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WI-FI BASED MOTION SENSOR INTRUDER SYSTEM WITH VIDEO MONITOR

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ABSTRACT

Nowadays security has become an essential part in life especially home security. This is because the crime rate involving intrusion, burglary and robbery has increased drastically day and night especially in the residential areas. Thus, this project was introduced to increase the safely level by designing a cheap and affordable system which consist of a motion sensor, Arduino Yun; the communication between user and the system. This design also involves a webcam for remote viewing and speaker for the alert sound. An alarm will be triggered when motion detects a movement in the area. The webcam will then capture the picture and send it to the user via email. The email is then sent using the Simple Mail Text Protocol (SMTP). The prototype was developed and tested**.**

Keywords: Wi-fi, call, security system, microcontroller, SMTP.

INTRODUCTION

In the modern society nowadays, time is keeping up with the evolution of technology. The old day concept of home is changing with the evolvement of technology. With the implementation of technology to a home, thus a concept of smart home is introduced. The advancement of the internet has helped to increase the features in a security system in a home. Security system generally is defined as network of devices consisting of a trigger and an alarm. Nowadays the risk of home invasion and intruder has increase. This makes a security system essential in every house. Besides that, another factor of this project is that some people can't afford a good security due to cost which make them vulnerable. With the introduction of internets, the concept of internet of things is introduced where the device can communicate with humans. This is primarily due to the embedding of sensors on them. These sensors are linked through wired and wireless networks, often using the same Internet Protocol (IP) that connects the Internet (Arduino, 2014).

Internet as mentioned earlier has also become a part of daily routine for almost all people in the world who have the access to it. These people have become dependent on having an Internet connection in their daily lives to be able to actually carry on with their life for some reasons, but what is Internet? Internet can be defined as a system or entity which comprises of interconnected computer networks which uses standard communication protocol which includes TCP/IP. The uses of Internet include communication, research, education, business transaction, news and so much more. It can be concluded here that Internet do play an important role in this era of daily activities. The Internet has various types of Internet connections which are as follows; Wireless, Mobile, Hotspots, Dial-Up, Broadband, DSL, Cable, Satellite, and ISDN. For this project, it is using the wireless connection. Wi-Fi stands for wireless fidelity which means the user can access a network simply by using radio waves without the presence of the wires. In other words, being able to connect to Internet without having to connect the wire physically to the appliances from the Internet hardware itself.

In the previous researches, many communication techniques were implemented with security system such as GSM/GPRS, Bluetooth, and even the internet protocol. Although many of them are available for sale, most of the common parameters which effect the users to ignore it was the cost of installing it.

ZigBee is one of the favorite ways to create wireless communication. According to the paper by Ming Xu et al (2015) , the proposed system was created using the ZigBee technology to trigger the system and the monitoring application used the GPRS network. In the paper by Zhao (2007) , three sensors were connected to a GPRS gateway and when any of the three sensors were triggered, an alarm will be sounded. From Neha et al (2014), a web sensor was connected and a java system was implemented to communicate with user via internet or mobile devices. Sensor is an essential part in creating a trigger alarm. In a study by Proffit B (2012), intruder sensor can be the trigger to send information to the microcontroller. According to Hu et al (2011), wireless sensor helps to create a low power consumption for smart home security. Meanwhile, in the paper by Logeswaran (2008), it is also stated that ZigBee can send signal to other ZigBee in the main security room.

This main objective of this project is to create a low cost intruder system that is easy to be used and basically a home based system.

METHODOLOGY

First of all, the background of the related field has been studied to collect important information and to brainstorm ideas. Based on the market survey, intruder

system or security system still have some limitation and some of the system are very expensive especially to lower and middle class people. After taking some time in analyze and researching, the idea was then proposed. The idea was to design a cheap wireless home security intruder system and the proposal was written. When it was approved, the next step was to design the system functionality and the required specification. The components were studied and chosen according to cost, flexibility and user friendly. The flow chart of project development is as shown in Figure-1.

