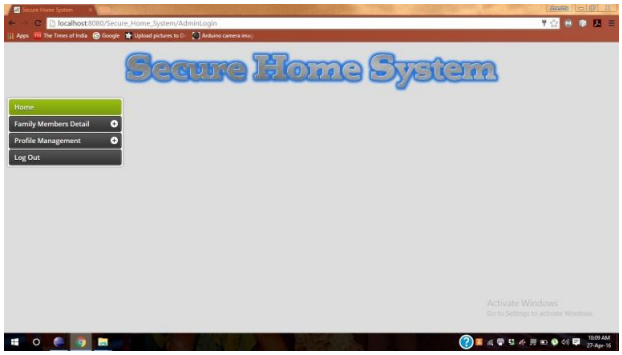

Figure 4.4: Home Page

Figure 4.5: Visitor Page

5. Results and Analysis

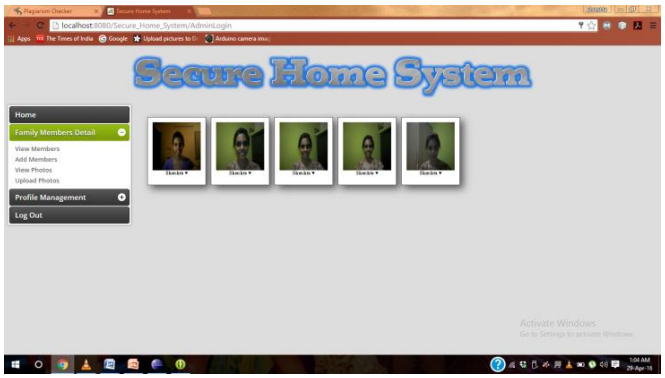

Figure 5.1: Member Images

Once the member images are added, the system is ready for implementation. The above image shows the images added for a single member. Thus if this person approaches the door, then the face recognition algorithm automatically directs the aurduino based smart lock to open. This is represented in the following image where access is granted.

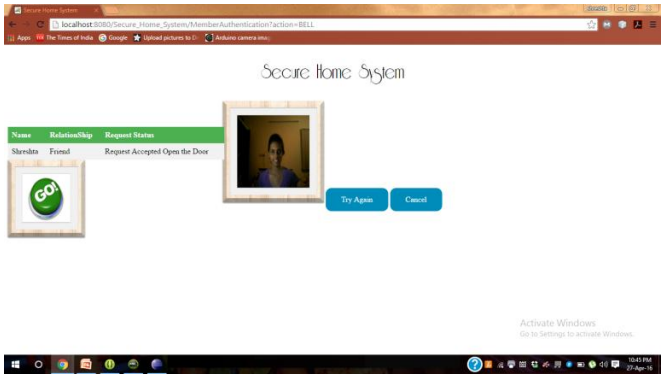

Figure 5.2: Access granted to known person – when person is in database

Now if the images in the database for the said member are deleted by the admin, then the person is no longer authorized to enter the house.

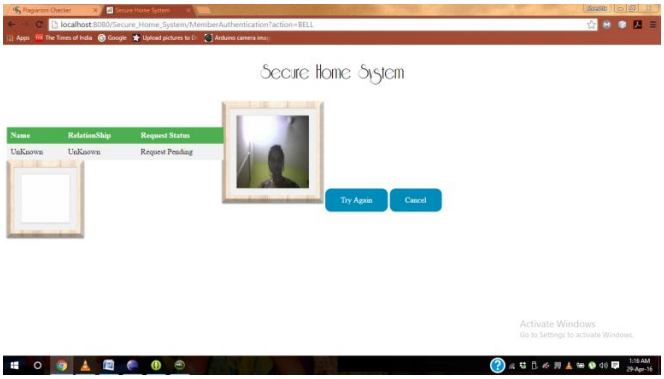

Figure 5.3: access denied when person is removed from database.

The above image illustrates that the access is denied and the image is forwarded to the android application.

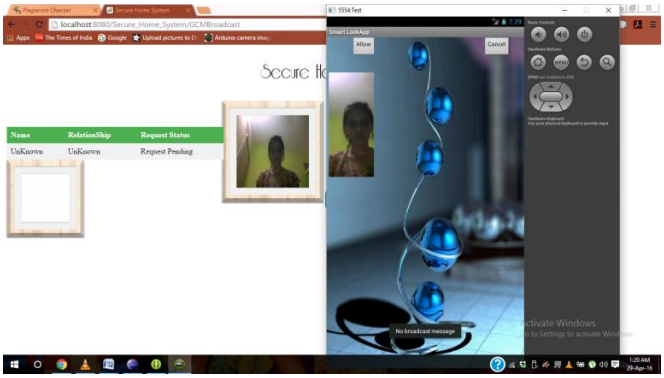

Figure 5.4: the unknown person's image is forwarded to the app

Here the image is forwarded to the app and the admin has two options- allow or cancel. Based on his input the necessary action is taken. In this case, allow is selected and the corresponding message is displayed on the screen as shown in the following figure.

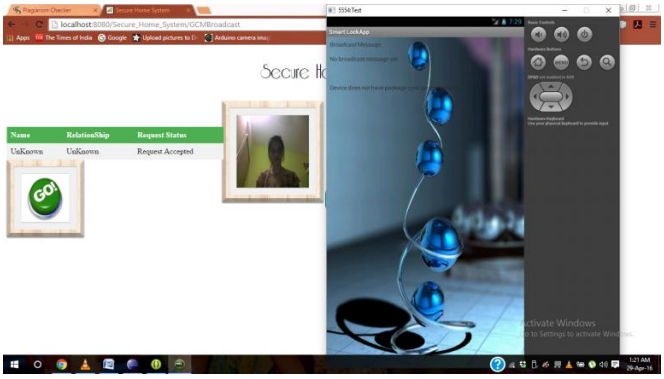

Figure 5.5: Request accepted by admin

6. Conclusion

Smart Lock System can greatly automate the security access to home environments. Use of Wi-Fi and GCM, remote access is provided for the owner. Android app simplifies the process and the system can work anytime, anywhere. Known members do not need to wait for the owner to let them in.

7. Future Enhancements

Multiple systems in the home environment can be integrated and allowed different levels of security. Motion sensors can be used to trigger alarms and inform law enforcement. More than one admin may be given power of decision making. Face recognition algorithms may be improvised.

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