University of Science and Technology

Faculty of Engineering

Department of Computer and Electronic SystemEngineering

A Research submitted in partial fulfillment for the Requirement of B.Sc. (Hon) in Computer and Electrical System Engineering

Camera Based surveillance system using Raspberry Pi

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April-2018

الآية

قال تعالي:

(والله أخرجكم من بطون أمهاتكم لا تعلمون شيئا وجعل لكم السمع والأبصار والأفئده لعلكم تشكرون) (78)

صدق الله العظيم

سوره النحل

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فلكم مني كل الاحترام والتقدير والشكر والعرفان عليي ماتقدموة لي من جميل الافعال

أخوالي ..... خالاتي

إلي المعطائة بسخاء من كانت خير عون وسند علي طول الخمس سنوات ..تحملتينا بمختلف أجناسنا وعاداتنا وطبائعنا المتباينة ..فلم تكوني الا اما رؤوم وحنون علينا فأدامك الله نورا علي دنيانا

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إلي اللصيقين بي دوما صديقاتي الجميلات أصدقائي وإخوتي إلي كل من يعرفني وجمعتني بة ظروف الحياة لكم كل الشكر والتقدير فأنتم من قواني وجعلني اتقدم جزيل الشكر علي هذا العطاء .

الشكر والعرفان :

من علمني حرفا صرت له عبدا

لابد لنا ونحن نخطو خطواتنا الاخيره في الحياه الجامعيه من وقفه نعود إلي اعوام قضيناها في رحاب الجامعه مع أساتزتنا الكرام الذين قدموا لنا الكثير باذلين بذلك جهودا كبيره.... وقبل ان نمضي أتقدم بأسمي آيات الشكر والإمتنان إلي الذين حملوا اقدس رساله في الحياة ...إلي الذين مهدوا لنا طريق العلم والمعرفة

"كن عالما ..فإن لم تستطع فكن متعلما ..فإن لم تستطع فأحب العلماء ..فإن لم تستطع فلا تبغضهم"

إلي جميع أساتذة كلية الهندسة قسم هندسة النظم الإلكترونيه والحاسوب

كل التقدير والاحترام للمعطائه دوما البازله في سخاء ..التي كانت لنا خير دليل ومعين

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دفعه 2013

ABSTRACT

Motion detection is one of the key techniques in surveillance.

This project mainly focuses on improve motion detection based on low computing system “Raspberry Pi” where used USB camera to captured image when detected the unauthorized Activity using hydroelectric infrared (PIR) sensors.

This system is suitable for small personal area surveillance offices/homes bank locker room, parking entrance. Whenever the motion is detected through PIR sensor the image is captured through camera and stored in the raspberry pi .module and then send to email sever

Internet of things based application can be used remotely to view the activity and get notifications when motion is detected.

System works standalone without the PC. IOT system to view the images of the motion occurrence over internet by sending to email server Thus the system provides an innovative approach to theft detection using IOT.

المستخلص

كشف الحركة هو واحد من التقنيات الرئيسة في المراقبة. ويركز هذا المشروع أساسا على تحسين كشف الحركة بلإعتماد نظام حاسوبي منخفض التكلفة "راسبيري باي" حيث نستخدم كاميرا لإلتقاط الصورة عند الكشف عن نشاط غير مصرح به عن طريق استخدام حساس الحركة استشعار باستخدام الأشعة تحت الحمراء. هذا النظام هو مناسب لمراقبة الغرف والمكاتب والبنوك والمنازل ومدخل وقوف السيارات. عندما يتم الكشف عن الحركة من خلال استشعار الحركة يتم التقاط الصورة من خلال الكاميرا وتخزينها في الراسبيري باي. ومن ثم يتم ارسال الى البريد الإلكتروني.

تطبيقات إنترنت الأشياء يمكن استخدامها عن بعد لعرض النشاط والحصول على إشعارات عندما يتم الكشف عن الحركة. يعمل النظام مستقل لوحده دون الإحتياج الى جهاز حاسوب. انترنت الأشياء هي نظام يعرض الصورة عند وقوع الحركة عبر الإنترنت عن طريق إرسال إلى خادم البريد الإلكتروني وبالتالي يوفر النظام نهجا مبتكرا للكشف عن السرقة باستخدام انترنت الأشياء.

