SMART INTRUSION ALERT SYSTEM USING RASPBERRY PI AND PIR SENSOR

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ABSTRACT

This paper deals with the design and implementation of Smart Intrusion Alert System for home and office security using open source hardware platform. The model use Raspberry pi 3 (model B), Passive infra-red (PIR) sensor and Raspberry pi camera integrated with smartphone. It use home Wi-Fi to integrate with web server for notifying via Telegram application. Raspberry pi operates and controls motion detector and camera for remote sensing, capture any motion image and send the alert to the user via Telegram application. For instance, when motion is detected by PIR sensor, the Raspberry Pi camera automatically capture image and the Raspberry pi device alerts the owner regarding the possible intrusion. The result seems satisfy, the PIR sensor detect any motion well and with a several seconds it sends an alert to Telegram application. Selected indoor and outdoor locations are tested and it seems that it works well for both. This research is significant and benefits for recent technology of home or office security.

Keywords: Raspberry Pi, PIR sensor, intruder alert system

1. Introduction

The rapid growth of statistic of home invasion has been giving a crucial impact to traditional home security. Smart system of home security is increasingly gaining high demand especially for home that located at critical area. As well, security is a major concern in our day-to-day life since it can prevent intentional or unintentional interference in human life with the proper operation of security system (Sultana *et al.,* 2016). The inspiration to develop this system is due to the increasing number of home intrusion reported each year.

Intrusion detection is implemented by an intrusion detection system and nowadays there are various intrusion detection systems available. In general, most of it is relative ineffective and insufficient, which give an effort to develop for more dynamic intrusion detection system (Hoque, 2012). Mostly, home security systems available in the market consist of a device that is installed in the house and user will not be able to detect any intrusion except if they view through the video. Basicly, intrusion is monitor by using camera to records video and unfortunately, it is just a passive monitoring device. Most technology used by implementing a CCTV device in watched area. A CCTV consists of video devices, PC to monitor the video real time, and human as person who monitor the area. The weakness occurs from that kind of mechanism, it needs a human to watch every time (Sukmana *et al.,* 2015).

Most of the home security system available in the market, users is not able to monitor their home security remotely. According to Luor *et al.* (2015) smart home security should provide intrusion detection and should alert security personnel when unauthorized access is attempted. It is crucial to get alert immediately in order to take appropriate action in protecting safety. Therefore,to overcome this our reseach is to develop a Smart Intruder Alert (SIA) system that able to give notification or alarm to user when intrusion is detected. Furthermore, this research is to upgrade traditional home security and implement a real time home security system that able to alert user of any intrusions by using Telegram application.

2. Literature Review

2.1 Home Security System

Various home security systems have been developed to solve home invasion problem. Home and office security system seem to have high demand from users. The advancement of technology in mobile devices has driven the users to incorporate their mobile devices to perform daily tasks and improve the basic operations of the device (Jaafar et al., 2016). For home automation by making use of the same set of sensors. The leverage obtained by preferring this system over the similar kinds of existing systems is that the alerts and the status sent by the Wi-Fi connected microcontroller managed system can be received by the user on his phone from any distance irrespective of whether his mobile phone is connected to the internet (Kodali *et al*., 2016).

2.2. Raspberry Pi

Raspberry Pi computer, which was introduced in 2012, is currently a mainstream system subject to widespread availability that can be used in home automation. The subsequent analysis has shown that Raspberry Pi is computer board with support for a large number of input and output peripherals. It is currently a mainstream system subject to extensive availability that can be used in home automation (Khedkar Malwatkar, 2016). This makes it the perfect platform for interaction with many different devices and usage in a wide range of applications. Combining Raspberry Pi with home Wi-Fi it can communicate remotely, therefore increasing suitability for the construction of wireless sensor nodes and Sensor Web nodes.

2.3. PIR Sensor

It is necessary to detect any intruder as early as possible so that user can take immediate action to protect their properties. The detection range of an ordinary low-cost PIR sensor based system is 10 m but this is enough to cover most rooms with high ceilings (Fateh *et al*., 2012). PIR sensor able to detect sense motion and it able to detect whether a human movement in the sensors range. Furthermore, the operating principal of this sensor is the apparent motion can be detected when an infra-red source with one temperature such as a human passes in front of an infra-red source with another temperature such as wall. (Selvabab and Ganesha, 2012). In addition, PIR sensors were chosen as the sensing modality, motivated by the passive nature of the sensor, the relatively low cost, their wide commercial availability, and ability to operate in the absence of visible light (Choubisa *et al*., 2016).