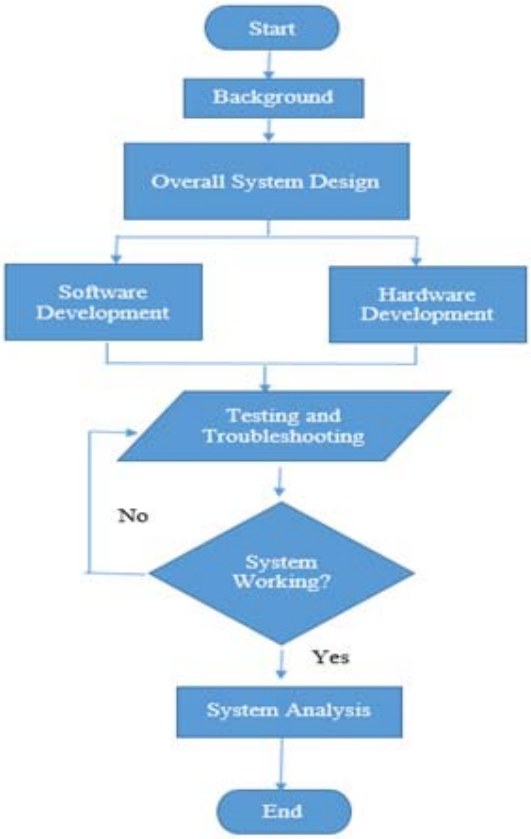

Figure-1. Project development flow chart.

The next step was working on the hardware and the software implementation. This step consumed much time and was very challenging where lots of major problem were faced during this step. The software being used was the Arduino Ide and other software such as python and Linux. The hardware design was simple as it only consists of Arduino PIR motion sensor, Arduino Yun, Webcam and speaker. After developing the software and hardware, the system was created through interfacing the hardware and the software. The troubleshooting step then began. During the troubleshooting, many problems had occured.

System design

The system was designed as shown in Figure 2. The system consisted of two part which is the remote viewing and motion sensing. For remote viewing, it consists an interaction between the Linux part in the Arduino Yun and the webcam. For motion sensing part, it consists of interaction between the motion sensor and what it will do when interacting with the Arduino Yun.

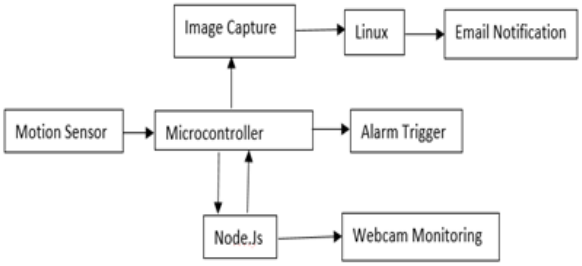

Figure-2. System block diagram.

SOFTWARE

Python programming

Python programming language is a general-purpose interpreted, interactive, object-oriented and high-level programming language. It was created by Guido van Rossum in the late 80's and early 90's. It is also available under the GNU General Public License. It allows the programmers to translate concepts to few lines of code than would be possible in languages such as C. It supports multiple paradigms as mentioned above. It has a dynamic type system and automatic memory management and also has a large and comprehensive standard library. Most of Python implementations can function as CLI which also means it acts as a shell itself. Python is user friendly, open source and easy to learn. The downloadable Python coder are available at www.python.org/downloads/ .

Python coding is used to send the email of the attachment to the user's email. The python coding is put into the SD card and will be called by the C language of the Arduino. Python coding is written using the text editor and saved as python.py.

C language and SSH

C language is the programming language used for the Arduino. In this case, C language is used to declare the PIR input pin in the Arduino, to called out the python code and to interact with the Linux side of the Arduino Yun. This code can be compiled using the Arduino IDE that can be downloaded in the official website.

SSH or secure shell is used to run the Linux in the Arduino Yun. SSH is used as a remote connection for the Linux.

Linux

Linux is one of operating system available out

there which is well known as free and open source software. It was released in 1991 which was 23 years ago. Simillar to other operating systems out there such as Windows and Macintosh, Linux also is used to send instructions from an application to the computer processors (Proffitt, B. 2012). In other words, it acts as a middle man who sends the message from the application to computer processor and then the processor will perform the desired task. However, as mentioned earlier, Linux is an open source software which by means; no one owns it or responsible for the development of the Linux itself. It is open to everyone to either enhance it or to do anything to it, unlike Windows and Macintosh which are controlled or owned by a company.

Linux is used to install driver and to play the mp3 format file in the SD card. Linux helps to operate the webcam and also to create a personal server for the network.

HARDWARE

Webcam

Webcam is used to capture image of the intruder and to provide the web streaming of the places. The webcam that is used for this project is the Logitech webcam C170. Figure-3 shows the webcam which was being used.