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Table of Abbreviation

CCTV	Closed Television circuit
CSI	Camera serial interface
DC	District current
DSI	Display serial interface
DVR	Digital video recorder
GPIO	General Purpose input output
GRD	Ground
GUI	Greater user interface
HDMI	High definition media interface
IDE	Integrated development environment
IoT	Internet of thing
LAN	Local area network
MAC	Media access control
PIR	Passive infrared red
POE	Power over Ethernet
RISC	Reduced instruction set computer
R j	Registered jack
SD	Secure digital
USB	universal serial bus
VCR	Video camera recorders

Chapter One

Introduction

1.1 Background

Starting from small houses to huge industries, surveillance plays very vital role to fulfill our safety aspects as Burglary and theft have always been a problem. In big industries, personal security means monitoring the people's changing information like activities, behavior for the purpose of protecting, managing and influencing confidential details. Surveillance means watching over from a distance by means of electronic equipment such as CCTV cameras. But it is costly because of the use of computer. It reserves too much space for continues recording and also require manpower to detect the unauthorized Activity. But compared to the existing system raspberry Pi system is much cheaper and low power consumption feature .

The raspberry Pi is credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything we would expect a desktop computer to do, from browsing the internet and playing high- definition video, to making spreadsheets, word-processing, and playing games .

The Internet of Things (IOT) can be described as connecting everyday objects like smart phones, Internet TVs, sensors and actuators to the Internet where the devices are intelligently linked together enabling new forms of communication between things and people, and between things themselves. Building IOT has advanced significantly in the last couple of years since it has added a new dimension to the world of information and communication technologies.

1.2 Objective

- monitoring theft using an electronic system
- Cut in costs in monitoring places using electronic system in steading of personal.
- Lessening the crimes and theft accident accused.
- Adjustment of red-handed in concert (make it easy to prove).

1.3 Problem statement

- Saving time (that is monitored instantly by camera)
- Public places and office need not completely to be guarded

1.4 Methodology

This system is designed to determine crimes and theft accident. The system has two main components a monitoring component (camera) and a processor the activates are detected and monitored by a base camera at the time when accidents take place. The input data from the camera is processed by the processor. the output from the system is as follows an image of what happened is save , and alarm occur and e-mail is send a computer.

1.5 Thesis layout

The project contains of five chapters,

Chapter one is an introduction,

Chapter two is about literate review,

Chapter three is about hardware components

Chapter four is about implementaion and result,

And chapter five is about conclusion and recommendation

Chapter Two

History of Video Surveillance

2.1 Introduction

Considering video in the simplest of terms, video surveillance began with simple closed circuit television monitoring. As early as 1965, there were press reports in the United States suggesting police use of surveillance cameras in public places. In 1969, police cameras were installed in the New York City Municipal Building near City Hall. The practice soon spread to other cities, with closed circuit television (CCTV) systems watched by officers at all time [1]. The use of technology to aid surveillance is reported to have begun in the 1970s with the CCTV systems [2].

The major components of these analog----based systems include cameras, multiplexers, video camera recorders (VCR) and monitors. The limitations of these systems included the need for a lot of coaxial cable wiring to send and store the video onto video tapes, the tedious and labor----intensive routine in maintaining the VCR due to their low storage capacity, their need for frequent service checks and short life span of two years and finally the time---consuming and strenuous task of rewinding the tapes to trace evidence. The Digital Video Recorder (DVR) technology was birthed in response to the shortcomings of the VCR. In a DVR, a digital storage media such as a computer hard drive is used for storing the video recordings and there cording could be transferred to a tape for archiving if needed. However, a DVR also has its own limitations in that it is usually a local solution where at least one DVR unit is required per location. Axis communications invented the first network camera in1996 while IQ invasion built on this feat to produce the first megapixel model in 1998 [2]. Milestone Systems contributed its quota by introducing the first open plat form software for managing IP Camera---based video surveillance system. By 2003 there were

more sophisticated computer---based DVRs on the market that could handle multi----camera input and provide additional functionality such as alarm handling, activity detection, alarm notification and remote access [2]. With the IP network approach, archiving and storage are more efficient and compression standards also improved for optimized system use.

Chapter three

Hardware components

3.1 Introduction

Camera surveillance system consist of many of different components are divided for three units such as shown below

3.2 Input unit

An input component is piece of microcontroller hardware equipment used to provide data and control signals to an information processing system such as a microcontroller. The input components include camera pi, PIR sensor, and power supply.

