DESIGN & IMPLEMANTATION OF RASPBERRY PI BASED SECURITY SYSTEM.

(Case study: UMEME co ltd)

Final Year Project Report Submitted To Kampala International University in Partial Fulfillment of the Requirements for the Award of the Degree

of

Bachelor of Science in Electrical Engineering

BY

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DECLARATION

I BOGERE INNOCENT solemnly declare that this project report "DESIGN & IMPLEMANTATION OF RASPBERRY PI BASED SECURITY SYSTEM" is based on my own work carried out during the course of my study under the supervision of MR IBRAHIM ADABARA.

I assert the statements made and conclusions drawn are an outcome of my research work. I further certify that the work contained in the report is original and has been done by me under the general supervision of my supervisor. The work has not been submitted to any other institution for any other degree in this University.

SIGNATURE……..

DATE……

APPROVAL

This final year project report has been prepared under my supervision and it is ready for submission to the school of engineering and applied sciences of Kampala International University in partial fulfillment of the requirement for the award of a bachelor's degree of Science in electrical Engineering

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TABLE OF CONTENTS

DECLARATION i
APPROVAL ii
ACKNOWLEDGEMENT iii
TABLE OF CONTENTS iv
LIST OF ACRONYMS viii
ABSTRACT ix

CHAPTER ONE 1
1.0 Introduction 1
1.1 Problem Statement 2
1.2 Objectives of the Study 2
1.2.1 Main Objective: 2
1.2.2 Specific Objectives: 3
2.2.3 Research Questions. 3
2.3 Scope of the project: 3
2.4 Significance of the study 4

CHAPTER TWO 5
Literature Review 5
2.0 Introduction 5
2.1 Theoretical Review. 6
2.1.1 Background. 6

CHAPTER THREE: 8
METHODOLOGY 8
3.1 Introduction. 8
3.2 Data Collection. 8
3.3 Major Components Used 8
3.4 System Design. 8
3.4.1 The Raspberry Pi 8

3.4.2 The Raspberry Pi Models....9
3.4.3 Programming the Raspberry Pi....10
3.4.4 Raspberry Pi Operating Systems....11
3.5 The Pi Camera Module....11
3.5.1 The hardware connection of camera to the PI....12
3.6 Power Supply Circuit....12
3.7 Cooling Fan....12
3.7.1 Specifications:....13
3.8 Software....13
3.9 Hardware System.....13
3.10 Conceptual Design/Framework.....13
3.11 Block Diagram for Raspberry Pi Based Security System....14
3.12 Circuit Diagram for Raspberry Pi Based Security System....14
3.13 system Working Principle....14
3.14 Flow Chart for Raspberry Pi Based Security System....15
3.15 System initialization and configuration....16
3.15.1 Read a Channel....16
3.15.2 Drive a channel....16
3.16 Source code....16
3.16.1 Developing the Full Code Listing.....17
3.16.2 Full code listing....17
3.17 OpenCv – Python Video Processing....20

CHAPTER FOUR:....21
RESULTS AND DISCUSSION....21
4.0 Introduction....21
4.1 Hardware testing....21
4.1.1 Continuity Test....21
4.1.2 Power on Test....21
4.2 Email Notification....21
4.3 Enabling the Pi Camera....22

CHAPTER FIVE 23
RECOMMENDATIONS, CONCLUSION AND FUTURE SCOPE OF WORK 23
5.0 Conclusions 23
5.1 Recommendations 23
CHAPTER SIX 24
REFERENCES 24
APPENDICES 26

LIST OF FIGURES

Figure 1: the Raspberry pi 9
Figure 2: camera module 11
Figure 3: Hardware wiring of pi camera to raspberry pi 12
Figure 4: Power supply circuit.....12
Figure 5: Cooling fan.....13
Figure 6: Circuit Diagram for Raspberry Pi Based Security System 14
Figure 7: Flow Chart for Raspberry Pi Based Security System 15
Figure 8: Flowchart of motion detection and tracking algorithm.....20

LIST OF ACRONYMS

CCTV	-	Closed Circuit Television
DVR	-	Digital Video Recorder
IP Camera	-	Internet Protocol Camera
VPN	-	Virtual Private Network
LCD	-	Liquid Crystal Display
SBC	-	Single Board Computer
RPI	-	Raspberry Pi
TCP/IP	-	Transmission Control Protocol/Internet Protocol
GSM	-	Global System for Mobile Communication
P2P	-	Point to Point
VCR	-	Video Cassette Recorder
HDMI	-	High Definition Multimedia Interface
GPIO	-	General Purpose Input/output
DAC	-	Digital to Analog Converter
SSH	-	Secure Shell
SMTP	-	Simple Mail Transfer Protocol
MIME	-	Multipurpose Internet Mail Extension
SEAS	-	School of Engineering & Applied Sciences

ABSTRACT

Raspberry Pi Based Security System For Electricity, Presents the idea of monitoring a particular place in a remote area. This project deals with the design approach of an Embedded Real-Time Investigation System Based Raspberry Pi SBC for intruder detection that reinforces surveillance technology to provide essential security to our life and associated control and alert operations. The proposed security solution hinges on our novel integration of cameras and motion detectors into web application. Raspberry Pi operates and controls motion detectors and video cameras for remote sensing and surveillance, streams live video and records it for future playback. This research is focused on developing a surveillance system that detects strangers and to response speedily by capturing and relaying images to owner based wireless module.

CHAPTER ONE

1.0 Introduction

The demands on video investigation systems are rapidly increasing in the present day. One of the first things people will want to know about their surveillance system is whether or not they have the ability to connect to it over the internet for remote viewing. In the past, security systems had to be monitored by a guard who was locked away in a room all day watching the monitors to make sure that nothing would happen. The other option was to come back and review the footage but damage could have happened. Therefore, researchers and scientists had to come up with ways of overcoming that, and thus improving security at large.

Commercial spaces, universities, hospitals, casinos, companies and warehouses require video capturing systems that have the ability to alert and record beside live video streaming of the intruder. The advancements in video surveillance technology have made it possible to view your remote security camera from any internet-enabled PC or smartphone from anywhere in the world. This encompasses the use of CCTV (DVRs) systems and IP cameras. This technology is awesome but its cost of implementation has proven to be an obstacle especially for a small home application.