According to Sukmana *et al.,* (2015) this sensor is reacts to receive stimulation in the form of infrared rays. Essentially every object emit infrared rays, PIR sensor catches every infrared that emitted, then analyse and make it an input based on frequency of analysis that accepted human essentially emit infrared strongly, therefore when the graphical analysis is done, human movement generates a strong frequency, different from another creature like a pet, plant movement, inanimate object movement, and so on.

2.4. Telegram

The Telegram is originally a smartphone messenger application that has as purpose to send and receive text and multimedia messages to and from person users. There are many messenger applications, but what sets it apart is the security feature through data encryption and the ability to create Telegram Bots with several functions via programming code using the Telegram Bot API (Olieveira *et al*., 2016). Furthermore, according to Chandar *et al*., (2016) unlike from other instant messaging, Telegram focused on speed and security. This gives an impressive impact for user in term of security.

Bots are Telegram accounts operated by programs that respond to messages or mentions and can be integrated in other programs. They mimic the behaviour of a human being in specific applications, like a help desk (Zennaro *et al*., 2016).

3. Methodology

3.1. System Design

The development of Smart Intrusion Alert (SIA) system requires integration of software and hardware components. The SIA system consist of Raspberry Pi 3 Model 3 credit-card-sized single-board computer powered by a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, VideoCore IV GPU, 512 megabytes of RAM, and 256 megabytes of RAM for the older model. The Raspberry Pi does not include a built-in storage device, but uses an SD card for booting and storage. The performance and power consumption of which are suitable for processing various data and long term usage without consuming a lot of power. Despite of the Raspberry Pi size, it has the capabilities to become a fully functioning computer that can run several programs at once. Also, Raspberry Pi can be operated using terminal through the SSH (Secure Shell) or through the GUI that has been provided by the Raspbian operating system.

Raspberry Pi NoIR Camera Board that include Raspberry pi NoIR camera Module v2 with high quality 8 megapixel Sony IMX219 image sensor custom designed add on board for Raspberry Pi, featuring a fixed focus lens. The capability is 3820 x 2464 pixel static images, and also supports 1080p30, 720p60 and 640x480p60/90 video. Passive infra-red (PIR) sensor is a device that detects and responds to some type of input from the physical environment such as heat, motion, moisture, pressure, or any one of other environmental phenomena. At this process, the sensor will detect vibration on the door that we put a sensor. Then the sensor sends alert or responds to microcontroller to take over the next process.

For software specification, Raspberry Pi mainly uses Linux kernel-based operating systems (Prasad *et al*., 2014). Raspbian is a free operating system based on Debian optimized for Raspberry Pi hardware. Smart Intruder Alert System also use PuTTY, a free open source terminal emulator, serial console and network file transfer application and it supports several network protocols. Moreover, this system also uses Telegram bot to create prototypes and communicate with the same tool applied in the communication with other people (Olievera ***et al***., 2016). Figure 1 shows the overall system architecture of smart intruder detection system that we have developed. The system includes Raspberry Pi No InfraRed (NoIR) camera board V2, Passive infrared (PIR), Raspberry Pi 3 Model 3, micro SD card and Telegram application.

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors. If there any motion the camera will capture the image that is detected by the (PIR sensor. Raspberry Pi processed images and send to telegram application. User will receive notifications that include images, date and time. It will display the picture, the date and time.

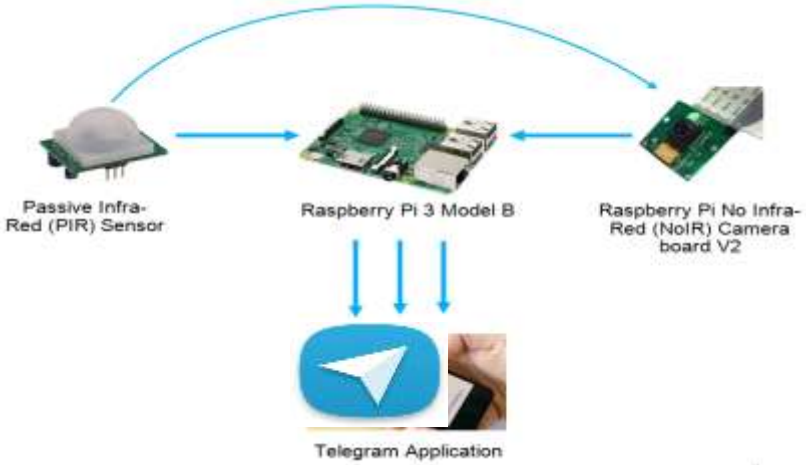


Figure 1. System architecture

4. Implementation

4.1. System Design

The main aim of this research is that user can receive real time alert through smartphone or laptop using Raspberry Pi and PIR sensor. A telegram bot is written to send alert to user if there is any intrusion occurs from camera connected to raspberry Pi. By using Telegram user is able to create a Telegram group whereas can give alert to other members if there any intrusion occurs. Thus Raspberry Pi acted as the central authority to control the intrusion detection system. Refer Figure 2.