3.2.1 Camera pi

The Raspberry Pi camera module is capable of taking full HD 1080p photo and video and can be controlled programmatically. The flex cable inserts into the connector situated between the Ethernet and HDMI ports, with the silver connectors facing the HDMI port. The flex cable connector should be opened by pulling the tabs on the top of the connector upwards then towards the Ethernet port. The flex cable should be inserted firmly into the connector, with care taken not to bend the flex at too acute an angle. The top part of the connector should then be pushed towards the HDMI connector and down, while the flex cable is held in place.

The camera may come with a small piece of translucent blue plastic film covering the lens. This is only present to protect the lens while it is being mailed to you, and needs to be removed by gently peeling it off.

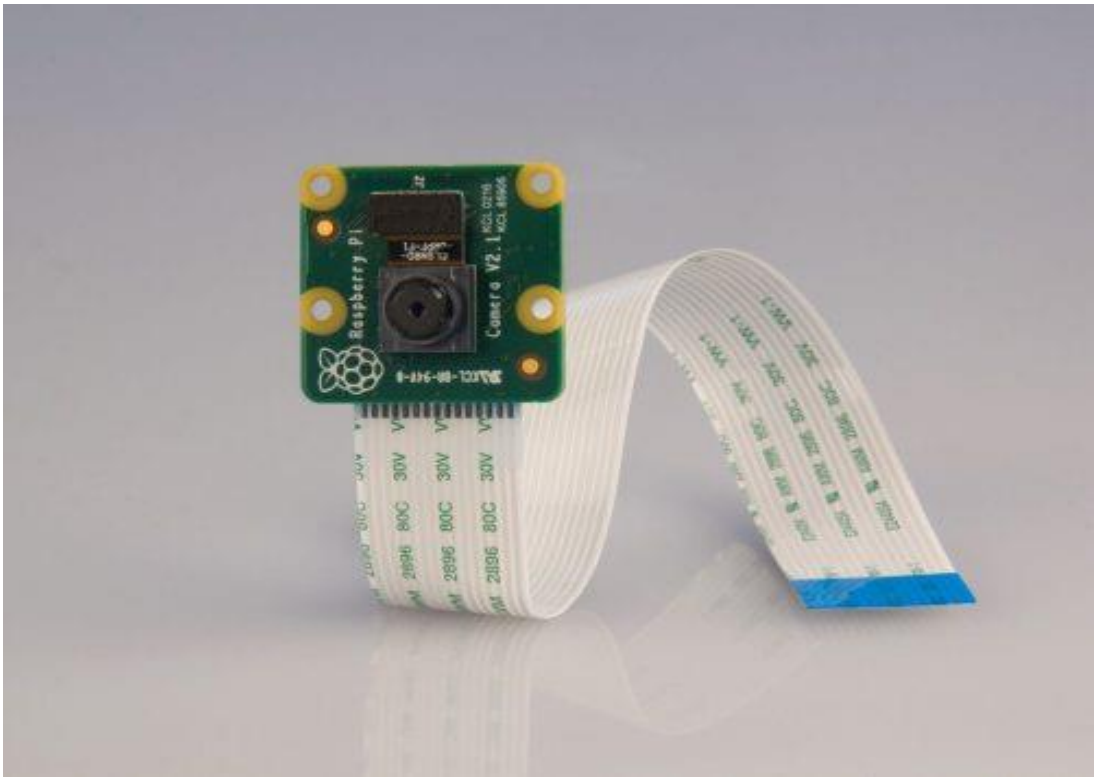

Figure 3.1 Camera Pi

3.2.2 PIR sensor

PIR sensors are more complicated than many of the other sensors explained in these tutorials (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. To begin explaining how a basic sensor works, we'll use this rather nice diagram

The PIR sensor itself has two slots in it, each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and so we see that the two slots can 'see' out past some distance (basically the sensitivity of the sensor). When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a *positive differential* change between the two

halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change.

This image shows the internal schematic. There is actually a JFET inside (a type of transistor) which is very low-noise and buffers the extremely high impedance of the sensors into something a low-cost chip (like the BIS0001) can sense.PIR sensors are rather generic and for the most part vary only in price and sensitivity. Most of the real magic happens with the optics. This is a pretty good idea for manufacturing: the PIR sensor and circuitry is fixed and costs a few dollars. The lens costs only a few cents and can change the breadth, range, sensing pattern, very easily.

