The Secured House System based on Raspberry Pi: What is Penta? Is it able to guarantee the Door Security?

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***Abstract*— Nowadays, many people are more likely to use smart systems and devices rather than usual and physical tools for a door security. In this paper, we will introduce a new kind of smart product-Penta that works with Raspberry Pi. It provides users with five ways for locking and unlocking a door. Additionally, it includes Streaming Camera which the functionality is showing and recording a current situation beside the door. Furthermore, Penta contains Magic Mirror that works for presenting streamed or recorded videos, and this mirror also displays information about a current humidity, temperature, date and time using the Internet of Things. There may still be some similar devices. However, the advantage of the proposed product over existing ones is that the users can have five functional ways to lock and unlock the door at a time, and all implementing technologies work interactively with each other using Raspberry Pi. We also implement a two-step verification process to our system. In this paper, we provide an overview of Raspberry Pi architecture firstly and its features. Furthermore, we will try to explain the working system of the Penta product in a detailed way and then, compare the product to the existing ones. We also lay out some possible future trends and new additional technologies for the Secured House System.**

***Keywords*— Raspberry Pi, Penta Product, Streaming Camera, Magic Mirror, Sensors, Secured House System.**

I. INTRODUCTION

Today, many people in the field of computer science are using Raspberry Pi (credit card-sized computers developed in the United Kingdom to promote education in schools [1]) on developing different kinds of projects. Interestingly, it does not have output devices (such as keyboards and mice) and cases. It is very comfortable to use and costs notably cheaper than the real desktops and laptops. Thus, the Raspberry Pi Foundation declared that more than 5 million Raspberry Pies were sold by February 2015, making it the best-selling British computer [2]. In March 2018, the sales went to 19 million [3].

So far, several generations of Raspberry Pi have been released. Every version promote a Broadcom system on a chip with an integrated ARM-compatible CPU and GPU. Processor speed ranges from 700 MHz to 1.4 GHz, onboard memory ranges from 256 MB to 1 GB RAM. Secure Digital (SD) cards are used to store the operating system and program memory in either SDHC or Micro-SDHC sizes. The boards have one to four USB ports. HDMI and composite video give the chance to use the video possibilities, with a standard 3.5 mm tip-ring-sleeve jack for audio output. A few GPIO pins provide lower-level outputs for supporting common protocols like I²C. The “B-model Raspberry Pi” has an 8P8C Ethernet port. And the Pi 3 and Pi Zero W have onboard Wi-Fi 802.11n and Bluetooth. Figure 1 below shows a hardware view of the Raspberry Pi 3.

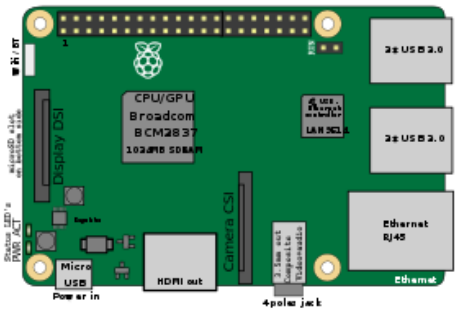


Fig. 1. Functional block schematic of the Raspberry-Pi [5].

The Raspberry Pi was designated for working with the Linux operating system, and many Linux models now have a version specialized for the Raspberry Pi. Most popular ones are Raspbian and Pidora, which are based on the Debian and Fedora operating systems, respectively. In addition to one of those operating systems, several things such as Raspberry Pi itself, monitor, HDMI cable, USB keyboard, USB mouse, power supply and 8GB SD card are needed to get started with Raspberry Pi. How the hardware related ports positioned has shown in Figure 2 below, and it shows a schematic view of the Raspberry Pi simultaneously.

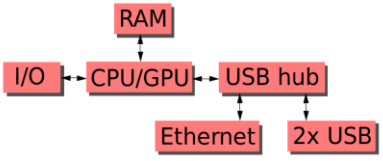


Fig. 2. Functional block schematic of the Raspberry-Pi [5].

So far, a few versions that could be differentiated on memory capacity and peripheral-device support have been introduced such as Raspberry Pi B, Raspberry Pi A+, Raspberry Pi 2, Raspberry Pi Zero, Raspberry Pi 3, Raspberry Pi Zero W, Raspberry Pi Zero WH, and Raspberry Pi 3 B+. The RAM ranges from 256MB to 1GB DDR2 according to the versions of it [6].

Its performance differs according to its versions that means as it has been upgraded, the quality of its performance has also considerably been improved. For example, The Raspberry Pi 3 has ten times more powerful processor compared to Raspberry Pi 1 [7]. Furthermore, the Raspberry Pi 3 has been considered to be approximately 80% faster than the Raspberry Pi 2 in parallelized tasks [8].

When it comes to its video performance process, the video controller can generate standard modern TV resolutions, such as HD and Full HD, and higher or lower monitor resolutions as well as older NTSC or PAL standard CRT TV resolutions. As it has been changed its versions time by time, the following resolutions can experiment: 640×350 EGA; 640×480 VGA; 800×600 SVGA; 1024×768 XGA; 1280×720 720p HDTV; 1280×768 WXGA variant; 1280×800 WXGA variant; 1280×1024 SXGA; 1366×768 WXGA variant; 1400×1050 SXGA+; 1600×1200 UXGA; 1680×1050 WXGA+; 1920×1080 1080p HDTV; 1920×1200 WUXGA [9]. We have also tried several resolutions to stream and record the current events beside the door in terms of the Secured House System. Here, rather than webcams or cameras, Raspberry Pi camera is very appropriate for the testing with its easiness.