Figure-3. Logitech C170 webcam.

Arduino yun microcontroller

Arduino Yun board was manufactured by the Arduino in Italy. It can be powered through a Micro USB connection. The analog input pins are labelled as A0 to A5 pins while the digital input/output pin the pin 0-13. The“~” sign represents the PWM input/output pins. The Arduino Yun consists of the Micro USB for activating the Yun and the USB port for connection such as webcam or speaker as shown in Figure 4. The pin 4 in the digital will act as the input for the motion sensor. The main board of the Yun consists of the Wi-Fi module, the Ar9331 Linux, Ethernet port, USB host, Micro USB, Micro SD slot and the ATmega32U4 (Arduino, 2014).

Since the Yun has it’s own Linux distribution Board, we can write the own shell and python scripts for robust interaction (Arduino, 2014).The bridge library helps to connect the two processors in a way that it provides the ability to run scripts and communicate with the network interface (Arduino, 2014).

There are also several LED status displays on the Yun, which indicated the Serial Receiver (RX), Serial Transmitter (TX), input LED (PIN13), WAN indicator, Power Indicator, WLAN indicator and USB (Arduino, 2014).

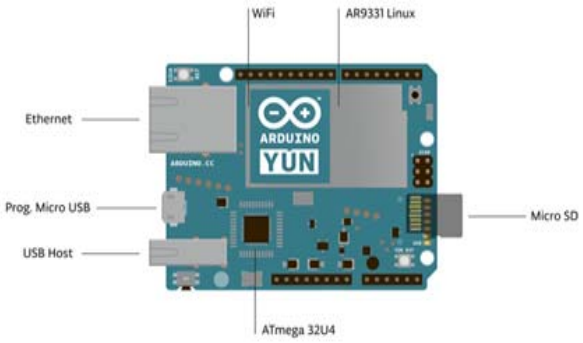

Figure-4. Arduino yun board.

Arduino PIR motion sensor

Passive Infrared (PIR) sensor detects motion by comparing the infrared radiation that reaches a pair of detectors as shown in Figure-5. The sensor will indicate movement when the two detectors read different values. PIR Motion Sensor has a very simply low/high output: when it is HIGH, the sensor will detect movement and when it is LOW, the sensor stops detecting. PIR operated much as a switch or a trigger. To connect it to the Arduino, simply connect the output pin to any designated digital input pins and connect the VCC and the Ground pin to the 5v and ground to give the supply. The sensitivity for the PIR can be up to 7m and the detection angle is around 120 degree.

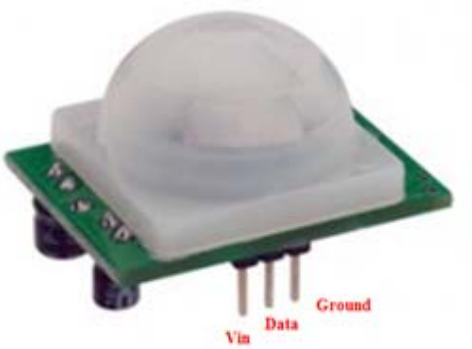

Figure-5. PIR motion sensor.

The PIR sensor has two adjustable analog button configurations. Both of the buttons have different functions. The right side is used for sensitivity as shown in Figure-6. When it is turned counter clockwise, it will decrease the sensitivity as low as 0.5m and meanwhile, by turning it clockwise, it will increase the range up to 7m.

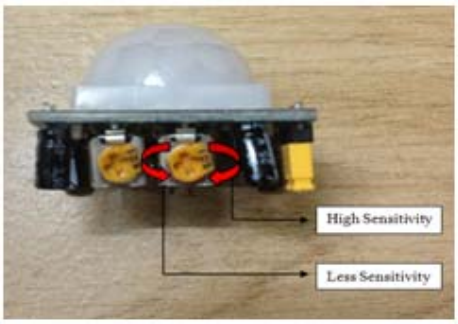

Figure-6. PIR motion sensor sensitivity button.

On the left side on the other hand will be used to set the LED time on/off. If the LED is turned clockwise, it will be on for 20-25s before it is turn off and if it is turned counter clockwise, the LED will be on for 1-2s before it is turned off as shown in Figure-7.