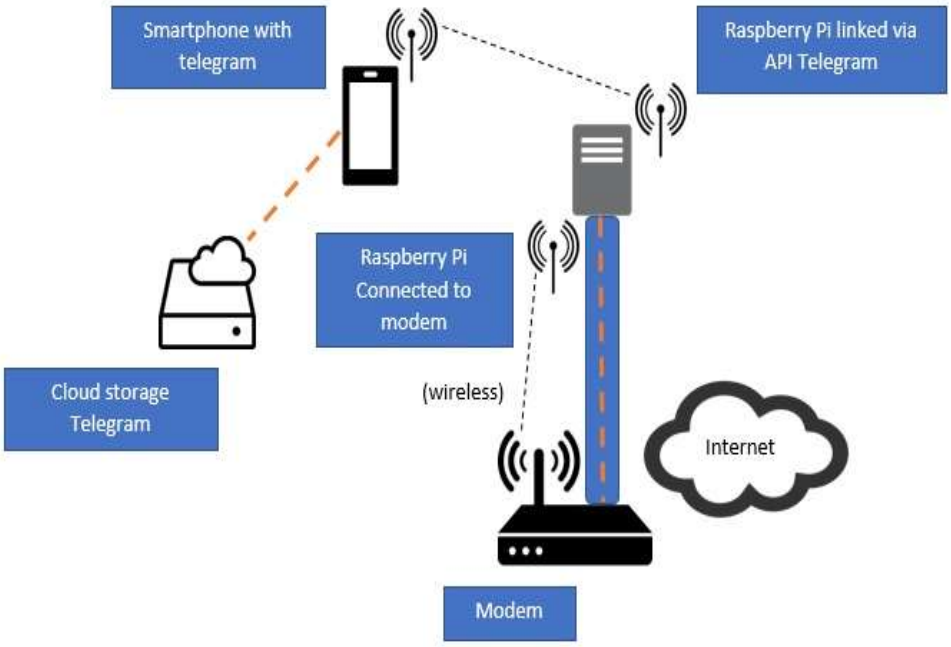


Figure 2. System design

Figure 3 shows the research flowchart of SIA system. Software and hardware integration were being tested and evaluate in order to complete the tasks. The hardware's used in the development system are Raspberry Pi 3 Model B, Raspberry pi NoIR camera Module v2 and PIR sensor. The software's used are Raspbian, PuTTY, Remote Desktop Service and Telegram application. After the installation, the main controller is examined to identify whether the PIR sensor and Raspberry Pi NoIR Camera are fully functional.