Networking characters on Raspberry Pi also varies according to its different versions. That is to say, The Model A, A+ and Pi Zero does not have Ethernet circuitry and are commonly connected to a network using USB Ethernet or Wi-Fi adapter, while the Model B and B+ the Ethernet port is provided by a built-in USB Ethernet adapter using the SMSC LAN9514 chip [10]. The Raspberry Pi 3 and Pi Zero W that is wireless are supported with 2.4 GHz WiFi 802.11n (150 Mbit/s) and Bluetooth 4.1 (24 Mbit/s) based on the Broadcom BCM43438 FullMAC chip with unofficial support for the mode of the monitor but applied through unofficial firmware patching [11] and the Pi 3 also has a 10/100 Mbit/s Ethernet port.

In this paper, we have just given a brief information about Raspberry Pi models and its several features. In the second section, we will describe our security based Penta product carried on Raspberry Pi. Next, we will explain the functions of the Penta product one by one orderly with some use case, class diagrams and use case scenarios, and in the fourth section, we will talk about results and analysis. Then we will try to provide related works of the proposed system followed by a discussion in the fifth and sixth sections, respectively. Finally, we will conclude our paper and give some future scopes in the last section.

II. PENTA PRODUCT

Let's consider we need the security product for our house or office. Here, a fingerprint or face recognition device can come to our mind firstly in terms of the door security. There are also other devices such as QR code, encryption-based cards, and security tools for the user authentication besides the door. Recently, there have been continual development on the security terms as the technology has been improving day by day.

Besides, new innovative ideas and investments on home security have been increasing gradually. For example, these days people across the world are investing their hard-earned money in home security. And the systems could range from light sensors or security cameras to a suite of integrated "smart home" solutions. Together, security products are big business. The global security market is slated to surpass $100 billion by 2020. Home security systems will account for an estimated $47 billion of the total security market [12].

When it comes to our Penta product, it is the kind of security device that can hold several functions such as face recognition, fingerprint system, keypad system, mobile application and metallic key on it at a time in terms of securing the door of the house or workplaces. This product enables host users to open the door conveniently with one of the above alternatives. At the same time, it can also be a real problem to hack for the intruders with its complex features and characteristics. Because the users can also use a two-step verification method. With its multi-functionality and easy usability, it could get fast and big interests from the audience.

Interestingly, the product also includes the Magic Mirror and Streaming Camera. Here, the Magic Mirror is fixed inside the house for showing a few data about temperature and humidity of the room and some other information, while the Smart Camera around the gate can show the current situation or who the person beside the door is. Importantly, all devices including the Magic Mirror and Streaming Camera are connected to the Raspberry Pi, and they work interactively. We are using Python and JavaScript programming languages to make the product.

A. Use Case Diagram for Penta System

Figure 3 below shows how the user can execute the Penta product for the Secured House System step by step. And it is door based part of the product. As Fig. 3 demonstrates, there might be two kinds of users host and guest who can interact with the Raspberry Pi based system. There are also two actors called IoT device and App in figure 3 that can help run the true environment and the process with the user. The end user can select one option to open the door among five ways, for example, face recognition. Then, only with the recognition of the IoT device, he or she can get the door opened. Otherwise, the system fails and a user should select another method or try again the process from the beginning.

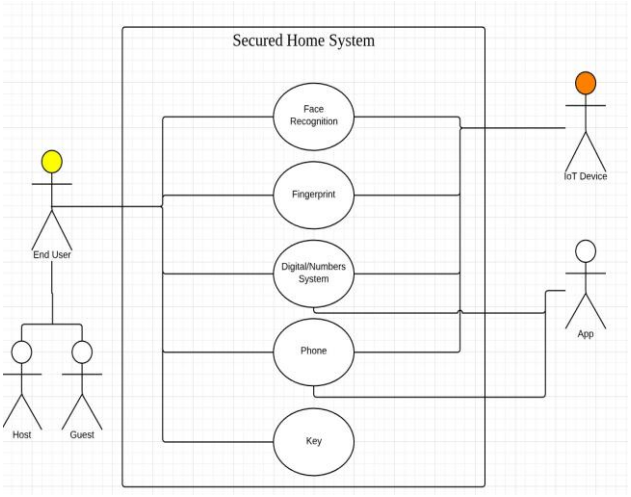


Fig. 3. Overall Use case diagram for Penta product (door based part).

B. *Use Case Scenario for Penta System*

In the following you can see the use case scenario for the working condition of the Penta product:

Start of Primary scenario/transaction

1. The user unlocks the door by face recognition.
2. The system recognizes the user`s face / Open the door.
3. If the system cannot recognize the face then **<<Scenario1>>.**
4. The user unlocks the door by the fingerprint sensor.
5. The system recognizes the fingerprint.
6. If the system cannot recognize the fingerprint then **<< Scenario2>>.**
7. The user unlocks the door by Digital system.
8. The mobile app receives the request and sends 4 digits to the Internet of Things and shows to the app owner(user).
9. If digital passwords do not match then **<<Scenario3>>.**
10. The user unlocks the door by the phone.
11. The app opens the door via the server.
12. If the app does not work then **<< Scenario 4>>.**
13. The user unlocks the door by metallic key.
14. If the key does not unlock the door then **<<Scenario5>>.**
15. Open the door.

End of the scenario.

Scenario 1: The user uses another method to open. End of face recognition.

Scenario 2: The user uses another method to open. End of the fingerprint.

Scenario 3: The user uses another method to open. End of the keypad (digital system).

Scenario 4: The user uses another method to open. End of the mobile app.

Scenario 5: If none of methods work then, use the metallic key.

C. *Class Diagram for Penta System*

In our research paper, we have also tried to consider approximate classes for the Penta product with the intention of clarifying the coding part of the project more clearly. This can also give data about the whole product interacted with the central Penta - Raspberry Pi and helps better understand the general overview of the system. For example, in case we understand one of the classes is a <<Penta>> class, it includes the name of the class, the attributes of the class such as -try: int, -verified: bool and -isOn: bool in order to describe the qualities of the class. Also, it may contain operations (methods), and these operations describe how a class interacts with data along the whole system.