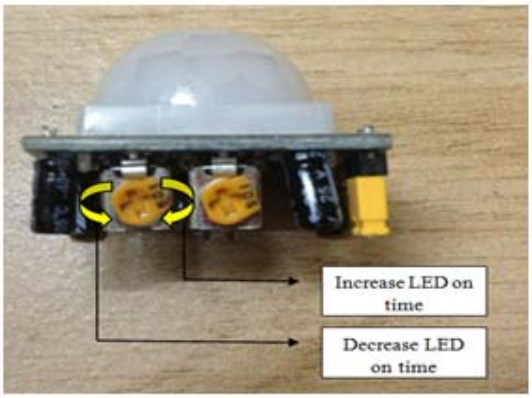

Figure-7. PIR motion sensor LED time button software.

Arduino IDE

Arduino IDE was used to compile the code for the Arduino language. The open-source Arduino environment helps to simplify the code writing and to upload into the board.

A. Testing and troubleshooting

During the period of developing it, the hardware did not faced much problems compared to the software part. The first problem was trying to take a good image from the webcam. The problem happened because when the webcam snapped a picture, the picture was out of shape and sometime it is black. The solution was to control the resolution using the Linux part of the Arduino. The second problem was to send the captured images to the email. This problem was then solved by knowing the smtp port for the preferred email and to install the python package to the Arduino. The third problem was to use port forwarding. This was solved by learning how to change the router setting. However, after full research, an alternative method was discovered which is by installing node.js into the Arduino. Another problem occurred was the memory limit of the Arduino. Since node.js packages needs a big space to install, the solution was to change the root of the Arduino into the micro SD card.

B. System operation

The system used Linux part to remotely control the webcam and getting the email to be sent to the user. The webcam can be viewed anywhere if there is a network or data available. This system works via fairly simple system consisting of PIR motion sensor and the microcontroller interfacing with both Arduino and Linux part of the board. When the sensor is active, any movement will be detected and will be sending the information to the microcontroller. The microcontroller will then trigger the camera to take image and send it back to the user's email. The user also is able to view their home using video streaming.

RESULT AND DISCUSSIONS

The aim of this project is to create a security system that is easy to be used and can be placed anywhere. The concept is much like DIY. In this section, the hardware will be discussed further. The prototype of the project system has been done successfully. The hardware will be discussed further in the subtopics below.

Webcam

The driver of the webcam was installed using the following command (1),(2),(3)

$OPKG UPDATE (1)
$OPKG FSWEBCAM (2)
$OPKG KMOD-VIDEO-UVC (3)

Figure-8 shows that the webcam was installed and updated. By entering the SSH of the Arduino Yun and entering LSUSB, the driver of the webcam can be seen.

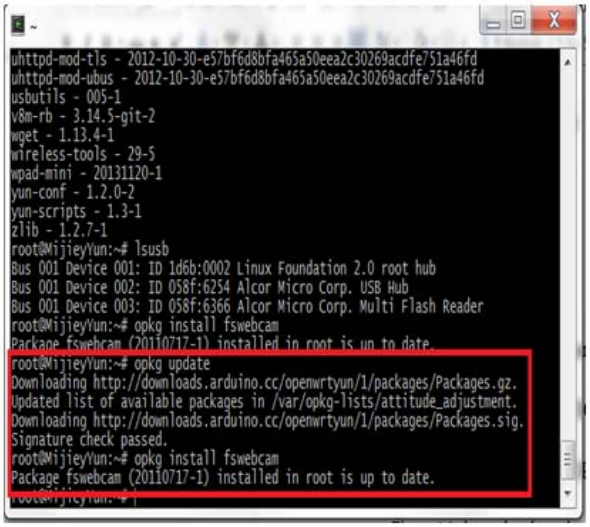

Figure-8. Webcam is successfully installed.

PIR motion sensor

The PIR motion sensor have 3 pin attached which is the Vcc, Pin, Gnd. The Vcc have been placed into the 5v pin at the Arduino, the Pin have been placed into Pin 6 of the digital pin and Gnd has been placed into the ground pin. The Motion Sensor is the declare in the C language of the Arduino using the

Int pirPin = 6

The Motion sensor are then set digitalRead(pirPin) == HIGH. This means that when the PIR is in a HIGH state, the system will be triggered.

SD card

SD card has been turn into a primary root storage for all the packages. This is to enable more packages to be installed. Besides that, the SD card also was the location to save the images and to save the python code. Figure-9 shows the contents of the SD card.

