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DEVELOPMENT OF PROGRAMMABLE HOME SECURITY USING GSM SYSTEM FOR EARLY PREVENTION

Jamil Abedalrahim Jamil Alsayaydeh[1,2], Azwan Aziz[1,3], A. I. A. Rahman[1,2], Syed Najib Syed Salim[1,4], Maslan Zainon[1,4], Zikri Abadi Baharudin[1,5], Muhammad Inam Abbasi[1,6] and Adam Wong Yoon Khang[1,6]

[1]Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, Durian Tunggal, Melaka, Malaysia

[2]Center for Advanced Computing Technology, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, Durian Tunggal, Melaka, Malaysia

[3]Centre for Advanced Research on Energy, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, Durian Tunggal, Melaka, Malaysia

[4]Centre of Smart System and Innovative Design, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, Durian Tunggal, Melaka, Malaysia

[5]Centre for Robotics and Industrial Automation, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, Durian Tunggal, Melaka, Malaysia

[6]Center for Telecommunication Research and Innovation, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, Durian Tunggal, Melaka, Malaysia

E-Mail: jamil@utem.edu

ABSTRACT

Lately, the security technology business has been offering an inflexible and expensive alert system. Home security assumes an essential role in the current lifestyle to help identify illegal activities. In addition to the increasing familiarity with productive home security system, the execution of real-time alert system is enticing for users. Home security and control of it are among the basic reserves of humanity since the early days. Provided that it is updated with the rapidly changing technology to ensure vast coverage, remote control, reliability, and real time operation. Deploying wireless technologies for the security and control of home automation systems provides attractive advantages along with an easy-to-use interface. In the proposed project, a programmable home security system by using GSM system was developed. Raspberry Pi 3 was used as the main controller (server). A Passive Infrared (PIR) sensor was utilized to detect the intruder when an intrusion occurs. It performs its ability by measuring changes in the infrared rays in its field of view. When any potential break-ins are identified, the pi camera module installed on the Raspberry Pi 3 will capture the intruders' photo. Meanwhile, the installed GSM module will send a warning message to the user, which shall also include the intruders' photo link. Finally, the image will be loaded into the created web page. Along these lines, the user can confirm the message received and take a quick step by reporting the incident to the authorized entity. With everything in mind, this improvement provides a reasonable and easy-to-use home security system.

Keywords: raspberry Pi, PIR, home security, new technology applications, paper specifications, internet of things, home control.

INTRODUCTION

Nowadays, burglaries and home invasions are gradually increasing. Residents could not keep their expensive things and properties with full safety. With the advent of this project, we can prevent the loss of property and lives by creating some kind of security system that allows an alert message to be sent to the users and residents when a burglar enters the house. Keeping in mind the end goal to upgrade an enhanced and life hazard free security system, it is substantially more secure to have a system that screens and conveys to the device owner without putting human life to risk in the name of "Guard". This has a tendency to use the accessibility of GSM system to accomplish a mechanized system which is customized to fill in as deduction gadget [1].

Therefore, the home security system which can detect the presence of intruders is needed. As a result, for this situation, a reliable GSM based home security system has been designed. This system will provide real time house monitoring by sending immediate notifications to users through GSM network if there is an illegal intrusion. House owners that are away from house also will get the notifications as long as the GSM signal is available. Additionally, some thefts happen repeatedly due to lack of evidence and to combat this, the proposed will provide sufficient evidence of the thieving incidents such as the image of the thief, which will facilitate the submission of report to the authority.

Advances in technical knowledge of new technology applications have allowed it to come up with various products and solve problems for many previous tasks and responsibilities that were previously only formed through human intervention. The normalization of smart devices or machines derived from smart technology in the contemporary world have given path to implementing traditional way of work in a new manner. Much is then done to lend a hand to the tasks based on human monitoring at all levels - home businesses, businesses and industrial businesses [2].

The objective of the project is to design a home security system using Raspberry Pi 3 in the help of GSM system Second objective is to develop a notification system for the user through SMS and the last objective is to reduce the occurrence of house theft and burglaries.

PROJECT BACKGROUND

In recent times the necessity of home security system has become very important and it is used often in home or residence, commercial buildings, offices and also for traffic control systems. The purpose of a home security system is primarily used to check activities, behavior, or other changes in information in order to manage or protect personal belongings. These days, this system is installed in the house to monitor and avoid any unwanted activities. Thus, the owner can quickly take necessary action in case of any exacerbations [3].