D. *Registration part for the system*

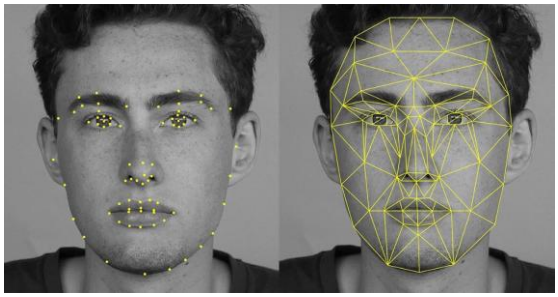


Fig. 4. Face recognition mockup example [13].

It is time to specify the registration process for the system by the host users. The registration process has several steps. The host users should possess some walks on the enrollment for the system. As there are face recognition and fingerprint systems in the product, the users should follow the procedures of the authentication. The figures 4 and 5 show mockup examples for the process of the face and fingerprint registration, respectively.

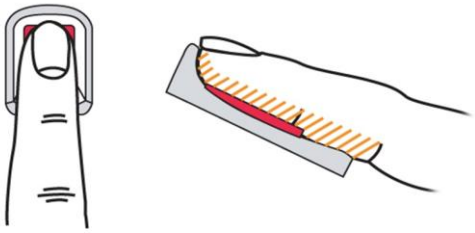


Fig. 5. Fingerprint registration mockup example [14].

E. *Use Case Diagram for the Registration Process*

Figure 6 below shows how the user enrolls for the Penta System step by step. It mainly includes face recognition and fingerprint system registrations. The process is explained in a more detailed way in the following use case scenario part.

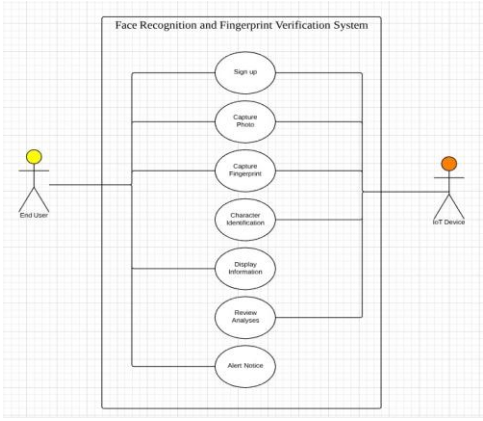


Fig. 6. Face recognition and Fingerprint system Registration use case diagram.

F. Use Case Scenario for the Registration Process

In the following you can see the use case scenario for the working condition of the Registration Process:

Start of Primary scenario/transaction.1. The user provides face photo and fingerprint for registration. 2. The system saves the user`s data into the database. 3. The user inputs information (name, mail…). 4. The system analyses the given data and shows an alert (ok) button. 5. If the user does not confirm the process then << Scenario 1>>. **End of the scenario.**

Scenario 1: Restart the registration process. End of current registration.

After all, the Penta product gives the multifunctional ways to the users to open the door.

As you see, the registration process is very formative and easy to understand. We should know a registration process is a very important part of the system because it should list the real host users and members of the system (Penta product). Other different functions of the Penta product will be described in the coming section.

III. PENTA PRODUCT FUNCTIONS

The Penta product has five functions which mean, the users can lock and unlock the door by using one of them. And it includes face recognition, mobile application, fingerprint, and keypad system and a usual metallic key. This is the door based part of the product. Besides, the Penta product also contains Magic Mirror and Streaming Camera that is connected and run by the Raspberry Pi. They all work inter-connectively and interact with each other. In this section, we will try to illustrate them in a specific way one by one.

A. Face Recognition

A facial authentication system is a kind of technology that gives the chance to identify or validate a person from a digital image or a video frame from a video source. We can also know a facial recognition system as a Biometric Artificial Intelligence-based application that can uniquely identify a person by analyzing patterns based on the person's facial textures and shape [15]. We can also say facial recognition is a category of biometric software that comes across an individual's facial features mathematically and saves the data as a face print. In terms of authentication of the end users, and with its popularity according to security concerns we have also decided to use facial recognition in our Product. Here, it interacts with on-users and some Internet of Things such as Raspberry Pi.

Figure 7 in the below illustrates the use case diagram for the Face recognition system. Here, you can see several stages that are held via interactions by the user and IoT device. There is an important stage related to the case of the matching face. If the user's face matches then the Pi opens the door, otherwise it rejects the face and the user should follow the steps from the beginning or the user can use another method to open the door. The following scenario clarifies the steps in figure 7.

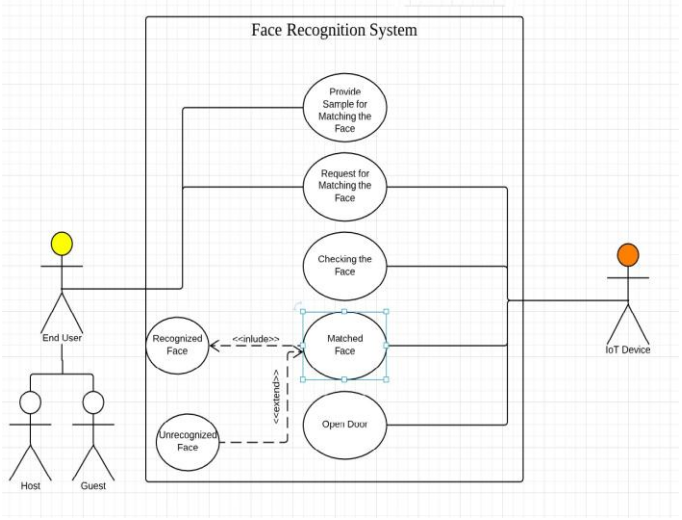


Fig. 7. Diagram for the Face recognition System.