In the diagram up top, the lens is just a piece of plastic, but that means that the detection area is just two rectangles. Usually we'd like to have a detection area that is much larger. To do that, we use a simple lens such as those found in a camera: they condenses a large area (such as a landscape) into a small one (on film or a CCD sensor). For reasons that will be apparent soon, we would like to make the PIR lenses small and thin and moldable from cheap plastic, even though it may add distortion. For this reason the sensors are actually Fresnel lenses, so now we have a much larger range. However, remember that we actually have two sensors, and more importantly we don’t want two really big sensing-area rectangles, but rather a scattering of multiple small areas. So what we do is split up the lens into multiple section, each section of which is a Fresnel lens.

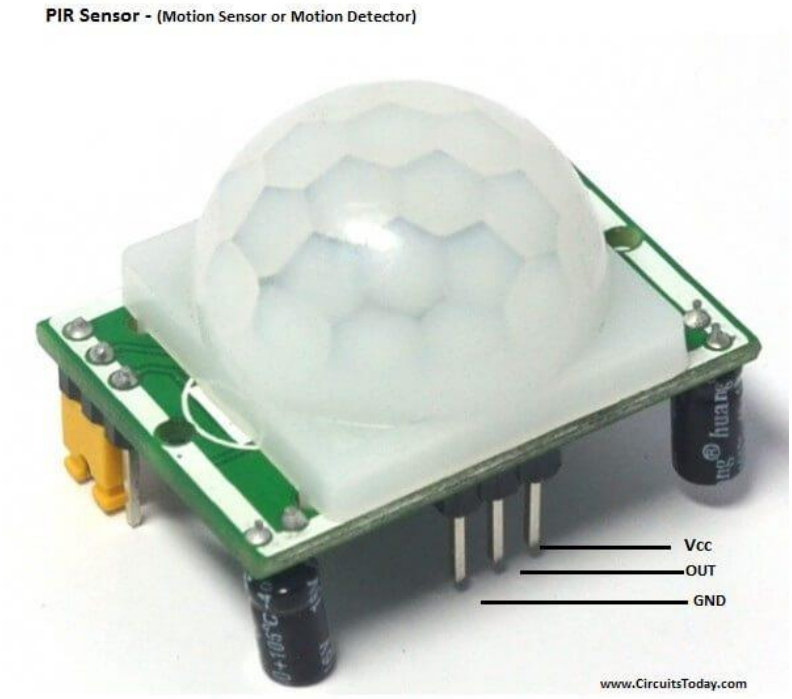

Figure 3.2 PIR Sensor

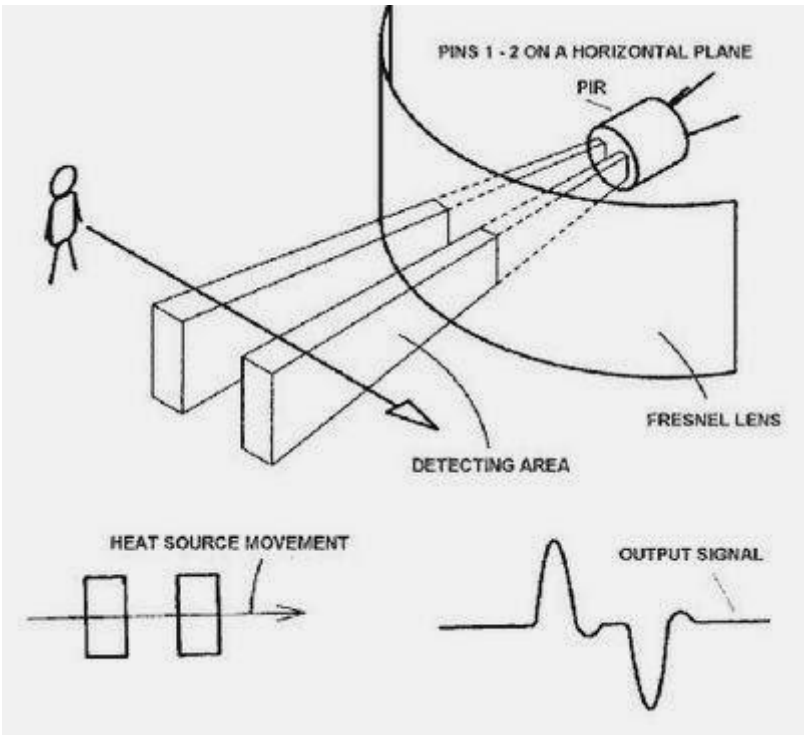

Figure 3.3 Working principle of PIR sensor

3.3 Processing unit

A processing unit is the main unit in system, which generates desired output for corresponding inputs. For that purpose, microcontrollers are used. In present days, there are several companies that manufacture microcontrollers, for example ATMEL, Microchip, Intel, Motorola etc.