Therefore, new innovative technology revolves around affordability of a product in terms of its cost and ease of implementation. The Raspberry Pi crosses both criteria in that it is a cheap, effective computer which can be interfaced with other modules to realize systems with immense functionality. A lot can be done on it ranging from motor speed control, automatic lighting, VPN server, security system etc. The latter is of great interest in this project.

The Raspberry Pi microcomputer is capable of implementing a cost effective security system for various applications. This new arising technology related to security provides a comfortable and safe environment for small homes. The various objectives of the system are to detect an intruder, take an image of the intruder and also convey an alert message to the facility owner. In doing so it thus allows for remote monitoring of homes from anywhere in the world.

The system to be designed cannot wholly replace the role of CCTV and IP surveillance cameras especially in large commercial set ups but will make it easy for low income home owners to monitor their homes at a very affordable price. In addition to the fact that the Raspberry Pi board is cheap, the camera to be used in this case is relatively cheap compared to the others. The whole

security system circuitry is simple and easy to implement.

Image processing is a term which indicates the processing on image or video frame which is taken as an input and the result set of processing is may be a set of related parameters of an image. The purpose of image processing is visualization which is to observe the objects that are not visible. Analysis of human motion is one of the most recent and popular research topics in digital image processing. In which the movement of human is the important part of human detection and motion analysis, the aim is to detect the motions of human from the background image in a video sequence. It also includes detection and tracking. The process of object tracking is segmenting a region of interest from a video frames and keeping track of its motion and position.

1.1 Problem Statement

The need to develop a cost effective surveillance system through innovative technology greatly influenced the development of this project. The system should be able to detect motion activate a camera to take frames of video after motion is sensed and then send an alert to the company's administrators through electronic mail plus an image attachment.

In this project wireless technology is used to monitor theft in Electricity meter. An electric meter is a device used for measuring the amount of electrical energy supplied to a residential or commercial building. Due to the increasing cost of electricity, the electricity related theft increases and thus tampering and security in electric meters has become a major concern for government agencies across the globe. Ineffective and inefficient present methods of detecting and preventing Power and electricity theft cause a revenue loss along with damage to personal and public property.

The proposed system will be hidden in where most of the insecurity is likely to occur i.e. in the meters and as soon as an attempt is made for the theft, it will send an SMS to the company's managers.

1.2 Objectives of the Study

1.2.1 Main Objective:

The main aim of this project is to design and develop a security system that includes features such as motion detection, image processing and emailing or SMS to company's owner. The system is to be based on Raspberry Pi.

1.2.2 Specific Objectives:

- To develop and build a prototype of an electrical investigation system based on Raspberry Pi
- To detect an exact area of motion occurrence, identity notification and highlights it accordingly.
- To design and implement a motion spy camera detection and tracking system for real time video analysis.
- To design an electrical theft system for UMEME Co ltd
- To study and describe how the Raspberry Pi can be interfaced with a motion spy camera detector.
- To study how a Raspberry Pi can be programmed using python code so as to be able to send an email to a prescribed mail hub.
- To configure SMTP server so that the Raspberry Pi can be to communicate via email

2.2.3 Research Questions.

- How to develop and build a prototype of an electrical investigation system based on Raspberry Pi.
- How to detect an exact area of motion occurrence, identity notification and highlights it accordingly.
- How to design and implement motion spy camera detection and tracking system for real time video analysis.
- How to the Raspberry Pi can be interfaced with a motion spy camera detector.
- How to a Raspberry Pi can be programmed using python code so as to be able to send an email to a prescribed mail hub.
- How to configure SMTP server so that the Raspberry Pi can be to communicate via email

2.3 Scope of the project:

This project is focused on developing a surveillance system that detects motion and to respond speedily by capturing an image and relaying it to an administrator device through the internet platform. The system will require Raspberry Pi module, motion detection sensor, camera and Internet connection. It will come up with an implementation of a surveillance system which

presents the idea of monitoring a particular place in remote areas. The system can be monitored by the user form anywhere in the world.

However, this project will not attempt to design the motion detection device, camera or the Raspberry PI. It will therefore use these systems together with a suitable program script to accomplish a real time surveillance system as desired.

2.4 Significance of the study

The security system to be designed in this project can be used extensively to monitor facilities l by owners. The owner shall be able to monitor their property from wherever they are in the world. It will not replace the use of CCTV and camera surveillance systems but reduce the cost of implementation of a basic security system. This thus will enable small home owners to secure their facility at a cheaper cost.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

In the present day, researchers and developers have come up with a wide range of surveillance systems that are used for remote monitoring, alerting as well as controlling tasks through affordable and easy to implement hardware systems. Some have so far been realized while others still remain a proposition.

An embedded home surveillance system which assesses the implementation of a cost effective alerting system based on small motion detection was presented by Padmashree A. Shake and Sumedha S. Borde. They worked on implementing cheap in price, low power consumption; well utilize resources and efficient surveillance system using a set of various sensors. Their system helps to monitor the household activities in real time from anywhere and based on microcontroller which is considered nowadays as a limited resource and an open source solution compared to SBC

D. Jeevanand worked on designing of a networked video capture system using Raspberry Pi. The proposed system works on capturing video and distributing with networked systems besides alerting the administration person via SMS alarm as required by the client. Their system was designed to work in a real-time situations and based on Raspberry Pi SBC. Contrasting to other embedded systems their real-time application offers client video monitor with the help of alerting module and SBC platform.

Sneha Singhd and his team described IP Camera Video Surveillance system using Raspberry Pi technology. The Researchers aimed at developing a system which captures real time images and displays them in the browser using TCP/IP. The algorithm for face detection is being implemented on Raspberry Pi, which enables live video streaming.

Mahima F. Chauhan and Gharge Anuradha offered to design and develop a real time video surveillance system based on embedded web server Raspberry PI B+ Board. Their system has low cost, good openness and portability and is easy to maintain and upgrade. Thus this application system provides better security solutions. This system can be used to affect security

in banking halls, industry, and environment and in military arts

Jadhav G. J evaluates in 2014 the use of various sensors, wireless module, microcontroller unit and finger print module to formulate and implement a cost effective surveillance system. He and his team adopted an ARM core as a basis processor of the system. PIR sensor is used to detect motion in the vision area, while vibrating sensor is used to sense any vibration events such as sound of breaking. The intruder detection technique is proposed by using the PIR sensor that detect motion and trigger a system of alerting and sending short message service through GSM module for a specified phone number. Their work can be featured by adopting numerous diverse kinds of demanding database and thus it will be more secure and difficult to hack.