Start of Primary scenario/transaction.

1. The user provides a sample for matching the face.
2. He or she requests the identification from the system.
3. The system accepts and checks the user`s face from the database.
4. The system recognizes (detects) the given face, and opens the door.
5. If the system does not verify the face then **<<Scenario1>>.**

End of the scenario.

Scenario 1: The user uses another method to open. End of face recognition.

The Face recognition system classes approximately contain detection, face recognition, database and recognition classes in terms of programming in our project. Logically, a detection class has a "receive image" attribute with detect_Face() and draw_Rectangle() methods. In the face recognition class, we can write user attribute with integer value and send_Message(), verify_Login() methods.

A database class mainly works with methods that save the images and users' data. In the recognition class, attributes on receiving images, names and numbers of the faces are accomplished and a compare_Face() method is executed.

Next, another function of the Penta product is explained in a detailed way.

B. *Fingerprint System*

A fingerprint identification system is a kind of automated method that uses biometric technology in order to store digital images of individual fingerprints for database comparison to make a match. Fingerprints are considered a foolproof method for identification purposes because each fingerprint is unique [16]. Actually, fingerprints have been widely used with criminology, specifically detecting the crime. As a result of development on it, such as producing cheaper and robust automated fingerprint authentication systems has led to its widespread commercial and civilian applications, nowadays. For this, we have also decided to add this kind of biometric authentication for our product via making the interaction between Fingerprint System and Raspberry Pi. Looking at figure 8, we can easily understand communications between the user and Internet of Things on the fingerprint system. There is somehow similarity on working face recognition and fingerprint system as both of them are related to one system. Instead of the face, the user should provide a fingerprint sample for being authorized.

For more clear understanding we can consider the following scenario:

Start of Primary scenario/transaction.

1. The user provides a sample for matching the fingerprint.
2. He or she requests the identification from the system.
3. The system accepts and checks the user's fingerprint from the database.
4. The system recognizes (detects) the shown fingerprint, and opens the door.
5. If the system does not verify the fingerprint then **<<Scenario 2>>.**

End of the scenario.

Scenario 2: The user uses another method to open. End of the fingerprint.

When it comes to an estimated programming part of the system for the fingerprint, mainly database, fingerprint system, scanning pattern and matching classes are included. Here, one of the most interesting and important parts can be the methods for searching the given pattern from the database and comparing it with other existing patterns and lastly, matching it or not.

Over the next, we will try to highlight another system to open the door in a clear way.

C. *Keypad System*

A Keypad system is a kind of simple security system that requires just a PIN code for a door or gate entry with no access card or credential required. The keypad is also a central component in the world of access control, nowadays. Most of the modern offices with electronic locks popularly use a keypad either as a secondary access option, with another security access control system, or as a stand-alone access point. However, many people think that it is not a secure solution to make an office safe, only a convenient method to gain access because a PIN can be shared an infinite number of times between people, regardless of permission levels. For this reason, we have also decided to integrate it with a mobile application. A mobile application is also another method to open the door in our project, at the same time it is one-time random number generator for the keypad system. More specifically, the user requests for one time random PIN for the mobile application and it sends random digits both to the user and Raspberry Pi server that fixed to the door. If the inputs by the user and sent digits by the app are the same, the door is opened. The following diagram can show the working process of the keypad system step by step:

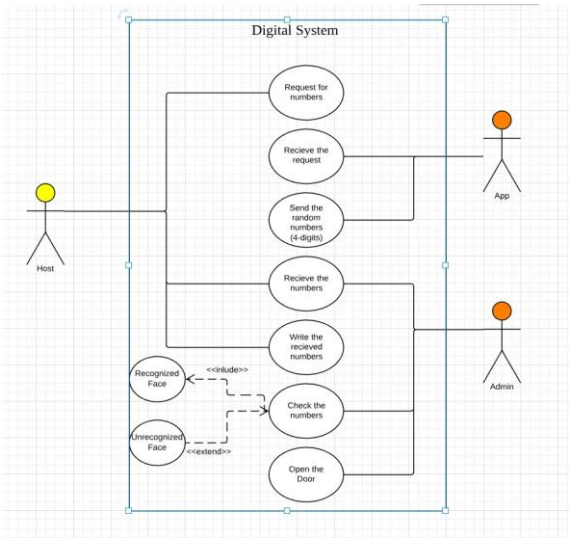


Fig. 8. Diagram for the Keypad System.

It is important to note that, the keypad system only works when the user requests PIN for the mobile application. Otherwise, it is in a default state, and if someone tries to enter inputs more than given times, it alerts the host user. Below scenario shows the working steps of the keypad in our system:

Start of Primary scenario/transaction. 1. The user requests numbers for the app. 2. The app receives the requests and sends random 4 digits to the user and admin (Penta system). 3. After receiving the digits, the user inputs the numbers to the keypad. 4. The admin compares the user's and app's numbers. 5. If the digits are the same (valid), the admin opens the door. Otherwise, << Scenario 3>>. **End of the scenario.**

Scenario 3: The user uses another method to open. End of the keypad (digital system).

So, we have reached the compatibility and trustability of the keypad system through one-time random PIN numbers. that are sent by mobile application and should be proven by a Raspberry Pi system in order to increase the reliability of the Keypad system.

In the next, we will analyze another method to open the door.

D. *Mobile Application*

Indeed, the industry of smartphones has been revolutionizing time by time and today's' smartphones are capable of doing something new every day, from translating speech to monitoring our health. Now, we can see there are many new applications such as remotely lock and unlock doors on our phones from wherever we are. So, we have

targeted to make a mobile application that works collaboratively with other existing technologies inside our system. And, we use the Blynk server and mobile application to organize and run our system. Specifically, it generates random digits when the user requests and sends it both to the user and Raspberry Pi system.