Raspberry PI Microcontroller is used in this project. A microcontroller often serves as the “brain” of most of the resent electronic system. Like a mini, self-contained computer, it can be programmed to interact with about the hardware of the system and the user. Even the most basic microcontrollers can perform simple math operation, control digital output and monitor digital inputs.

Newer microcontrollers are much faster, have more memory, and have a host of input and output features that dwarf the ability of earlier models. Most modern controllers have analog-to-digital converters, high-speed timers and counters; interrupt capabilities, output that can be pulse-width modulated, serial communication ports, etc.

3.3.1 Introduction to Raspberry Pi

A Raspberry Pi is a credit card-sized computer originally designed for education, inspired by the 1981 BBC Micro. Creator EBenX Upton's goal was to create a low-cost device that would improve programming skills and hardware understanding at the pre-university level. But thanks to its small size and accessible price, it was quickly adopted by tinkerers, makers, and electronics enthusiasts for projects that require more than a basic microcontroller (such as Arduino devices).

The Raspberry Pi is slower than a modern laptop or desktop but is still a complete Linux computer and can provide all the expected abilities that implies, at a low-power consumption level.

3.3.2 Raspberry Pi Hardware

The Raspberry Pi is open hardware, with the exception of the primary chip on the Raspberry Pi, the Broadcom SoC (System on a Chip), which runs many of the main components of the board–CPU, graphics, memory, the USB controller, etc. Many of the projects made with a Raspberry Pi are open and well-documented as well and are things you can build and modify yourself.

3.3.3 Raspberry Pi Software

The Raspberry Pi was designed for the Linux operating system, and many Linux distributions now have a version optimized for the Raspberry Pi.

Two of the most popular options are Caspian, which is based on the Dalian operating system, and Pandora, which is based on the Fedora operating system. For beginners, either of these two work well; which one you choose to use is a matter of personal preference. A good practice might be to go with the one which most closely resembles an operating system you're familiar with, in either a desktop or server environment.

If you would like to experiment with multiple Linux distributions and aren't sure which one you want, or you just want an easier experience in case something goes wrong, try NOOBS, which stands for New Out Of Box Software. When you first boot from the SD card, you will be given a menu with multiple distributions (including Caspian and Pandora) to choose from. If you decide to try a different one, or if something goes wrong with your system, you simply hold the Shift key at boot to return to this menu and start over.

There are, of course, lots of other choices. Open ELEC and RaspBMC are both operating system distributions based on Linux that are targeted towards using the Raspberry Pi as a media center. There are also non-Linux systems, like

RISC OS, which run on the Pi. Some enthusiasts have even used the Raspberry Pi to learn about operating systems by designing their own.

3.3.4 Raspberry Pi Models

The Raspberry Pi Foundation has just recently released a new model, the Raspberry Pi 2, which supersedes some of the previous boards, although the older boards will still be produced as long as there is a demand for them. It is generally backwards compatible with previous versions of the board, so any tutorials or projects you see which were built for a previous version of the board should still work.

There are a two Raspberry Pi models, the A and the B, named after the aforementioned BBC Micro, which was also released in a Model A and a Model B. The A comes with 256MB of RAM and one USB port. It is cheaper and uses less power than the B. The current model B comes with a second USB port, an Ethernet port for connection to a network, and 512MB of RAM.

The Raspberry Pi A and B boards been upgraded to the A+ and B+ respectively. These upgrades make minor improvements, such as an increased number of USB ports and improved power consumption, particularly in the B+. The A+ and B+ have been reviewed on Opensource.com here

If you have a Raspberry Pi and aren't sure which version you have, plug it in and from the terminal window, and run:Cat /proc/cpuinfo.

The output will include a revision code. The numbers indicate further differences, but if it is 0002-0006, it is an older Model B with 256MB of RAM. If it is 0007-0009, it is a Model A. The newer Model Bs are listed as 000d-000f. The B+ is 0010, and the A+ is 0012. (Revision 0011 was used for the Raspberry Pi Compute Module.)

Figure (3.4) Raspberry pi 2 model B

3.4 Output unit

An output unit peripheral that receives data from a microcontroller, usually for display, makes buzzing and transport data. An output unit peripheral contains buzzer and RJ45.