An electronic system is an electronic circuit with components that are designed to perform simple or complex functions of standing in home automation architecture. Typical examples of these subsystems used in home automation include elements such as a communication system; Computer system and some automation systems [4].

Moreover, there are very few universally accepted industry standards for developing domino-based devices / systems. Therefore, the smart home domain / space are still highly fragmented while there are many competing vendors [5].

GLOBAL SYSTEM FOR MOBILE (GSM)

Global System for Mobile Communications is a digital cellular technology used for mobile data and transmitting mobile voice. The time division multiple access (TDMA) variance is the most widely used of the three wireless digital telephony technologies (TDMA, GSM, and CDMA). GSM packs the information, then sends it to a channel with two different streams of user data, each in its own period of time. GSM has few services which are remote services, data services and supplementary services. Remote services include cell phones, and data services consist of short message services and supplementary services for incoming and outgoing calls, call transfer, call waiting, call hold and conference. This device supports voice calls and data transmission speeds of 9.6 Kbps, including SMS transmission. GSM operates in 900MHz or either 1.8GHz recurrence band. GSM first launched at Finland 1991.In current era, more than 690 mobile networks provide GSM services across 213 countries.

Many network operators have signed agreements with foreign operators, so this makes the user continue to use their mobile phones even while travelling. The Global System for Mobile (GSM) is known as the second era communications framework standard that has been worked out to deal with cracking problems in major cell structures. Formerly known as Group Special Mobile. The Chamber was tasked with demonstrating a standard mobile messaging infrastructure for Europe in the 900 MHz band [6].

Table-1. Worldwide development of mobile telephone systems.

Year	Mobile System
1981	Nordic Mobile Telephone (NMT) 450
1983	American Mobile Phone System (AMPS)
1985	Total Access Communication System (TACS)
1986	Nordic Mobile Telephone (NMT) 900
1991	American Digital Cellular (ADC)
1991	Global System for Mobile Communication (GSM)
1992	Digital Cellular System (DCS) 1800
1994	Personal Digital Cellular (PDC)
1995	PCS 1900-Canada
1996	PCS-United States

Table-2. GSM milestone.

Year	Milestone
1982	GSM formed
1986	Field test
1987	TDMA chosen as access method
1988	Memorandum of understanding signed
1989	Validation of GSM system
1990	Pre-operation system
1991	Commercial system start-up
1992	Coverage of larger cities/airports
1993	Coverage of main roads
1995	Coverage of rural areas

Retrieved on April 2017 from book “Global System for Communication” [7].

GSM BASED HOME SECURITY ALARM SYSTEM

In view of Abhishek S. Parab, innovation influences used to impart contribution to motion from machines to yield message on gadget. That implies after recognition of any interruption, GSM Modem sends the fitting message to house proprietor's telephone. The signs or information which is originates from sensors or other gear digitize it by GSM module and send it to receiver [8].

It is very easy to install and cost efficient. Essentially it introduced over the section entryway and that entryway comprise with magnet which is associated with relay, as transfer disengaged from magnet, signal will produce by means of relay and sends it to microcontroller and actions makes put by bit of code written in the chip and GSM module sends the message to proprietor's telephone. In general, GSM based home security systems is the best and more adaptable than other security systems. This system is likewise the least expensive system [9].

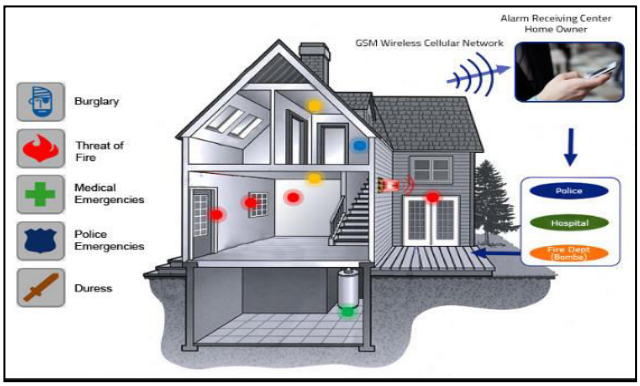

Figure-1. Overview of GSM based home security system.