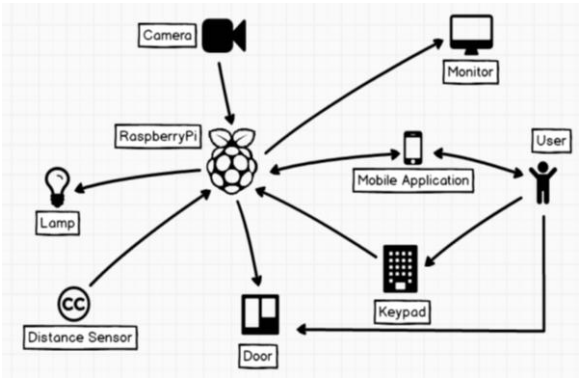


Fig. 9. Schematic view of working Mobile Application.

Figure 9 in the above gives a clear comprehension about working mobile application based system of the project. There are several functions of mobile application:

- Open the door with Mobile Application (lock and unlock functions);
- Making the connection with online streaming using this Mobile Application;
- Remotely controlling the lamps of the house using the Mobile Application;
- Watching the videos that have been recorded and streamed.

Generally, in our system, users can open the door, control the lamp and watch the stream or recorded videos from Raspberry Pi memory via a mobile application. Furthermore, we can say the Mobile Application is a connector between Raspberry Pi and the user. So, they also work parallel which means, Mobile Application sends the data and given requests from the user to the Raspberry Pi. While Raspberry Pi also displays information to the user via Mobile Application. Moreover, the camera makes a live stream and sends it to the Raspberry Pi. Then, the user can watch it using Mobile Application.

The main goal for making this Mobile Application is giving an enhanced control to the users over the devices by using this App, which means we have aimed to supply the users with a valid and worthy comfort.

Case Study: Tom is the user. He has owned this Mobile Application. Firstly, he comes home and opens the door with this app by clicking" unlock the door" button. Here, after receiving the unlock request the Pi opens the door. When he enters his room, he sees the lamp is on and he does not need to the light. So, he can turn off the lamp using this application by clicking "off the lamp" button. Later, somebody knocks the door and Tom knows who he is. He is Tom's friend James. Tom knows this easily because he can see the streaming camera next to the door using the Application on his mobile phone. Here, streaming video is sent to Raspberry Pi which can be displayed on the App then.

Case Study Conclusion: Tom is very satisfied with this application as it can assist Tom in many situations. Besides, it supports enough comfort for Tom on controlling the existing devices appropriately.

Mobile Application is the fourth method to open the door in our system. The fifth one is just using a metallic key. The users can open the door using the simple and ordinary key.

For the following, we will describe other parts of the Penta product namely, Streaming Camera and Magic Mirror, respectively.

*E. **Streaming Camera***

There are a few functions of Streaming Camera:

- Making a live video (Streaming by using localhost);
- Monitoring the outside using this camera by the user host inside the house using the same local host;
- Recording the video that has been streamed;
- Watching/Reviewing the video using the mobile application.

The main goal for making the Streaming Camera System is giving the chance to the users to be informed about the current situation next to the door and monitor it. Of course, using this streaming camera improves the users' convenience and the security of the house. In a somewhat way, it can also develop the connectivity between the existing systems and the users with displaying the live videos and recording them. Looking at figure 10, we can simplify and easily understand the characteristics of the Streaming Camera.

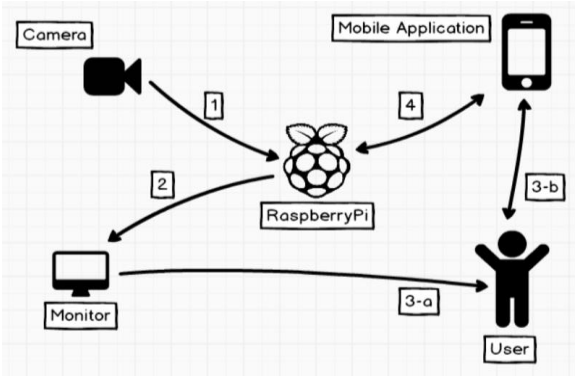


Fig. 10. Schematic view of working Mobile Application.

In figure 10:

1) The Camera continually streams the current situation next to the door and Raspberry Pi records it daily. (It is fixed around the door above the PENTA Product).

2) Raspberry Pi provides the Monitor with the streaming video. (Camera sends to the Pi the video every time).

3) User able to interconnect both phone and monitor

a) When the user wants to see the current situation next to the door, he or she can watch it via Monitor.
b) The app can also display the live video or recorded video next to the door in case of the user request.

4) The Pi and the app works inter-connectively which means, they exchange the data (The user requests live or recorded video for the Pi via the app, and the Pi supplies the User the requested data via the app).

F. Magic Mirror

A magic mirror is a raspberry pi based and powered monitor that is fixed behind a double-sided mirror. The black web page permits you to add some widgets or data to the mirror's reflection as if by magic. This version includes widgets for displaying the weather forecast, the date/time and a nice randomly generated greeting [17]. Our Penta product also includes this mirror as it can get an interest by users. Technically, the mirror gets data from sensors. Then, it displays data of climate (inside/outside temperature and humidity, time/year/date). If the user requests Live Stream to watch outside next to the door, the mirror receives the request and displays live stream data.
When it comes to a coding part of the mirror, it might include several classes such as settings, magic mirror, sensors, and live stream. They are followed by different types of methods like set_Temprature(), set_Date(), receive_Live_Stream() and so on.