3.4.1 Buzzer

A buzzer is a device which makes a buzzing or beeping noise. There are several kinds; the most basic is a piezoelectric buzzer, which is just a flat piece of piezoelectric material with two electrodes. This type of buzzer requires some kind of oscillator (or something more complicated like a microcontroller) to drive it—if you apply a DC voltage you will just get a click. They are used in places where you need something that emits an audible tone, but don't care about high-fidelity sound reproduction, like microwave ovens, smoke alarms, and electronic

toys. They are cheap and can be very loud without using very much power. They are also very thin, so they can be used in flat objects like “singing” greeting cards.

A piezoelectric element also produces a voltage in response to pressure, so piezoelectric buzzers can also be used as crude pressure sensors or microphones. A similar device, the crystal earpiece, can be used in unpowered crystal radios (now mainly built by hobbyists), because its very high sensitivity means it can be powered by the radio signal itself.

More complex buzzers include the oscillator circuit and the piezoelectric element or speaker in a single package, so all you need to do is apply a voltage and you will get an annoying beeping or buzzing sound. Son alert is a common brand name for these devices, and sometimes you will hear the word “Son alert” used generically to refer to any kind of modular buzzer or siren.

There are also electromechanical buzzers, which use a coil and a moving electrical contact. When the coil is energized, the contact is pulled toward the coil, but this breaks the circuit and the contact rapidly moves back to its original position. This makes a loud buzzing sound. (If you add a gong to this apparatus, you get an electric bell.) You can make a buzzer with an electromechanical relay by connecting the coil and normally-closed contacts in series, although it probably won’t be as loud as a purpose-built buzzer. Electromechanical buzzers are (or were) used in alarm systems, doorbells, and school “bells.”

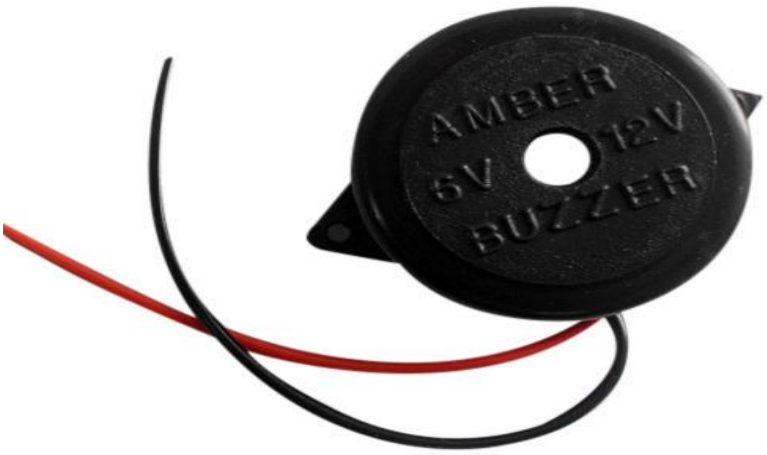

Figure (3.5) Buzzer

3.4.2 Ethernet

Ethernet is the most widely installed local area network (LAN) technology. Ethernet is a *link layer* protocol in the TCP/IP stack, describing how networked devices can format data for transmission to other network devices on the same network segment, and how to put that data out on the network connection. It touches both Layer 1 (the physical layer) and Layer 2 (the data link layer) on the OSI network protocol model. Ethernet defines two units of transmission, packet and frame. The frame includes not just the "payload" of data being transmitted but also addressing information identifying the physical "Media Access Control" (MAC) addresses of both sender and receiver, VLAN tagging and quality of service information, and error-correction information to detect problems in transmission. Each frame is wrapped in a packet, which affixes several bytes of information used in establishing the connection and marking where the frame starts.

Figure 3.6 Ethernet cable

Chapter four

Implementation and result

4.1 Hard Description

The camera surveillance system represent in figure (4.1) which the main controller (the raspberry pi) senses the movement of person and then send it to the camera pi. The camera pi takes some image in case of no movement when the object moves it take a video instead from an image.

The images and video are then stored in an electronic mail (Email), after that the buzzer is make a sound indicate up-normal case happened.