In 2014, Sanjana Prasad and his colleagues worked on developing a mobile smart surveillance system based on SBC of Raspberry Pi and motion detector sensor PIR. Their development boosts the practice of portable technology to offer vital safety to our daily life and home security and even control uses. The objective of their research is to develop a mobile smart phone home security system based on information capturing module combined with transmitting module based on 3G technology fused with web applications. The SBC will control the PIR sensor events and operates the video cameras for video streaming and recording tasks. Their system has the capability to count number of objects in the scene

Uday Kumar worked on implementation of a low cost wireless remote surveillance system using Raspberry Pi. Conventional wireless CCTV cameras are widely used in surveillance systems at a low cost. He and his team implemented a low cost and secure surveillance system using a camera with Raspberry Pi and the images acquired have to be transferred to the drop box using a 3G internet dongle. This was successfully implemented using Raspberry Pi and 3G dongle

2.1 Theoretical Review.

2.1.1 Background.

With the invention of electricity, the art of home protection was greatly improved. In 1853, the first patent on electro-magnetic alarms meant that businesses and wealthy residents could secure valuables. Magnetic contacts were installed on the windows and doors that, when tripped, would send a signal through the electromagnetic wiring and sound an alarm. These groundbreaking

security systems were effective in deterring break-ins from occurring

According to Cisco Expo, major strides have been made with regards to surveillance systems. After the alarm system, analog video camera with Video Cassette Recorder evolved. It had poor imaging and no remote access. To overcome the drawbacks of this system, digital video recorders evolved. They gave good quality pictures and enable for transmission of video signals through data networks and thus allowed for remote monitoring

Network Video Recorder then emerged. They have the advantages of the DVRs but have other merits over DVRs. They give more storage options and network connection. The most superior version is the type that uses Cisco Video Surveillance Platform. They give secure remote access and control from anywhere, fail-safe redundant storage, easy integration with other systems and enterprise class storage and support

Security literally means a way or method by which something is secured through a system of interworking components and devices. On the other hand, security systems are networks of integrated electronic devices working together with a central control panel to protect against burglars and other potential intruders. Security systems work on the simple concept of securing entry points into a home with sensors that communicate with a control panel or command center installed in a convenient location. The sensors are typically placed in entrances as well as easily accessible windows. A typical home security system has the following components: A control panel, which is the primary controller of a security system, door and window sensors, motion sensors, wired or wireless security cameras, high-decibel siren or alarm and window stickers.

This security system project deals with the design and development of a theft control system for home, which is being used to prevent/control any theft attempt. The developed system makes use of an embedded system comprising of an open hardware microcontroller (Arduino) and a modem based on Global System for Mobile communication (GSM) technology

The designed and developed system can be installed in the home. An interfacing intrusion-detector unit is also connected to the microcontroller-based security system. The system thus incorporates a passive infrared sensor (PIR) for motion detection. In case of an intrusion attempt, a warning message is being transmitted by the system (as an sms) to the owner's mobile phone, or to any pre-configured mobile phone number for further processing.

CHAPTER THREE:

METHODOLOGY

3.1 Introduction.

This chapter explains in detail the methodology and components that were used in the project. In this chapter also explains the technical plan, analysis and also the specifications.

3.2 Data Collection.

Experimental data collection method was used in this project. It is data produced by a measurement, test method, experimental design or quasi-experimental design. Also, it is data produced as a result of a clinical trial. Experimental data may be qualitative or quantitative, each being appropriate for different investigations. The data therein used in this project is both qualitative and quantitative where qualitative data is considered more descriptive and can be subjective in comparison to having a continuous measurement scale that produces numbers normally experimentally repeatable. Qualitative information is usually more closely related to phenomenal meaning and is, therefore, subject to interpretation by our observations as it will be shown in the experiments and block diagrams in this and the next chapters

3.3 Major Components Used

Raspberry Pi

USB powered cable.

Spy camera (pi camera)

Power supply (9v Battery)

Rectifier

Cooling Fan

Memory card (Micro SD card)

3.4 System Design.

The system is designed with the use of a combination of tools. These tools are categorized as hardware tools and software tools as elaborated below:

3.4.1 The Raspberry Pi

The Raspberry Pi is a Linux based microcomputer based on ARM architecture. It was built

mainly to aid in developing open source game.

3.4.2 The Raspberry Pi Models

This part describes the models of Raspberry Pi available. This report will not attempt to provide full specifications but an overview in order to help in making a decision as to which device it is required to accomplish the objectives in question. Currently, five Raspberry Pi models do exist. They are: Model B+, Model A+, Model B, Model A and the Compute Module (currently only available as part of the Compute Module development kit). All these models use the same SoC (System on Chip - combined CPU & GPU), the BCM2835, but other hardware features differ