Overall, Penta product is a product that can support different kinds of security devices and the Internet of Things. It is willingly reliable and trustworthy product with its multifunctional possibilities based on security concerns.

IV. Results and Analysis

We have achieved the security system that works with Raspberry Pi. This system gives us the product Penta that holds a few functionalities such as face recognition, fingerprint system, mobile application, keypad system, streaming camera and magic mirror and Internet of Things. These all interact each other using Raspberry Pi. We have achieved to run main parts of the coding process in Python and JavaScript programming languages using the Linux Operating System. Overall, we get the system to

- Give understandable knowledge on security protocols (users can know briefly about communications among existing devices and interactions between users and the Internet of things through the system);
- Stream and record (streaming cameras grant proper data about users' home and a real-time beside the door. The users then watch the live stream remotely using Blynk mobile application);
- Develop and improve door security levels (there are technically 5 ways to lock and unlock the door and users can use a two-step verification process if they want.);
- Expose the users of the product to experience on several door security appliances (such as face recognition, fingerprint system, keypad system, and mobile application);
- Provide an exact information about humidex of the room, date and current time (Magic mirror supplies this data using the Internet of Things. Users also get a strong surveillance using this mirror, which means it also works for presenting the stream or recorded videos);

In the following figure 11 shows the demos of the proposed Penta product:

Fig. 11. Demo of the proposed product.

In our keypad system, there are several buttons. Specifically, we also added clear and delete functions, in case a user inputs wrong numbers, he or she can clear or delete them.
In this section, we also want to demonstrate the result of the sequence diagram for getting clear comprehension about the working steps and orders of the overall system. Looking at figure 12 provides that firstly the user interacts, then the system reacts. For example, in case of face recognition the user provides a face sample and then Penta verifies the face and then opens the door. Otherwise, it rejects to unlock the door and shows "try again or use another method" text.

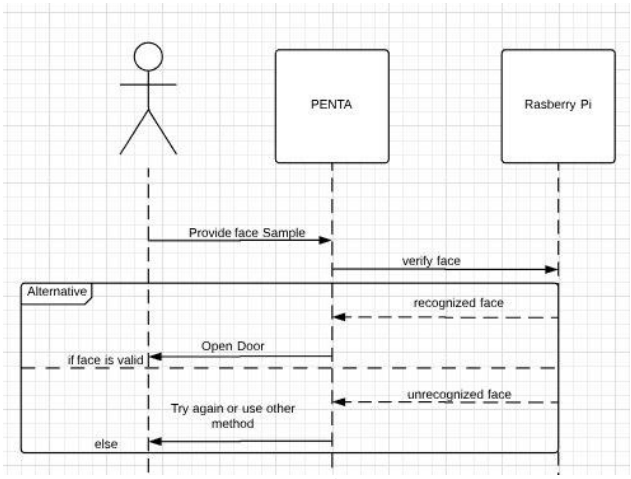


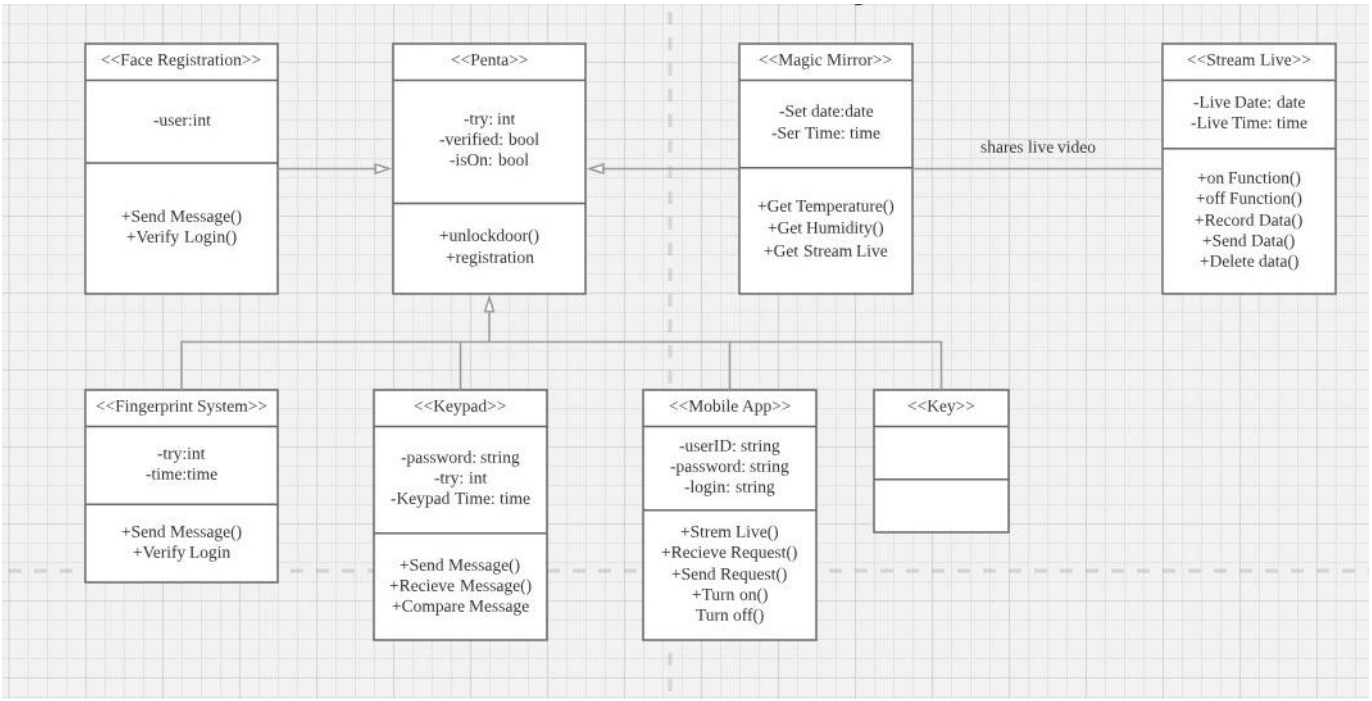
Fig. 12. Sequence Diagram for the overall system.