PASSIVE INFRARED SENSOR (PIR)

Sensor elements like other automation system are a very important part of a home remote control system. Common elements of the sensor system are magnetic contacts, infrared (IR) sensors, and passive infrared (PIR) sensors, etc. [10].

Passive infrared (PIR) sensors and thermoelectric effect have been known for too many years. The principle of the operation is that it detects movement and there is a very strong correlation between the movements in the room and the person in the room, so this choice must be one of the most reliable options. PIR sensors also allow motion sensing and are always used to detect whether a human has moved within or outside the sensor's range. [11] [12].

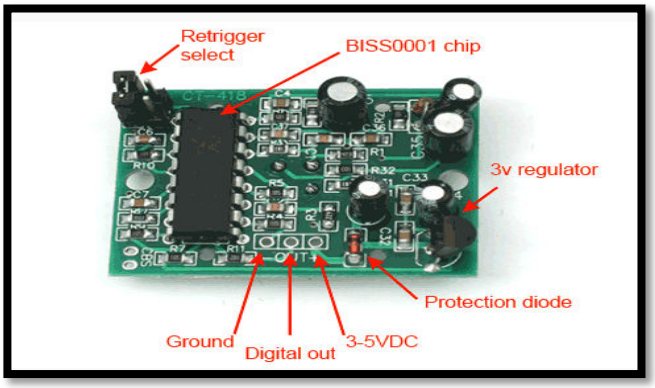

Figure-2. PIR former designs.

Besides the Pyro electrical sensor, there is a host of inexpensive booster circuits, resistors, capacitors, and chips. This chip takes the output of the sensor and does some simple manipulation on it to emit a digital output pulse from the analog sensor. They have a wide lens range, and are easy to handle [13].

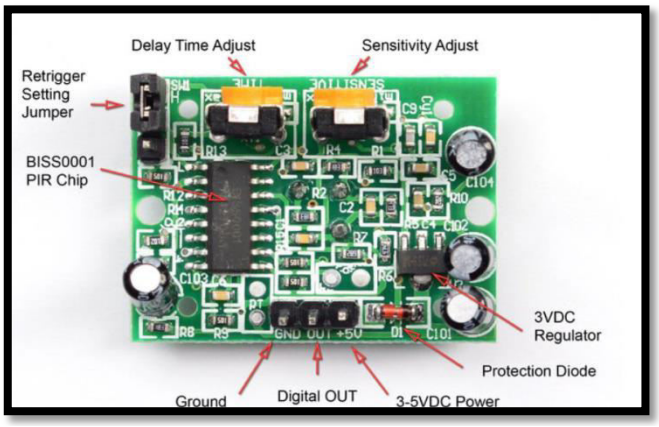

Figure-3. PIR recent designs

With cognitive and technological advances, new / modern PIRs have more adjustable settings compared to their previous designs (Figure-2).

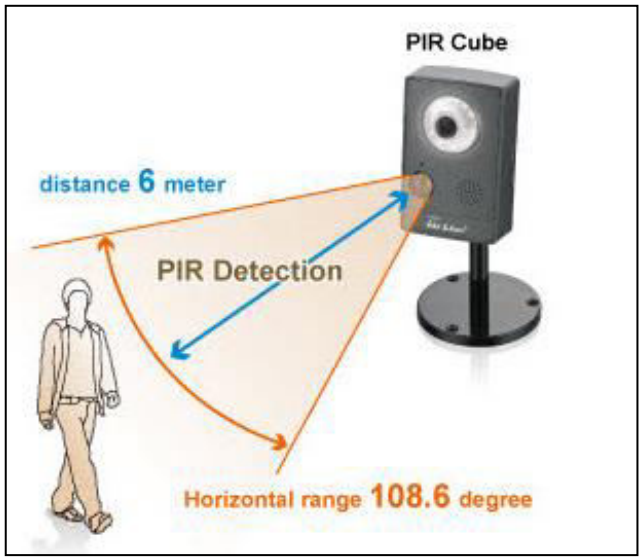

Figure-4. PIR recent designs.

Table-3. PIR Sensor pin configuration.

Pin	Name	Function
-	GND	Connects to Ground
+	V+ (input)	3.3V to 5V (Input voltage)
OUT	Output	Input/Output

Table-4. Jumper setting configuration.