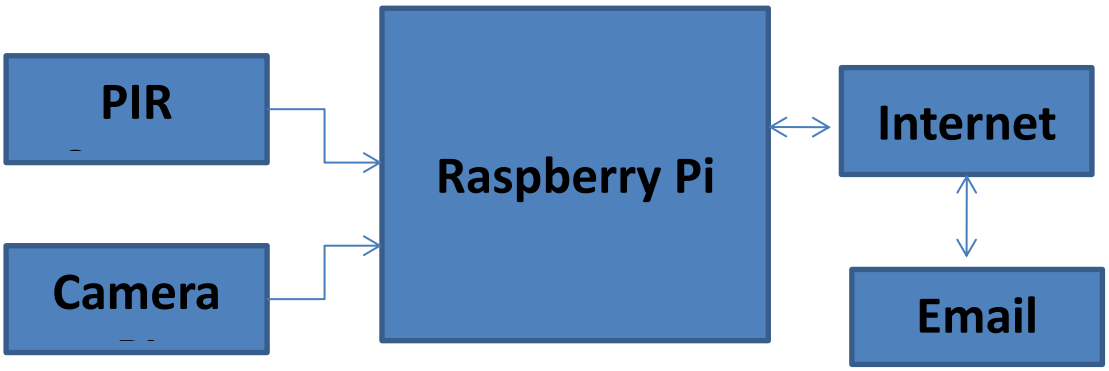

Figure (4.1) Block diagram

4.2 Circuit design

The electronic circuit and design of the camera surveillance system was shown in figure (4.2). The raspberry pi has a voltage of 5V and draws average current of 2A. Raspberry pi is credit card sized computer it has 40 general-purpose input/output (GPIO) pins. These pins are a set of connections that have various functions, but their main one of it is to allow to connect the raspberry Pi with an electronic circuit, a Secure Digital (SD) card slot contains OS, an HDMI port, an Ethernet port, micro-USB port (charging port), a CSI camera port and DSI Display port. It is contains everything needed to support the microcontroller. Simply connect it to computer with an Ethernet cable, the digital pins (4, GRD,

5V) connected with PIR sensor (Digital out, GRD, 5VDC), Buzzer connected with the pins (17, GRD) and Camera pi connected with CSI camera port.

As shown in figure (4.2) web camera was used in the first test of this project, but was note from reading takes is not clear and accuracy is null (low resolution), the problem was solved by using camera pi with high resolution. When sending an image that take by camera pi to the email an error occurs (i.e. High resolution sending data in low manner and use big data) this problem solved by decreasing the resolution of camera pi by compressing image to increase the speed of the e-mail transmission.