As long as the users want to implement a two-step verification process in the door based part of the system, they should select two ways to unlock the door. It means

visitors have to undergo two procedures for making the door unlocked. For instance, an A user should have both face recognition and fingerprint approval at a time to unlock the door. As a result, the system more guarantees the level of door security in the places.

We also get an approximated class diagram for the overall system. Figure 13 illustrates that all existing devices interact with each other via a central Penta system. According to the class diagram, it is also important to note that Raspberry Pi should definitely get linked to the network or IEEE 802.11x, in order to achieve a proper working environment of the structure. While Blyink mobile application in the system does not need to be connected to the same network or IEEE 802.11x with Raspberry Pi. Which means, users can remotely lock and unlock the door as we stated before.

Fig. 13. Class Diagram for the overall system.



Furthermore, we also achieved that the users can watch the stream using a hidden password of their Gmail account for YouTube channel. Importantly, the users can do this channel private rather than public for the security.

V. Discussion

Since there is a need to secure the entrance parts of the places from the intruders and thieves, people have dedicated many efforts and investments for different security projects around the world. Experts are still working on developing the systems to have more properly controlled entrance or exit flows. However, many apartments and offices have still problems with the door security although they have the kind of surveillance. In this paper, we have outlined the system that uses Raspberry Pi to create an easy communication between the users and the system appliances.

Our main effort is to ensure the security beside the door with the help of Penta product. Despite it has a few security based functionalities, it does not guarantee the door security fully or at 100%. Because, it is mostly said that if there are more ways, it is easy to break. Our Penta system has also 5 ways to lock and unlock the door. For this reason, we want to set up a two-step verification process to improve the level of the security and quality of the system.

Anyway, the field itself still needs to be evolved continually. Our proposed system is developed to contribute to the ongoing work on security concerns, and to popularize the availabilities of the Raspberry Pi on the security projects. The system is easy to use and provides a reliable atmosphere to the door security. Raspberry Pi is also a low-cost computer compared to the others and somehow new in this field. Many people have already enough experience and considerable knowledge of how to use face recognition, fingerprint, keypad systems, and a mobile application. However, our system is conceptual and required to be implemented and tested to show its reliability, usability, and effectiveness in the door security.

The main contribution of this paper is to show potential possibilities of the Raspberry Pi in the Secured Home Architecture, and the aim is to highlight the capabilities of Raspberry Pi based product Penta, as well as, to contribute to the development of security projects. Nevertheless, it has appeared and security availabilities, the system still has to be analyzed and advanced constantly. One of the downsides of the Penta system is that the product may cost higher as it has many functions and technological products. However, it gives a great opportunity to control and secure the house from being burglarized with its different functionalities.

VI. Literature Review

Nowadays, there are many security projects that similar to ours. We will try to highlight some of them in the following: Ankit Jain et al. In [18] have developed a low-cost electronic home security and automation system for unlocking the door and operating the light, fan, and others that are inside. This system also helps in preventing unauthorized unlocking. In case the user forgets the combination of password, the system gives to the user the changing or resetting options. In this system, Arduino UNO microcontroller board works for interfacing different hardware peripherals such as LCD and Relays. For the Penta product, we applied for Keypad system that works with one-time random numbers using Mobile application, which means the users do not need to remember the numbers. In [19] have represented Android-based control system in order to maintain the security of the home and also, the car door lock. In this system, Bluetooth does the security system interface and PIC microcontroller designs hardware part of the system. In our system, we can control and monitor the existing tools using Blynk Mobile application. It works both for Android and IOS systems appropriately.

Seo et al. [20] worked on convenient digital door lock functions, such as remote control via the integration of mobile devices and key sharing. Contrastingly, we also include a time limitation for key sharing because of security concerns. Lee et al. [21] proposed the system that has a method for detecting an accessing object and transmitting the object image. In our Secured House System, streaming camera shows a real-time beside the door and records it. Kwak et al. [22] studied a method for opening and closing the door lock using voice recognition, without using a network. Instead, we used Mobile application to lock and unlock the door without using the Internet. Potts et al. [23] proposed a security system that interfaces with an Android mobile device. The mobile and security system communicate via Bluetooth in a short range. Our targeted system works with Raspberry Pi using a few technology appliances and the Internet of Things for the home security. Choi et al. [24] developed an application for communication between devices for transferring the state of the alarms generated in a home through a door lock in the neighborhood. For our system, we get a mobile application for giving easy and distance control and surveillance of both inside the home and beside the door.

Hassan et al. [25] and Satti et al. [26] studied face recognition for the door lock open. In particular, the application of Satti et al. transfers the SMS about the legitimacy of the user to the mobile device. However, both of them cannot be a perfect IoT application because the door locks are not controlled by the mobile device remotely. In our system, the users can lock or unlock the door using face recognition or remotely using a Mobile application. Studies of Park et al. [27] and Verma et al. [28] are related to security applications for home automation. In our Secured Home System, we consider hardware tools and IoT devices rather than applications for home security. In [29], the Raspberry controls motion detection and video cameras for remote monitoring. For example, if the cameras detect a motion, they automatically begin recording and the Raspberry device gives alerting to the owner of the possible intrusion through a web page. The camera beside the door in our system, streams and records a real-time for remote surveillance continually because there may be the cases that camera could not detect the motions. Then, the host users are able to watch it through an exact link using Blynk mobile application or Magic Mirror.