Position	Mode	Description
H	Retrigger	Idle – Output is LOW Output - Output remains HIGH after triggered until motion is not detected.
L	Normal	Idle – Output is LOW Output – Output turns HIGH and then LOW (repeatedly)

RASPBERRY PI CAMERA MODULE

The camera may accompany a little bit of translucent blue plastic film covering the focal point. This is just present to ensure the focal point while it is being sent to you, and should be expelled by gently peeling it off [14].

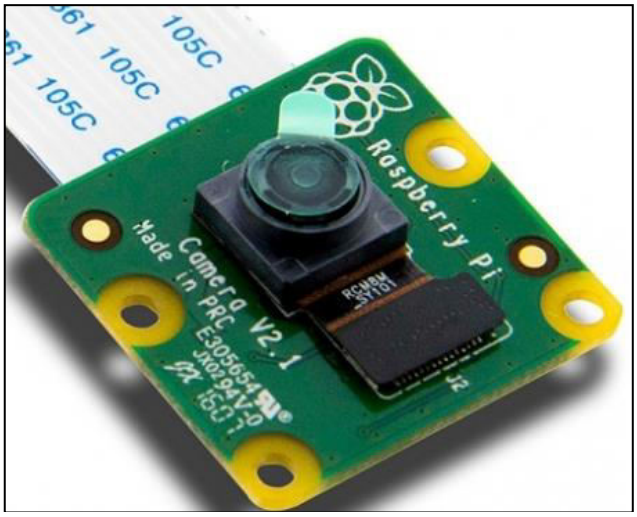

Figure-5. Raspberry Pi Camera Module.

RASPBERRY PI CONFIGURATION

- **Raspian installation**

Raspian is the operating system of the Rapberry Pi. Initially, it is downloading the Raspian from the Raspberry official site.

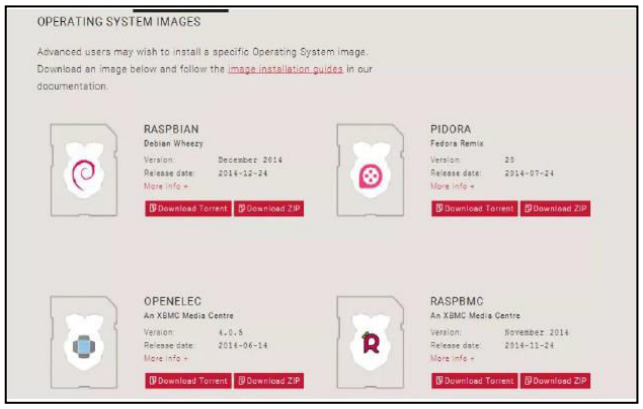

Figure-6. Raspian OS.

The ZIP file was downloaded and extracted to another folder on the computer. Your PC currently has a single .img image file containing the OS Raspian. Next, the Raspbian OS image file should form on the microSD card. The software utilized was Win32DiskImager. This programming collects all SD memory cards, SDHC memory cards and SDXC memory cards. After that, Win32DiskImager provides quick and basic access to the full capacities of your SD, SDHC and SDXC memory cards [15].

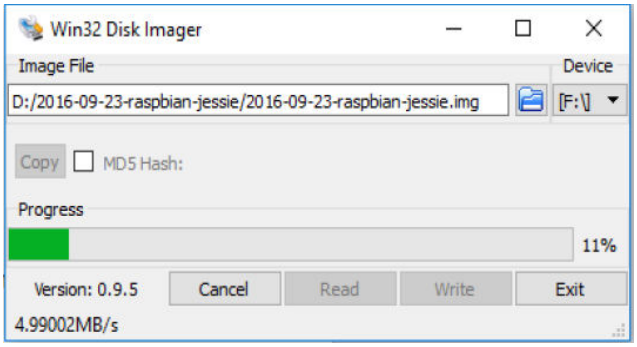

Figure-7. Win32DiskImager Software.

Once the .img files are exchanged to the SD card, the SD card was mounted in Raspberry Pi memory card slot and it is prepared to work. Presently, establishment of Raspian was finished and Raspberry Pi can be accessed through remote VNC viewer.