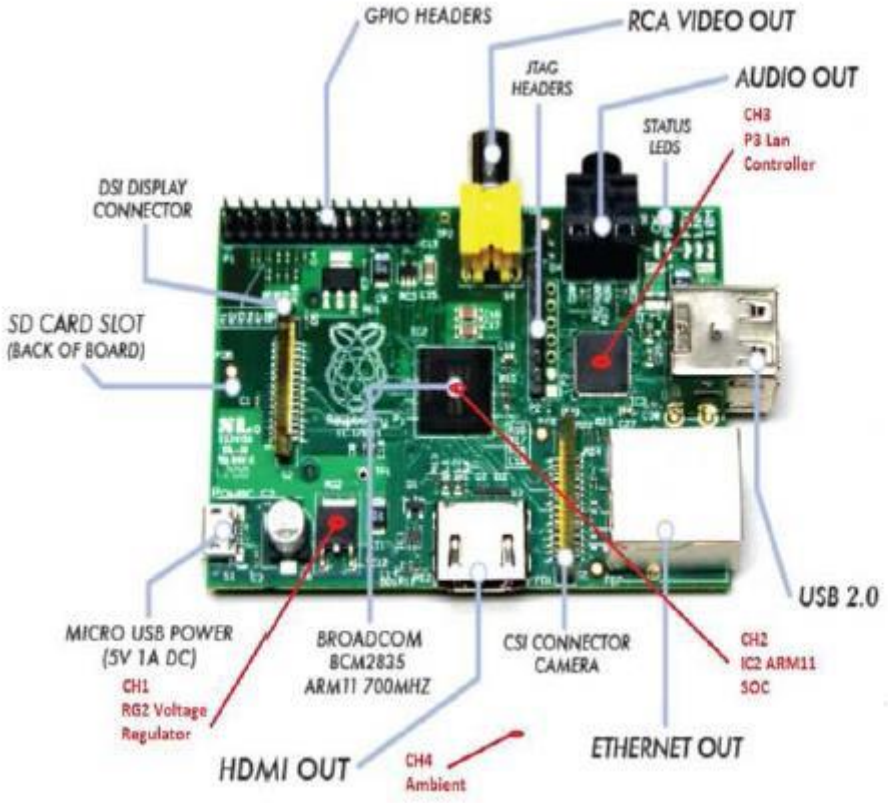

Figure 1: the Raspberry pi

a) Model B+/B

First release was made in July 2014. This Model is an upgrade of the Model B. It has the following characteristics: 4 USB ports, 40 pins on the GPIO header , Improved power circuitry which allows higher powered USB devices to be attached and now hot-plugged. The full size composite video connector of Model B has been removed and the functionality moved to the 3.5mm audio/video jack and the full size SD card slot of Model B have also been replaced with a much more robust micro SD slot. The following details some of the improvements over the:

b) Model B:

- Current monitors on the USB ports mean the B+ now supports hot-plugging
- Current limiter on the 5V for HDMI means HDMI cable-powered VGA converters.
- 14 more GPIO pins
- EEPROM readout support for the new HAT expansion boards
- Higher drive capacity for analog audio out, from a separate regulator, which means a better audio DAC quality
- No more back powering problems, due to the USB current limiters which also inhibit back flow, together with the "ideal power diode"
- Composite output moved to 3.5mm jack
- Connectors now moved to two sides of the board rather than the four of the original device
- Ethernet LEDs moved to the Ethernet connector
- 4 squarely-positioned mounting holes for more rigid attachment to cases.

c) Model A/A+

This is the basic device, with a single USB port and 256MB of SDRAM. Onboard ports include: Full size SD card, HDMI output port, Composite video output, One USB port, 26 pin expansion header exposing GPIO, 3.5mm audio jack, Camera interface port (CSI-2), LCD display interface port (DSI) and One micro USB power connector for powering the device

3.4.3 Programming the Raspberry Pi

To enable communication with the outside world, the Raspberry Pi has to be programmed with a suitable programming language. These languages include Java, FOTRAN, Pascal, Python, C,

C++ etc. Each language has its own syntax and semantics. RPI can be programmed using any of these languages but for purposes of this project, Python will be of great importance to study. It is provided by default through and thus optimum operation of the Pi can be achieved.

3.4.4 Raspberry Pi Operating Systems

An operating system makes Raspberry Pi run. Since Raspberry Pi is a credit sized computer that is based on Linux, optimum performance of RPI can be achieved if it is therefore operated in this environment. Raspbian provides more than a pure OS: it comes with over 35,000 packages, pre-compiled software bundled in a nice format for easy installation on RPI. Important to note is that the Raspberry Pi does not operate in a Windows environment. To get access to Pi from windows we require Putty Software. Putty is an SSH and TelNet client.

3.5 The Pi Camera Module

The Camera Board on the Raspberry Pi is a small printed circuit board with a camera on it. The PCB is connected to a ribbon cable which connects to the Pi itself on its own port. The ribbon can be extendable. The camera on the board is very small (5MP camera). As for now it is the only Camera made specifically for the Pi therefore these specifications cannot be updated. Since it uses 250mA, externally powering the Pi should be sufficient enough for the camera. Specific configuration settings are required to initialize the camera plus Python scripts to enable it take pictures.

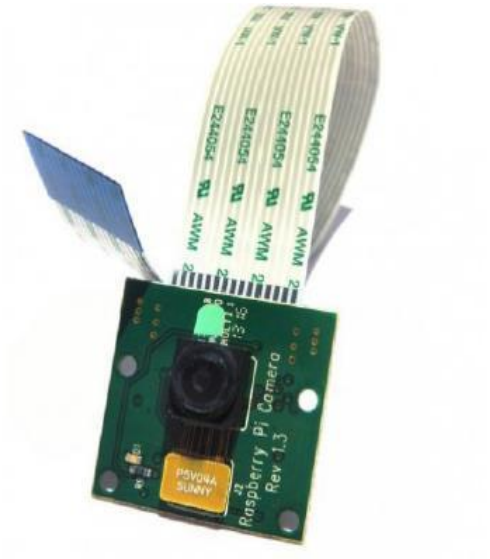

Figure 2: camera module

3.5.1 The hardware connection of camera to the PI

The hardware connection of PI camera to the raspberry PI module is shown in figure below

Figure 3: Hardware wiring of pi camera to raspberry pi

3.6 Power Supply Circuit

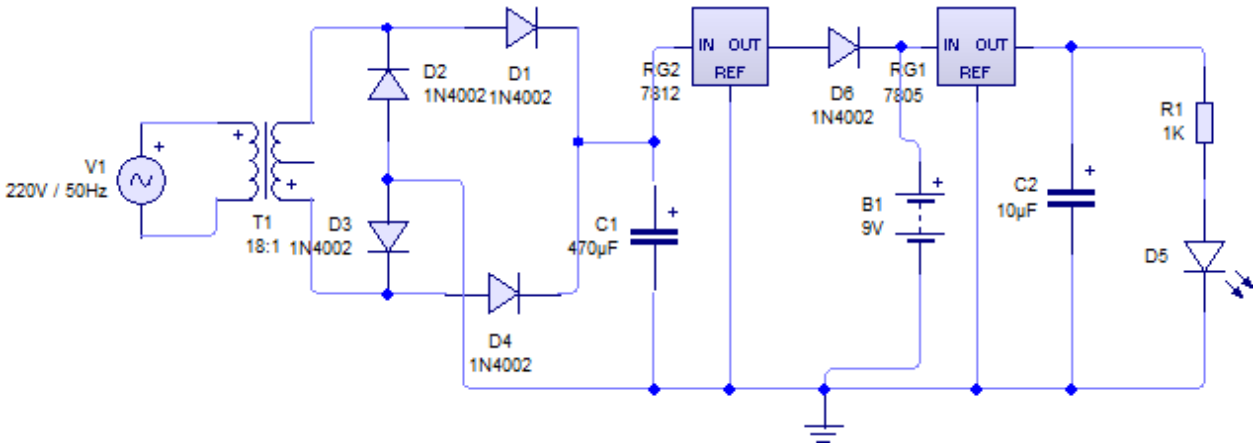

Figure 4: Power supply circuit

This design module includes a step down transformer, bridge rectifier, electrolytic capacitors, 9v voltage regulator, 5V voltage regulator, a resistor R1 and LED. This circuit was designed using circuit wizard