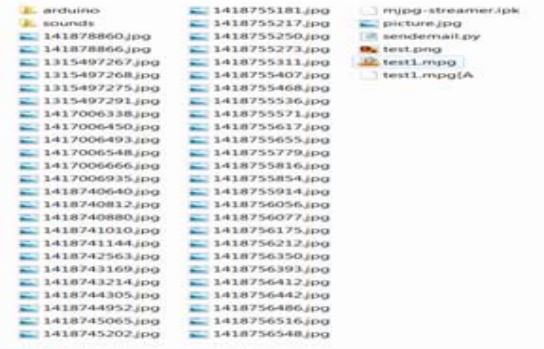

Figure-9. Content of the SD card.

Python coding

Python codes are written and have been tested. Before python can be used in the Arduino Yun, the package must first be installed into the Arduino. The installation are as follow in (4),(5).

$OPKG UPDATE (4)

$OPKG INSTALL PYTHON-OPENSSL (5)

By doing so, the python can be used. Figure-10 shows that python has indeed been installed.

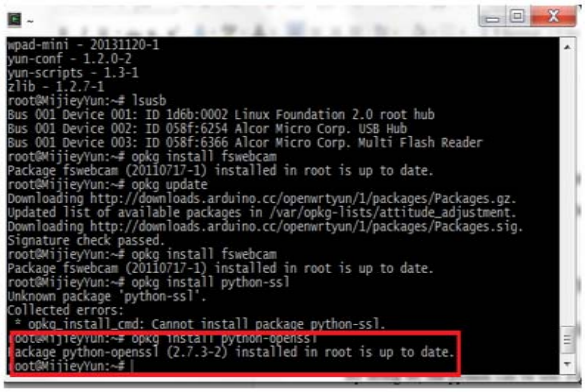

Figure-10. Python has been installed.

Since python has been installed, the following python code has been created. Python can be initiated by using the python sendemail.py.

Server

A server has also been created for the viewing of the webcam from out within the same network. This means that user can view their webcam using different networks. The package that is installed for this purpose is the local tunnel. Local tunnel helps to create a server by just typing lt –port 8080 which is the port for the webcam. Figure-11 shows the example of the local tunnel. The link that is produced is the website to view the webcam.

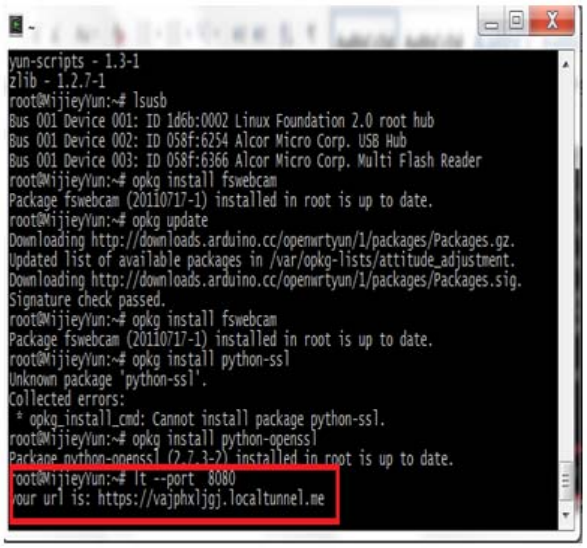

Figure-11. Local tunnel enable.

C language

The C language of the Arduino is the code that compiles all of the given driver, python and sensor. From the Coding, the code has been created so that the system work as what has been targeted. From the code, we can see that when the sensor turn high the camera takes the picture and upload it to the user email

Overall intruder system

Figure-12 below shows the completed hardware for the project. The main spec for this project is to make it light and portable. To do so, the design of the casing must be light and can be created using everyday household item. This prototype consists of PIR motion sensor for the detection. The main controller is the Arduino Yun as explained in the previous chapter. A micro Usb acts as the power connector to the power supply. The audio jack is where the user can connect their intruder to a speaker to create louder sound and user also can choose any types of mp3 as the alarm. When the sensor detects movement, the webcam will capture the images and send it to the user's email via python coding. This shows that the system is working.