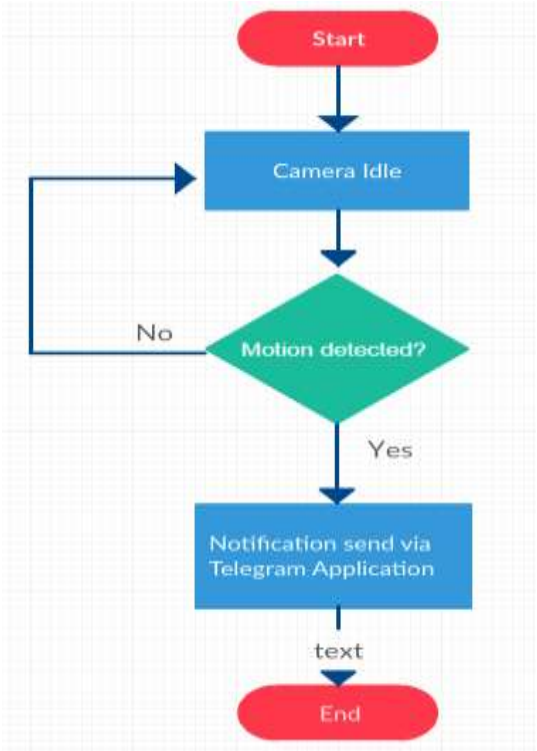


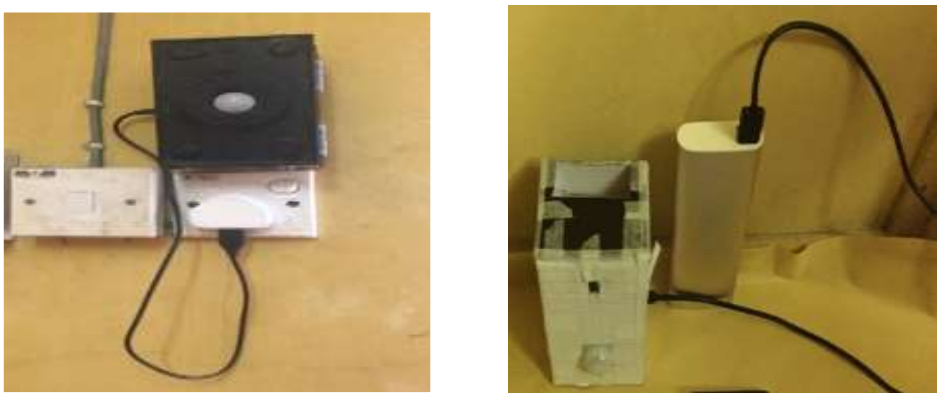
Figure 3. Flow chart of the process for Smart Intrusion Alert

5. Result and Discussion

Figure 3 show the hardware design for SIA that includes Raspberry Pi, Raspberry pi NoIR camera Module v2 and PIR sensor configuration. By using a box, the hardware is simplified and installed. Figure 4 shows the power supply for the device. There are two options that is either using direct power supply or by using power bank.

Figure 3. Hardware design

Figure 4 shows the power supply that can used for Smart Intrusion Alert (SIA) device. User is able to choose either to use direct power supply or power bank supply.



Direct power Power bank supply

Figure 4. Power supply options using either direct power or power bank

Figure 5 shows the interface of Telegram Application for SIA. When the PIR sensor detected motion Raspberry Pi will send alert through Telegram application to user. User is able to create a group in the Telegram application and later invite the telegram bot in the group.

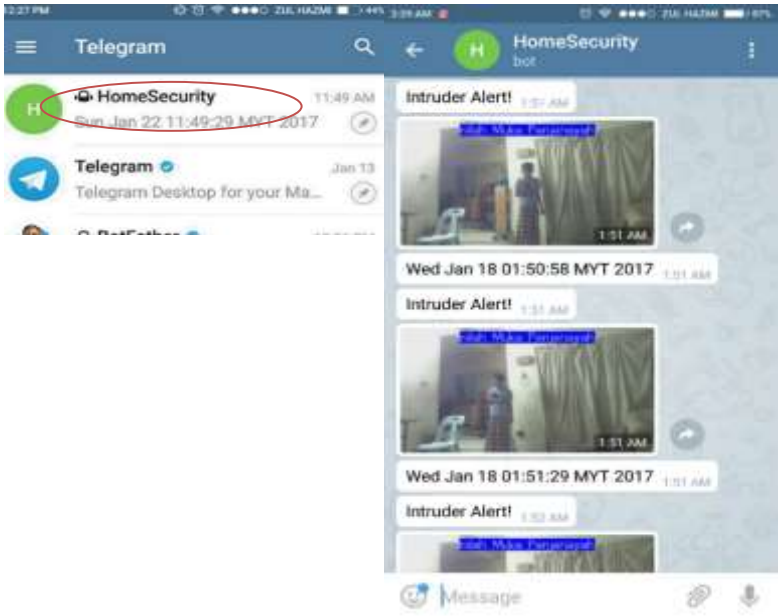


Figure 5. Telegram Application warning alert through image captured and notification

It can be summarized that the use of Telegram application is a good and effective solution as Telegram is a simple application that gaining popularity each days. The weakness of SIA is it cannot be used as monitoring system. Also it depends on the internet connection. However, it still very advantageous thank to the low development cost compared to CCTV based surveillance system which need another expensive component such as computer and its operator (Sukmana *et al.,* 2015).

6. Conclusion

In this paper, we have developed a smart intrusion alert system built with Raspberry Pi, PIR sensors and Telegram application. The system has an attractive value features, including low cost, compact, easy to customize easy to deploy and easy to maintain. For future works we recommend to create a mobile application for SIA and include surveillance monitoring option in the system.

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