3.7 Cooling Fan

It is used to keep the raspberry pi cool, and prevent hard working pi from overheating

The fan is plugged directly into Raspberry Pi's 5V+GND GPIO power pins.

3.7.1 Specifications:

- Operating voltage: 5V
- Current: 0.2 A
- Brushless DC fan
- Fan dimensions: 30mm x 30mm x 8mm
- Wire length: 3.25" / 80mm
- Fan weight: 6.2g / 0.22oz
- Mounting screws & nuts included

Figure 5: Cooling fan

3.8 Software

Python script

3.9 Hardware System.

- Spy camera
- Battery
- Rectifier
- Cooling Fan
- Memory card
- Raspberry Pi

3.10 Conceptual Design/Framework.

The block diagram consists of the major components that make up the system as shown below.

3.11 Block Diagram for Raspberry Pi Based Security System

Figure 6: Block Diagram for Raspberry Pi Based Security System

3.12 Circuit Diagram for Raspberry Pi Based Security System

The entire system modules were interfaced together as shown below.

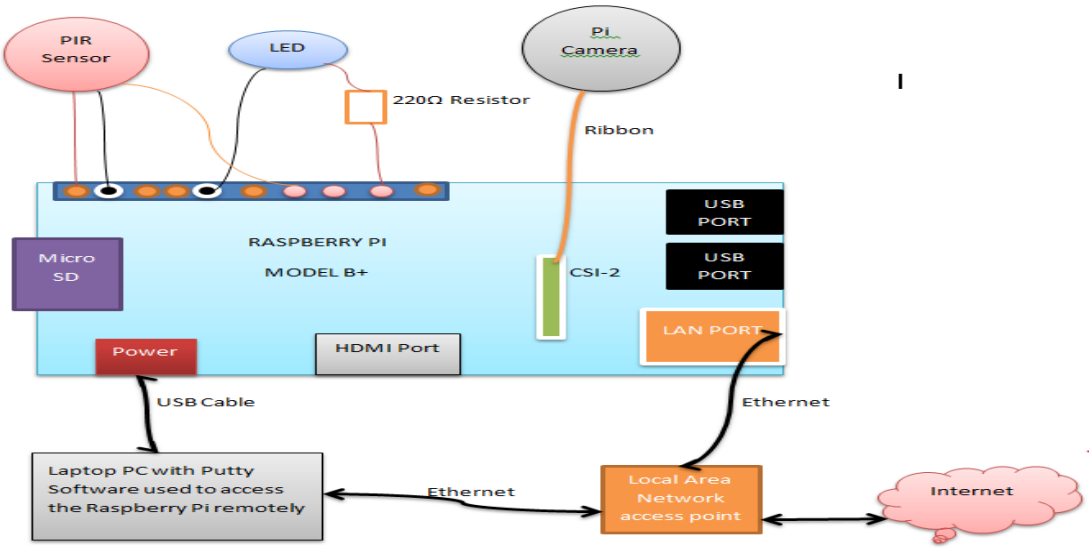

Figure 6: Circuit Diagram for Raspberry Pi Based Security System

3.13 system Working Principle

The power is received from ac mains at a voltage of 240V at the transformer primary side where it is stepped down 12V ac. Output of the transformer is connected to the bridge rectifier circuit where the 12V ac is converted into 12V DC and the electrolytic capacitor connected across is to store charge plus filtration purposes. This voltage is fed to the voltage regulator whose output is 9V dc to charge the battery to provide the backup power supply in case of power outage. 9V dc is supplied to another voltage regulator whose output is 5V dc which is output voltage supply that is needed as

an input voltage of the raspberry PI board where the 5V dc and 3.3Vdc are the output voltages of the its board. The cooling fan and the PI camera are supplied with 5Vdc from the Raspberry pi board at the common anode on the strip board.

3.14 Flow Chart for Raspberry Pi Based Security System

The flowchart is used to design and thus document the security systems project. It illustrates the series of events starting from intrusion event up to the point when it sends out an alert. This algorithm was implemented using a Python script. Figure below presents the basic flowchart of the entire system.