- **VNC viewer**

VNC Viewer allows controlling desktop computers remotely from Raspberry Pi. In order to control remotely, the VNC server should be enabled. On the Raspberry Pi, boot into the graphical desktop. Then go to the menu--> preferences--> Raspberry Pi configuration--> interfaces. The VNC was enabled. To connect the Raspberry Pi with the VNC viewer, the IP address of the Raspberry Pi should be known. So, using the terminal window of the Raspberry Pi, "ifconfig" was typed and run in order to discover the IP address of the Raspberry PI [16].

Besides that, the VNC viewer application was downloaded. After that, the IP address of the Raspberry Pi was entered into the VNC Viewer. The VNC server should be authenticated in order to complete the connection. The username to login was "pi" and the password was "123456".

GSM MODULE INTERFACING

Firstly, a sim card was inserted to the GSM module and suitable connection were made.

Table-5. Connection of the GSM module to the Raspberry Pi.

Raspberry Pi	GSM Module
Tx	Rx
Rx	Tx
GND	GND

Table above shows the connection between Raspberry Pi and GSM module. The Tx from Raspberry Pi will be connected to the Rx from GSM module. And the Rx from Raspberry Pi will be connected to the Tx from GSM module. Lastly, the ground will be connected to each other. The baud rate for the GSM was 9600.

AT command was used in order to control a GSM module. The command for select the message format as text mode was "AT+CMGF". Other than that, the command for sending message was "AT+CMGS".

```
port.write('AT+CMGF=1\r')
sleep(1)
port.write('AT+CMGS="' + phoneNumber + '"\r')
sleep(1)
port.write('WARNING, motion detected and image captured\r')
port.write('http://rpi-security.000webhostapp.com/')
port.write('application/views/images/' + filename + '.jpg')
```

Figure-8. The python script for the GSM module to send message.

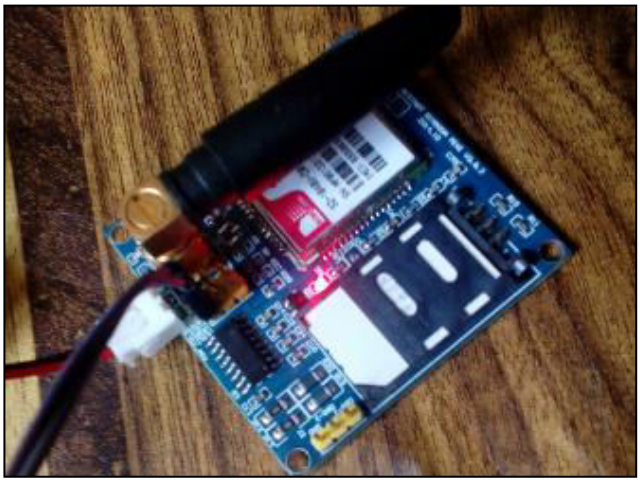

Figure-9. GSM Module.

RASPBERRY PI CAMERA MODULE INTERFACING

Raspberry Pi's camera unit is suitable for capturing a Full HD 1080p image and can be controlled automatically. The flexible cable is included in the connector arranged between the Ethernet and HDMI ports, with the silver connectors facing the HDMI port. The flex cable connector ought to be opened by pulling the tabs on the highest point of the connector upwards then towards the Ethernet port. The flex cable must be firmly embedded in the connector, with mind taken not to twist the flex at excessively intense a point. The finest piece of connector should then be pushed toward and down the HDMI connector, while the flex cable is held set up.Firstly, the Pi camera module should be enabled. Run the "sudo raspi-config" using terminal and enable the Pi camera. The library used to interface the Pi camera were "python-picamera" [17].

```
from time import sleep

from picamera import PiCamera
```

Figure-10. To import the library of camera module.

```
camera = PiCamera()
camera.rotation = 0
camera.resolution = (2592, 1944)
camera.framerate = 15
camera.brightness = 50
```

Figure-11. Class of Pi camera & Camera settings.

```
camera.capture('/home/pi/Pictures/' + filename + '.jpg')
```

Figure-12. Camera capturing the image.

RESEARCH METHODOLOGY

The change of this research will include a specific or particular methodology where the undertaking advancement is partitioned into three phases. Firstly, the literature review based on home security system, GSM, and Raspberry Pi that are available in the current market, also the past study with different method of implement. Moreover, the phase includes the software and hardware progression and usage in several products. Then, this phase is developed for hardware such as PIR sensor, GSM, Raspberry Pi 3 and camera module [18].