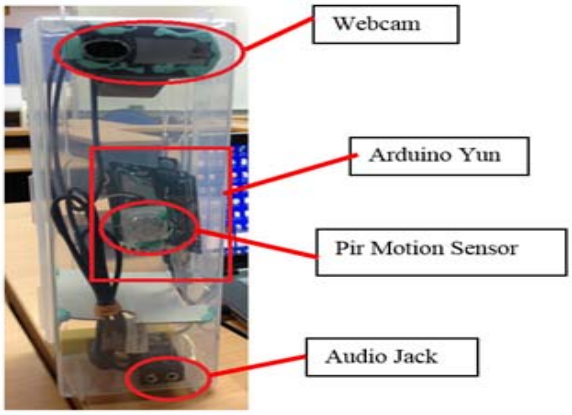

Figure-12. Intruder system.

Sensor triggered

When the sensor detects movements, the webcam will capture the image of the moment and will send it to the users email. The webcam will capture image until the sensor turns to LOW state. Figure-13 shows how the image is captured to the email.

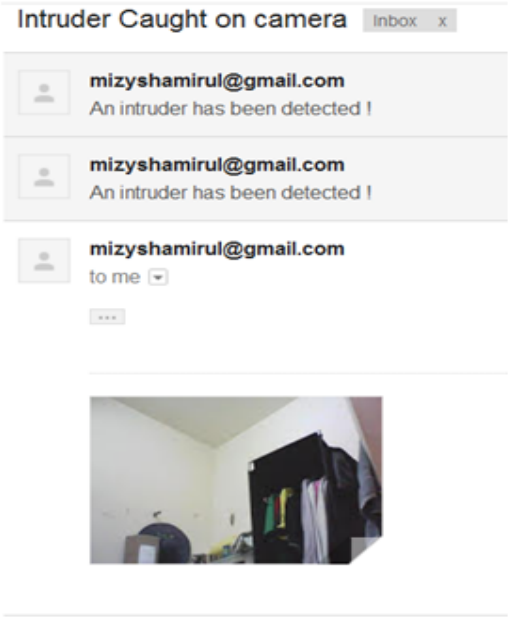

Figure-13. Email notification.

Monitoring

This system also consists of webcam monitoring. This means that users are able to view their room whenever they are away from their home. To do so, the user will have to key in the address of the webcam. The user can view the webcam anywhere using any devices that have access to a network. Figure-14 shows how the address will look like.

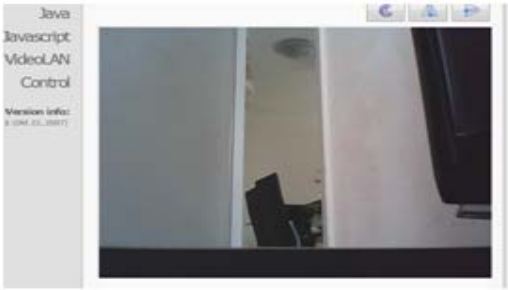

Figure-14. Webcam monitoring.

Testing

The testing was done in a Research Lab in Faculty of Electrical Engineering, UiTM Shah Alam and also in Bukit Indah, Ampang. The system was installed and tested according to real life situation and the results of the test are as stated in the result section. It was divided into two aspects which are the email alert with the image captured when intrusion occur and also video monitoring. The result will be measured based on how fast the alert is sent to the user's email when the intrusion occured as well

as when the alarm triggered. The video monitoring will also depend on the Wi-Fi connection of the device used by the user. The faster the Wi-Fi speed, the clearer the image are as well as the faster the video streaming.

System installation

Figure-15 shows the overall system being installed. As stated before, the portability of the system is flexible by means that; it can be placed anywhere the user wants. However, the height placement should be higher to avoid the intruder to easily terminate the system. The range should also be considered as the maximum sensor range is around 7m as stated before.

Figure-15. Installation of the intruder system.

ACKNOWLEDGEMENTS

The authors would like to thank Faculty of Electrical Engineering for their valuable support.

CONCLUSIONS

In conclusion, the Wi-Fi Based Motion Sensor Intruder System with Video Monitor has been developed and tested to satisfy the discussed features earlier. It can be said that the Wi-Fi is the foundation to this system. In addition, by connecting to Wi-Fi itself, the user will be able to monitor their house or premise by just checking the video streaming via their portable device even if they are away from their house. Thus, this provides convenience to the user themselves to be able to monitor and put their mind at peace while these days Wi-Fi technology is already part of their daily needs. However, this project is only developed to prevent and detect crime, it is not to deter or eliminate the crime itself. Creating awareness among the society will be the add up value to actually be aware of this kind of crime. In other words, this system will only be the precaution step which provides convenience to its user.

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