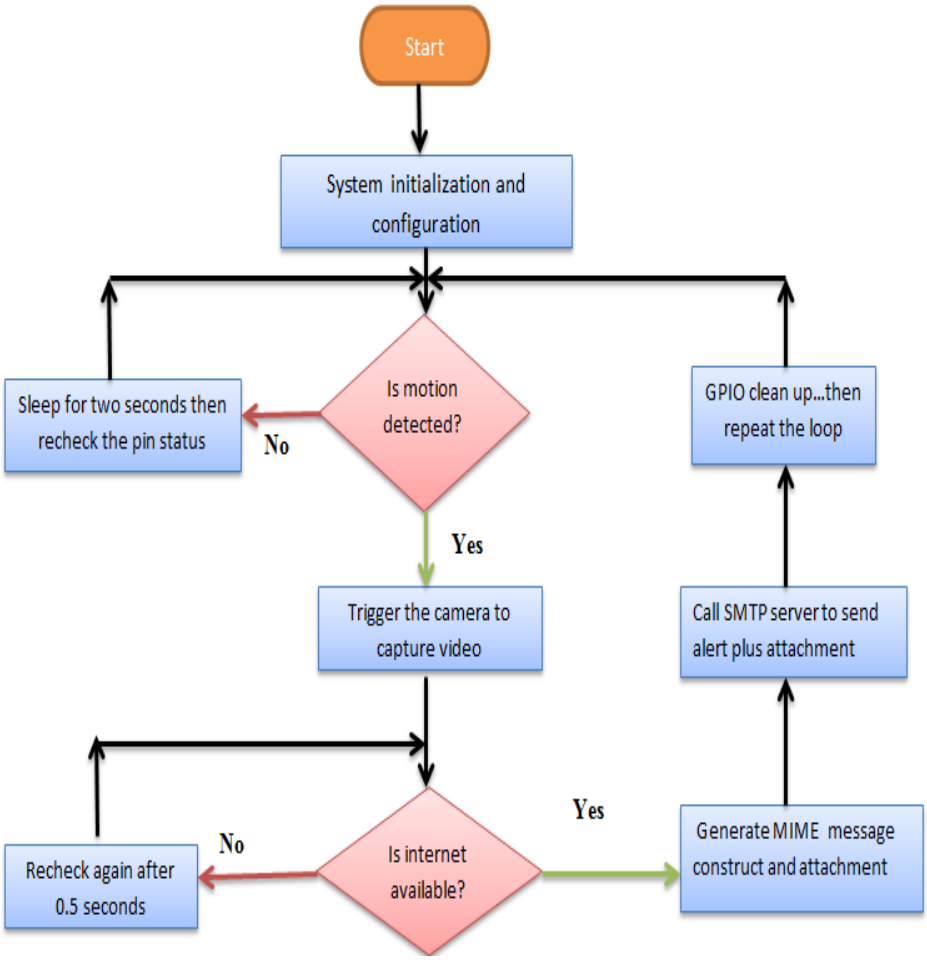

Figure 7: Flow Chart for Raspberry Pi Based Security System

3.15 System initialization and configuration

This involved the following tasks

- Importing Python libraries and packages. These libraries are predefined and help in making the interfaced modules work properly.
- Pi Camera setting and configuration.
- GPIO settings and pin initialization: (the channel was set using the BCM channel numbering. Passive infrared pin channel was set to read mode while the led channel was set to drive/write mode.

3.15.1 Read a Channel

In order to read the value of any GPIO pin, simply type; GPIO. Input (channel)

3.15.2 Drive a channel

In order to drive a channel of GPIO pin, type; GPIO.output (channel, status)

This sequence of events can be elaborated well using the block diagram below.

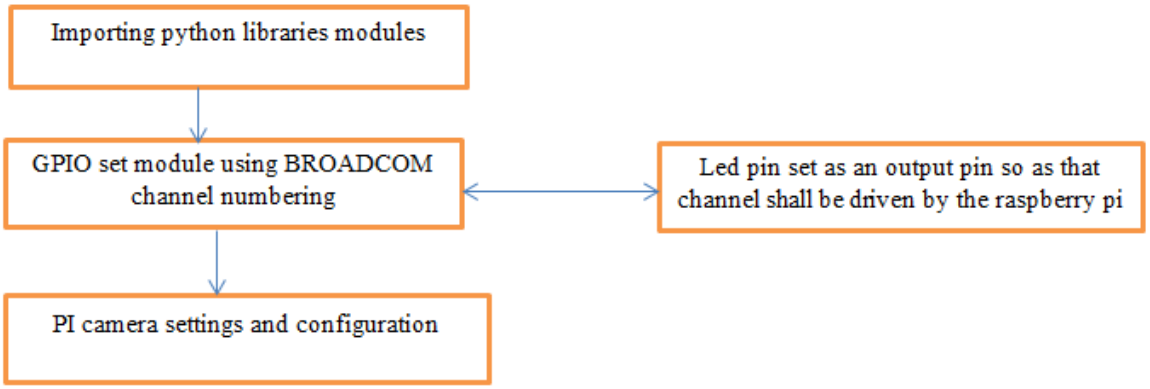

Figure 9: System Initialization and configuration

3.16 Source code

- Upon restart of the system, send out email with boot IP assigned to a mail host.
- Check the status of the GPIO pin. If the pin is LOW, GPIO output pin 13 should remain LOW and the system is idle. Else if the pin suddenly goes HIGH. Interpret this as an interrupt event.
- While the value of the input GPIO pin is HIGH (interrupt event), set pin 13 to be HIGH.
- This instance blinks the LED. Call the function that starts the Pi Camera.

- Camera takes a 10 seconds video and save it in a file.
- The system checks whether the internet is enabled on the Raspberry Pi.
- If internet, send email to a prescribed mail host. If no internet, wait for 5 seconds then check again.

3.16.1 Developing the Full Code Listing.

To be able to develop the Python script that executes the algorithm defined in the flowchart, the following were done at the CLI of the Raspberry Pi:

- The Pi was started and a directory was created using mkdir command
- Inside the directory, a file was created using the touch command and made executable using sudo chmod +x (filename).
- The nano command was then used to open the editor and the full Python code was written there. The script was executed using the following command:

```
Sudo python filename.py
```

3.16.2 Full code listing

OpenCv – Python Code.

```
# import the necessary packages
import argparse
import datetime
import time
import cv2
# construct the argument parser and parse the arguments ap =
argparse.ArgumentParser()
ap.add_argument("-v", "--video", help="C:\Users\shadrack\Desktop\opencv")
ap.add_argument("-a", "--min-area", type=int, default=1000, help="minimum area size") args =
vars(ap.parse_args())

# if the video argument is None, then we are reading from webcam if
args.get("video", None) is None:
```

```
        camera = cv2.VideoCapture(0)
        time.sleep(1)

# otherwise, we are reading from a video file
else:
        camera = cv2.VideoCapture(args["video"])
# initialize the first frame in the video stream
currentFrame = None
S
# loop over the frames of the video
while True:
        # grab the current frame and initialize the occupied/unoccupied
        # text
        (grabbed, frame) = camera.read()
        text = "No Motion Detected...."
        # if the frame could not be grabbed, then we have reached the end
        # of the video
        if not grabbed:
                break
        #convert it to grayscale, and blur it
        gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
        gray = cv2.GaussianBlur(gray, (21, 21), 0)
        # if the first frame is None, initialize it if
        currentFrame is None:
currentFrame = gray continue
previousFrame = currentFrame
currentFrame = gray
# compute the absolute difference between the current frame and
# first frame
frameDelta = cv2.absdiff(previousFrame, gray)
thresh = cv2.threshold(frameDelta, 100, 255, cv2.THRESH_BINARY)
```

```
# dilate the thresholded image to fill in holes, then find contours
# on thresholded image
thresh = cv2.dilate(thresh, None, iterations=2)
(cnts, _) = cv2.findContours(thresh.copy(), cv2.RETR_EXTERNAL,
cv2.CHAIN_APPROX_SIMPLE)
# loop over the contours for c in
cnts:
# if the contour is too small, ignore it
if cv2.contourArea(c) < args["min_area"]:
continue
# compute the bounding box for the contour, draw it on the frame,
# and update the text
(x, y, w, h) = cv2.boundingRect(c)
cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)
ext = "Motion Detected.."
# draw the text and timestamp on the frame cv2.putText(frame, "Room
Status: {}".format(text), (10, 20),
cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255), 2)
cv2.putText(frame, datetime.datetime.now().strftime("%A %d %B %Y
 %I:%M:%S%p"),
(10, frame.shape[0] - 10), cv2.FONT_HERSHEY_SIMPLEX, 0.35, (0, 0, 255),
 1)
# show the frame and record if the user presses a key
cv2.imshow("Security Feed", frame) cv2.imwrite("security.jpg",
frame)
#cv2.imshow("Thresh", thresh)
#cv2.imshow("Frame Delta", frameDelta)
key = cv2.waitKey(1) & 0xFF
# if the `q` key is pressed, break from the lop if key
== ord("q"):
break
```

```
# cleanup the camera and close any open windows
cv2.destroyAllWindows()
```