Here, the equipment is converged with the product utilizing Python programming so that the desired

output will be achieved. After that, Python programming will be used to send an SMS notification to user and to store the image captured in the web page. Once the software and hardware are created, both the software and hardware are coordinated [19].

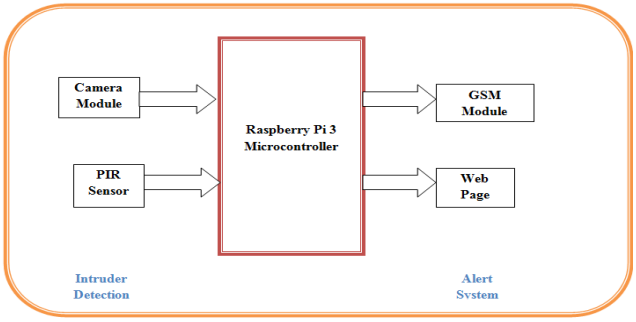

Figure-13. Block diagram of the system.

The designed system mainly consists of a Raspberry Pi 3, a PIR sensor, a camera module and a GSM module. PIR sensor and camera module was set as the input devices while the outputs were GSM module, and web page. This system runs by inspection the contribution from the passive infrared radiation (PIR) sensor persistently. Generally, the output of the sensor will be low. In the event that, if any adjustments in infrared radiation distinguished, the output will turn on high from low. Once the output of PIR sensor turns high, it will naturally trigger the camera module to snap a picture [20]. This will be presented as an evidence of the intrusion. Once the intruder is being detected by the PIR sensor, GSM modem will start communicate with Raspberry Pi 3 to send the SMS to the user's mobile phone number. User will receive a warning SMS of the intruders' image link. The image will be stored in the web page created.

In order to configure the web page, this system will require SMTP library [21]. SMTP is characterized as Simple Mail Transfer Protocol. Raspberry Pi 3 will be associated with the web and goes about as a server to this system. This alert notification is obeying the objective of this research where user will get a real time notification about the intrusion.

Overall, there are two processes in this proposed system that is intruder detection and alert system. The Raspberry Pi 3 acts as the principle microcontroller that will control the input and the output of the project.

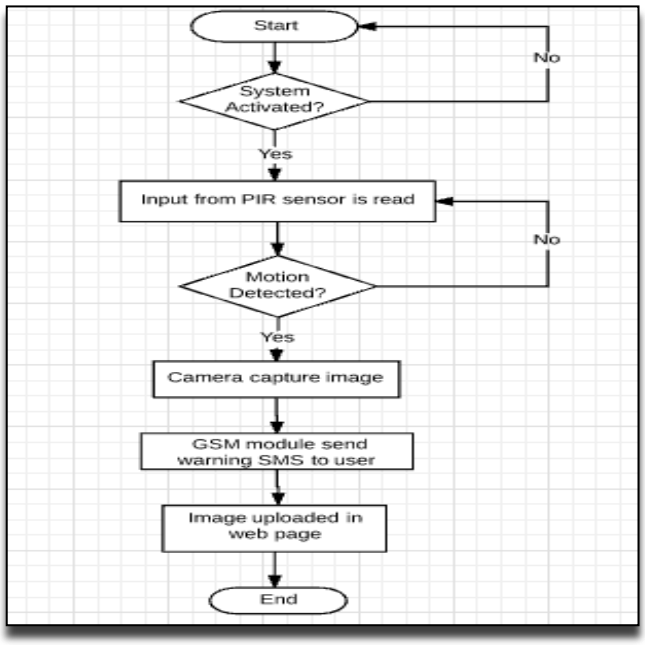

Figure-14. Flowchart of the system.

A flowchart is depicted as multi-utility when the page is split into different swimming paths. The image that appears in a specific path is inside the authorized unit. This system enables the client to find the obligation regarding playing out an activity or settling on a choice effectively as indicated by the need of a procedure [22]. Figure-14 shows the flowchart of how this system works. After this system was activated the PIR sensor will starts to monitor. The PIR sensor will read its input from surrounding. If there is motion detected, the camera module installed will capture the image. On the other hand, the GSM module sends warning message to the user to alert them. The message contains the link of the image. The mage will be uploaded in web page created.