VII. Conclusion and Future Scope

The system proposed in this paper strengthens the security functions considerably, and it has several multifunctional ways to lock and unlock the door at a time. Besides, it has a streaming camera beside the door that can support and enhance the level of the security in the places. Additionally, the smart mirror inside the room can enable users to watch or observe the current or recorded videos. Alternatively, the user can watch the video via a mobile application on his or her phone. A smart mirror also continually informs the user about the current condition of the room, such as humidity and heat levels. Importantly, the intended and ongoing project is mainly held on Raspberry Pi and using Python and JavaScript programming languages and the Blynk server and mobile application are used to develop the Penta product. All existing system interacts to each other and works collaboratively.

In the future, more functions and new technologies can be carried out on this system and more features can be incorporated, for instance, we can implement the designed digital lock technology that can sense the physical impact of unauthorized visitor and notify the host user's mobile device. Besides, we also think about to develop our system with QR coded and digitized cards which mean, the users can utilize them in terms of unlocking the door.

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References

[1] Cellan-Jones, Rory (5 May 2011). "A£15 computer to inspire young programmers". BBC News.

[2] Gibbs, Samuel (18 February 2015). "Raspberry Pi becomes best selling British computer". The Guardian. Retrieved 28 December 2016.

[3] Upton, Eben (14 March 2018). "Raspberry Pi 3 Model B+ on Sale at $35". Raspberry Pi Blog. Raspberry Pi Foundation. Retrieved 2018-05-04.

[4] Available from: https://upload.wikimedia.org/wikipedia/commons/e/e4/RaspberryPi_3B.svg.

[5] Available from: https://en.wikipedia.org/wiki/Raspberry_Pi#/media/File:Raspberrypi_block_function_v01.svg

[6] Available from: http://en.wikipedia.org/wiki/Raspberry_Pi.

[7] Upton, Eben (29 February 2016). "Raspberry Pi 3 on sale now at $35 – Raspberry Pi". Raspberry Pi. Retrieved

[8] 29 February 2016.

[9] "How Much Power Does Raspberry Pi3B Use? How Fast Is It Compared To Pi2B?". RasPi.TV. RasPi.TV. Retrieved 6 July 2016.

[10] "Raspberry Pi, supported video resolutions". eLinux.org. 30 November 2012. Retrieved 11 December 2012.

[11] "Microchip/SMSC LAN9514 data sheet;" (PDF). Microchip. Retrieved 15 July 2014.

[12] "seemoo-lab/nexmon". GitHub.

[13] Rapid innovations in the home security space – both globally and locally offer residents access to an array of hardware and software solutions to keep their environs safe and secure ETtech | Updated: January 02, 2018, 15:23 IST.
[14] Cole Murray, Software Engineer. Mobile & Full-Stack Engineering. Machine Learning. “Building a Facial Recognition Pipeline with Deep Learning in Tensorflow”.
[15] 6 Ways to Improve Fingerprint Enrollment Process Posted by Danny Thakkar on February 11, 2016 | No Comments.
[16] "What is Facial Recognition? - Definition from Techopedia". Techopedia.com. Retrieved 2018-08-27.
[17] “Automated Fingerprint Identification System (AFIS)”. https://www.techopedia.com/definition/11027/automated-fingerprint-identification-system-afis
[18] Available from: http://blog.dylanjpierce.com/raspberrypi/magicmirror/tutorial/2015/12/27/build-a-magic-mirror.html
[19] MIT International Journal of Electrical and Instrumentation Engineering, Vol.6, No. 1, January 2016, pp. 28-31 ISSN No. 2230-7648 ©MIT Publications
[20] Sadeque Reza Khan, Farzana Sultana Dristy, “Android Based Security And Home Automation System”, International Journal of Ambient Systems and Applications (IJASA), Vol. 3, No. 1, pp. 15-24, March 2015.
[21] D. Seo, H. Ko and Y. Noh, “Design and Implementation of Digital Door Lock by IoT,” KIISE Transactions on Computing Practices (KTCP), vol. 21, no. 3, (2015), pp. 215-222.
[22] S. Lee, J. Park, B. Woo and H. Choi, “Video Digital Doorlock System for Recognition and Transmission of Approaching Objects,” KIPS Transaction: Software and Data Engineering, vol. 3, no. 6, (2014), pp. 237-242
[23] T. Kwak and S. Moon, “A Digital Doorlock with Voice Recognition,” in Proceedings of KIIT Spring Conference, vol. 2012, no. 5, (2012), pp. 345-348.
[24] J. Potts and S. Sukittanon, “Exploiting Bluetooth on Android Mobile Devices for Home Security Application,” in Proceedings of IEEE Southeastcon Orlango, (2012), pp. 1-4.
[25] Y. Choi, Y. Park, W. Back, D. Lee and J. Byun, “Development of Home Automation System using Digital Doorlock based on Wireless Sensor Network,” in Proceedings of KIIT Summer Conference, vol. 2011, no. 5, (2011), pp. 189-193.
[26] H. Hassan, R. Bakar, and A. Mokhtar, “Face Recognition Based on Auto-Switching Magnetic Door Lock System Using”, in Proceedings of 2012 International Conference on System Engineering and Technology, (2012), pp.1-6.
[27] R. Satti, S. Ejaz, and M. Arshad, “A Smart Visitors’ Notification System with Automatic Secure Door Lock using Mobile Communication Technology,” International Journal of Computer and Communication System Engineering, vol. 2, (2015), pp. 39-44.
[28] Y. Park, P. Sthapit, and J. Pyun, “Smart Digital Door Lock for the Home Automation”, in Proceedings of TENCON 2009, (2009), pp. 1-5.
[29] Kanaga D., Raja S., Viswanathan C., Sivakumar D., Vikekanandan M. Secure Smart Home Energy Monitoring System. J. Theor. Appl. Inf. Technol. 2014;66:305–314.