3.17 OpenCv – Python Video Processing

OpenCv is a very powerful tool used to analyze images and video files. The basic processing procedure to be followed is detailed in the flowchart below. Thresholding as a technique of image processing was chosen for the implementation of motion detection and tracking in video streams. The choice to script using OpenCv – Python was because Python on its own does not support video processing. There is so far no video processing library in Python. OpenCv thus provided the necessary platform to achieve image processing. The following flowchart was used for this implementation

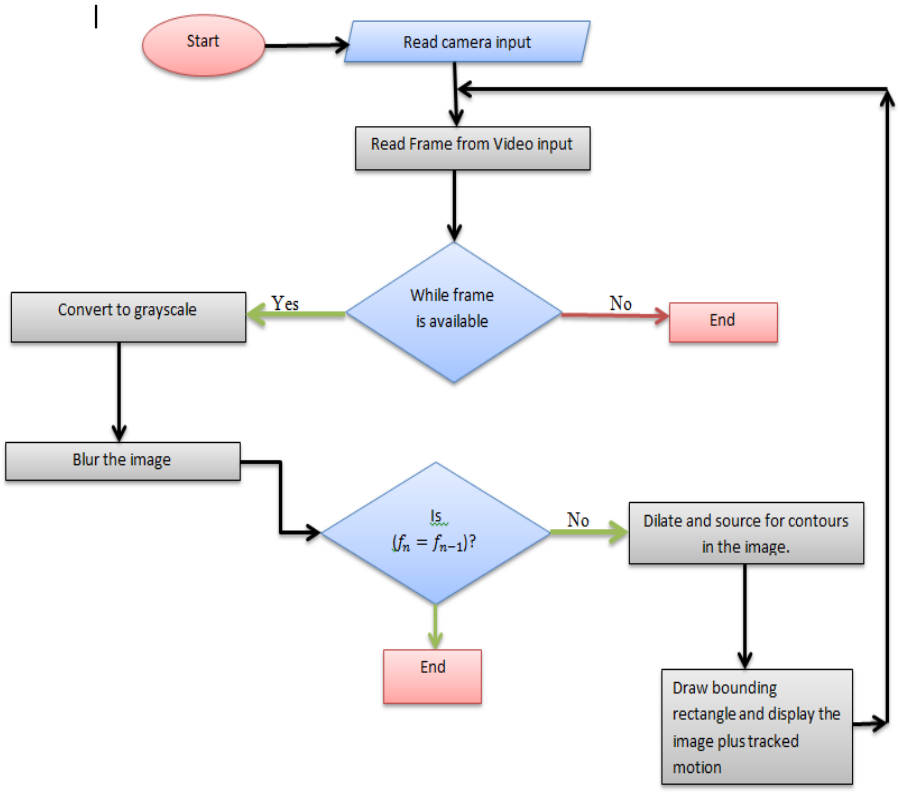

Figure 8: Flowchart of motion detection and tracking algorithm

f_n and f_{n-1} represents the amount of pixels (digitalized image form) for previous the object and the amount for the current object respectively.

CHAPTER FOUR:

RESULTS AND DISCUSSION

4.0 Introduction

4.1 Hardware testing

4.1.1 Continuity Test

Continuity test was carried out to check if there was current flow in the project circuitry and was aimed at finding electrical open paths in the circuitry after completing soldering and configuration. A multimeter was used to perform continuity test on the electric circuit by measuring electric current flow.

Procedures

a. A multimeter was kept in continuity mode.

b. Then the ground probe was connected to the common slot on multimeter and another probe was connected to slot for continuity, voltage and resistance.

c. Finally both terminals of the probes were connected across the path that needs to be checked and there was continuity in the path, a beep sound was produced by the multimeter

4.1.2 Power on Test

Power on test was performed to check whether the voltage at different terminals was according to the requirements or not. A multimeter was switched to voltage mode, note that, this test was performed without the microprocessor to avoid damage to the microprocessor due to any excessive voltages.

The output from the regulator LM7805 was connected to the USB head where the output of 5 VDC was connected to the microprocessor which takes 5 VDC to power the PI camera.

4.2 Email Notification

In order to allow for email notifications to send, the OS needs a program that allows for emails to be sent. Simple Mail Transfer Protocol (SMTP) is a program that allows a system to deliver an email from a local computer to a mail host. It does not receive mail but can send out mail. SMTP is ideal for situations where alerts are needed to be sent; therefore it is useful when sending notifications.

A python script can be used to achieve this. It may just send a notification without image or can be modified to send an attachment along with the alarm message For SMTP to support transmission of an attached file, Multipurpose Internet Mail Extension (MIME) is required.