RESULT AND DISCUSSIONS

Firstly, we switched on the system. The PIR sensor will starts to initialize itself. After initialized, the LCD display will display the IP address of the Raspberry Pi. This development system started with the PIR sensor detection. When the PIR sensor detects the movement, the LCD display will display "motion detected". The raspberry Pi camera module installed captured the image. Here, the LCD displays "image uploaded". If there is low network signal, the LCD will display "image uploaded error". At the same time, the GSM module will be triggered. GSM module SIM900A was used in this system. The GSM module will send the warning message to the user containing the link of the image. The image will be uploaded in the web page created using Raspberry Pi server.

Figure-15. LCD displays the IP address.

Figure-16. PIR sensor detects motion.

Figure-17. LCD displays "Motion Detected" & "Image Uploaded".

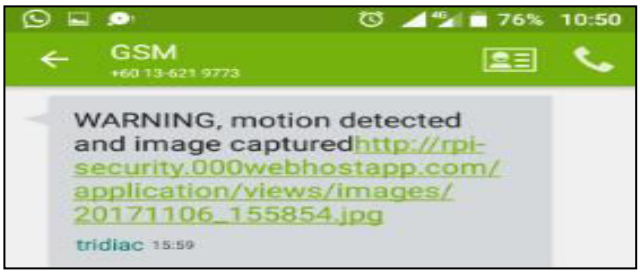

Figure-18. User received warning message from GSM module.

When we clicked the link, the image will be seen through the web page. All the image sent to the user will be uploaded and stored in the web page. We also can directly login to the web page to view the image captured presently or previously.

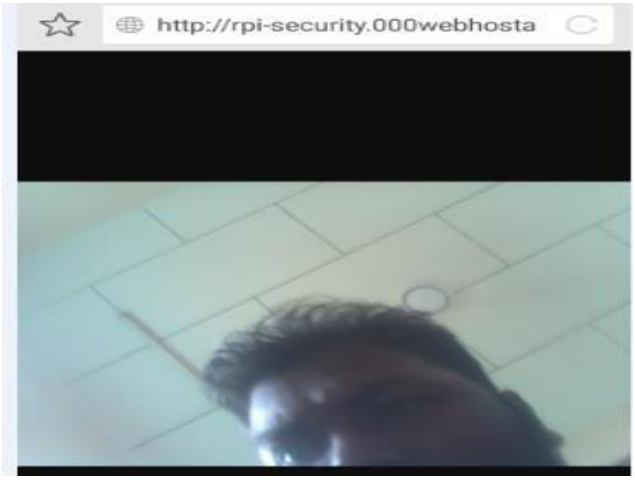

Figure-19. The image captured by the camera module.

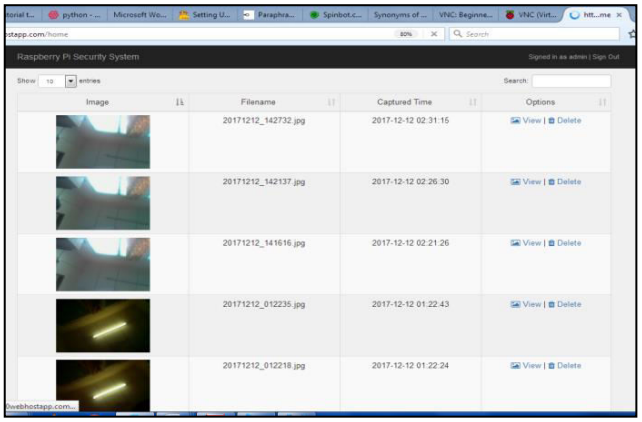

Figure-20. The images in the web page.

PERFORMANCE ANALYSIS

The PIR movement sensor examination depended on movement discovery execution approval. The trials were led for movement recognition at different extents beginning from inside 1m to up to 7m range in separate. This procedure was finished during trials in which 10 occurrences of development was recorded each for <1m, 3m, 5m and 7m ranges individually. In addition, the probability of detection (Pd) in view of these 10 emphases was figured for each range. In each one of the trials, the sensitivity potentiometer of the PIR sensor was set for maximum value, 7m range.