4.3 Enabling the Pi Camera

This is the camera made specifically for the Raspberry Pi. It was hooked to the raspberry pi through CSI-2 electrical port which is an extremely fast port. To configure and enable the camera, the following commands were executed at the CLI of the raspberry pi:

```
sudo apt_get update

sudo apt_get upgrade

sudo raspi-config
```

After these configuration settings, the system was rebooted. This was done to ensure that the camera was allocated enough space in memory. The camera takes 5MP image and has a resolution of 1080 by 890. And to ensure that the camera was well configured and functional, the following command was executed.

```
sudo raspistill –o image.png
```

This by default this command takes a three second image and save it in a file called image.png.

CHAPTER FIVE

RECOMMENDATIONS, CONCLUSION AND FUTURE SCOPE OF WORK

5.0 Conclusions.

The project designed and implemented a security system based on the Raspberry Pi. The aspects of the system are: motion detection, video capturing using a Pi Camera and sending out an alert through e-mail. This project system can be successfully used to monitor the places to prevent any intruders access by some an alert mechanism, image processing ,emailing or SMS to company's owner and to keep an eye on people enter and leave the premises using the pi camera. The significance of this project can be applied in the various and wide places such as; UMEME ltd , power transmission companies, homes, schools, institutions, government warehouses , hospitals, and some other places where critical security concern is highly demanded.

5.1 Recommendations

- This project can be further implemented and used as an independent security system. Therefore we recommend all security organs to fund the project to make it a successful and implemented project for security improvement in the places which are security conscious.
- The project can further be incorporated with a GSM module to enable sending and receiving text messages to and from the people who stay in the place.
- The system requires to be remotely controlled. Hence, future explorations should focus much more on the same.
- Major improvements on the system processor speed are much needed in order to process large files e.g. video for effective motion detection and tracking.

CHAPTER SIX

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APPENDICES

Appendix (i) :Table 1 Bill of materials

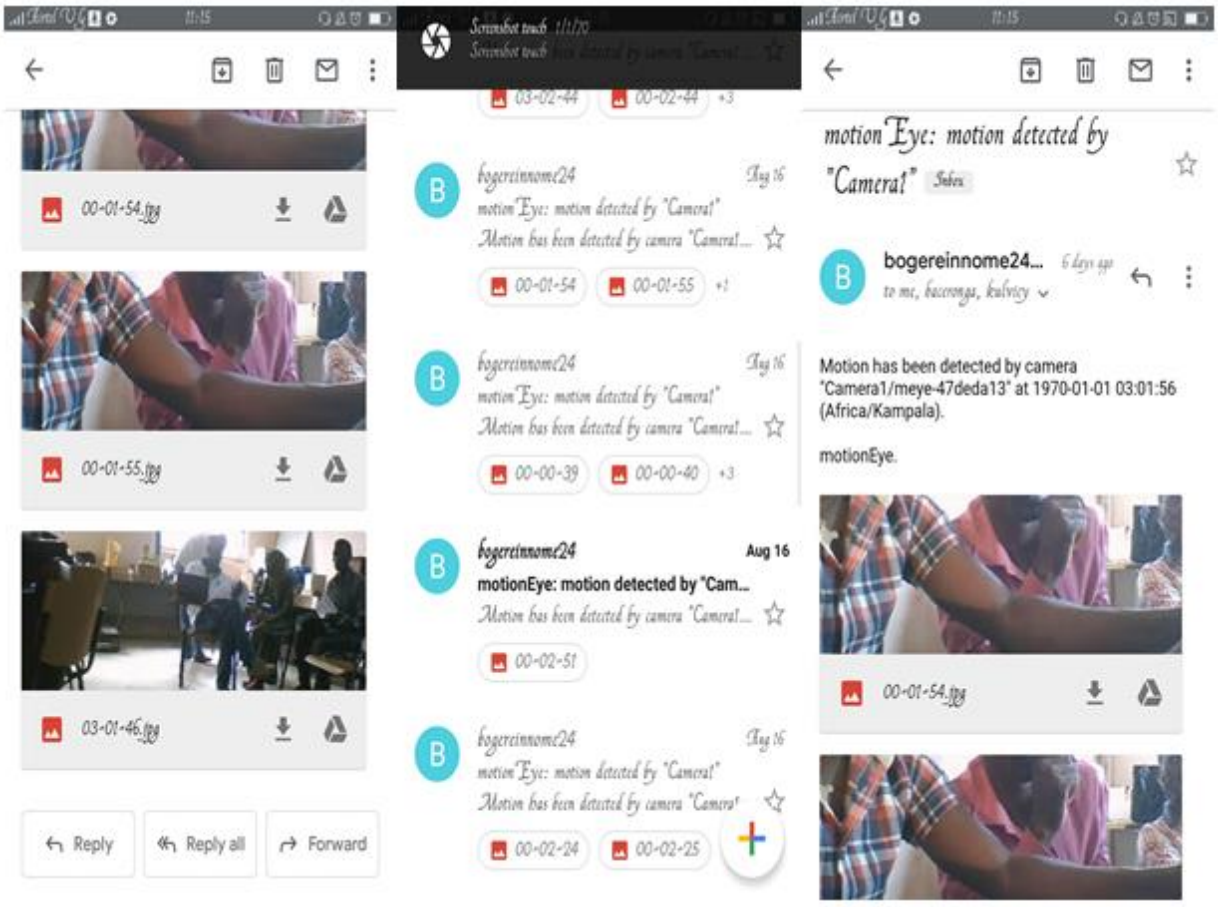
SN	Item(s)	quantity	Prices (ug. shs)
1	Raspberry pi 3 – B+	1	400000
2	Pi camera module	1	200000
3	Soldering gun	1	30000
4	Soldering lead	2	5000
5	Strip board	1	5000
6	9V battery	1	30000
7	Jumpers	30	10000
Total			680,000

Appendix (ii); the table below shows the number of activities performed and their respective duration

	NUMBER OF WEEKS							
ACTIVITIES	**WEEK 1**	**WEEK 2**	**WEEK 3**	**WEEK 4**	**WEEK 5**	**WEEK 6**	**WEEEK 7**	**WEEK 8**
DATA COLLECTION								
DATA PROCESSING								
DATA ANALYSIS								
PURCHSING OF COMPONENTS								
PROGRAMMING THE RESPBERRY PI								
DESIGNAND IMPLEMENTATION								
TESTINGAND ERROR RECTIFICATION								
REPORTINGAND DISSEMINATION								

Table: showing activities and their duration

Appendix (iii) results during an email notification:



Results during an email notification