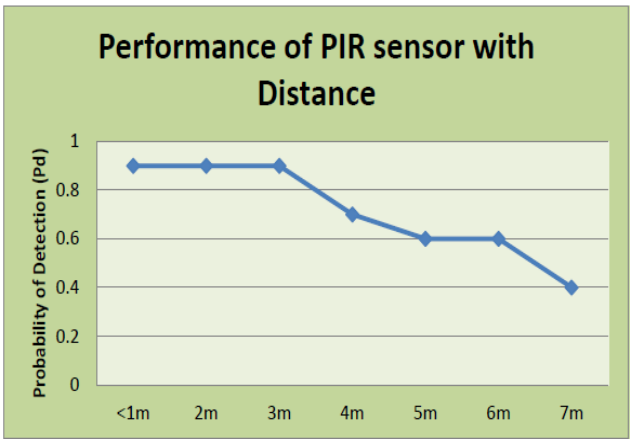

Figure-21. The analysis of performance of PIR sensor with distance.

From the analysis, it was seen that when the distance is up to 3m range, the probability of detection (Pd) is around 0.9. At 4m range, the Pd is 0.7. Notwithstanding, the Pd lessens to 0.6 for 5m and 6m range. Moreover, the probability of detection additionally reduces to 0.4 when recognition extend is at 7m.

Table-6. Time taken for a complete cycle.

Number of test	Time taken for system to complete cycle (seconds)
Test 1	11.96
Test 2	13.4
Test 3	12.95
Test 4	12.7
Test 5	13.65
Test 6	12.73
Test 7	12.65
Test 8	12.93
Test 9	11.65
Test 10	12.45

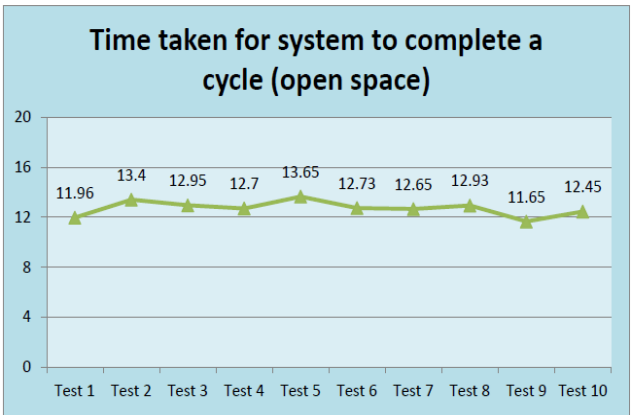

Figure-22. The analysis of time taken for a complete cycle.

The average time take for the system to complete its cycle is 12.73 seconds. The total cycle meant here is the time taken for the system to detect a motion through PIR motion sensor, capture image of the intruder through Raspberry Pi camera module, GSM module will send warning message of the intruder's image link and lastly the picture of the intruder is uploaded in the web page created as an attachment.

CONCLUSIONS

At the end of this study, the three objectives that have been clarified in the beginning was accomplished. The first objective of this study is to design a home security system using Raspberry Pi 3 in the help of GSM system. This objective was successfully achieved as the project "Development of programmable home security by using GSM system for early prevention" was designed and completed using microcontroller Raspberry Pi 3. The second objective of this study is to develop a notification system for the user through SMS. This objective also been successfully attained as the SMS of the intruder picture's link will be sent through GSM to user's phone. Thusly, the user will have the capacity to distinguish the intruder. Furthermore, the third and last objective is to reduce the occurrence of house theft and burglaries. This objective was successfully achieved as the intruders will be caught and the intruder can't repeat their activity again since the identity of the intruder is exposed.

As a conclusion, a programmable home security system using Raspberry pi in the help of GSM system has been successfully made by wanted targets and particulars. Aside from that, this study can be further developed to be more dependable.

FUTURE ENHANCEMENTS

Replace the usage of image-capturing technology into wireless video vigilance system. This will enable users to watch live video streams from video camera which have been set up inside the house. Besides, the outside video camera can identify if there is somebody sneaking about the property. In this manner, the unwavering quality of the study can be additionally expanded.

Moreover, this study can be advanced by sending the product or output of the study to the social media. For instance, this composed system sends SMS notification to user only when intrusions turn out. So, the future work should be possible as when an intrusions turn out, the caution message will be posted on Facebook or Twitter or other social media. From this, more individuals will be aware of the intruder’s identity, which will make it easier to capture the intruder.

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