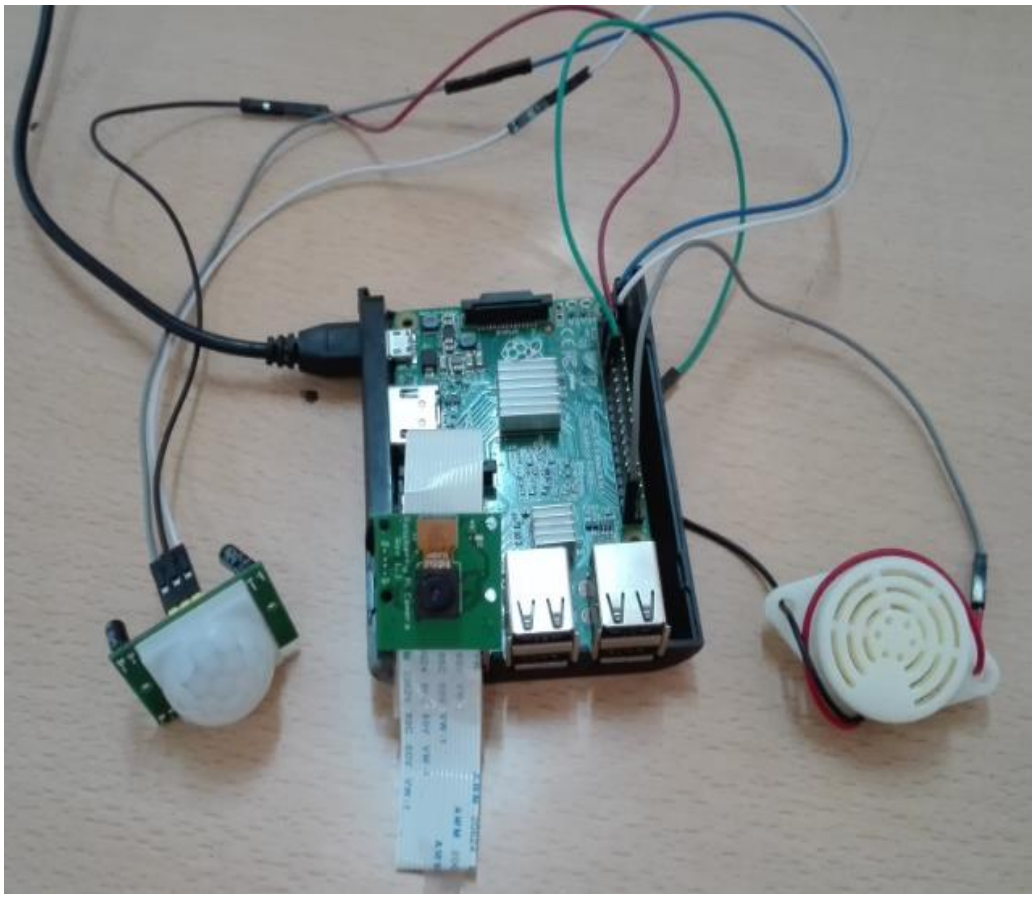

Figure (4.2) Circuit design

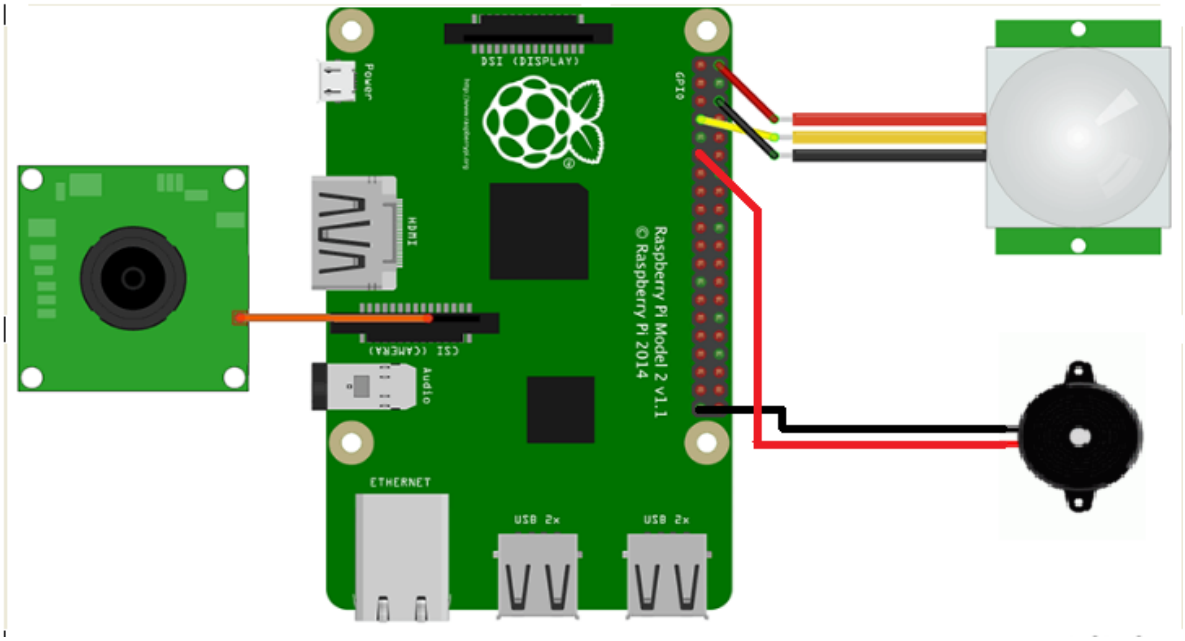

Figure (4.3) circuit diagram

4.3 Software Materials

There are many software materials that have been used during the development of the system. An operating system is a program that makes it easier for the end user to use the underlying hardware. Raspberry pi supports multiple Linux distributions.

4.3.1Linux

Linux is a computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released on 5 October 1991 by Linux Thorvaldsen; the Free Software Foundation uses the name GNU/Linux, which has led to some controversy. Linux is a great match for raspberry Pi because it‘s free and open source. On one hand, it keeps the price of the platform low, and on the other hand, it makes it more hack-able. And it is not

limited to just Raspbian, as there are many different flavors, or distributions, of Linux that you can load onto the Raspberry Pi.

Linux code is publicly available, different organizations have made slight changes to it and distributed it. This has led to different distributions (versions), including Red Hat, Fedora, and Debi an, Arch, Ubuntu and opens SUSE. Some companies sell their distributions and provide paid-for support, whereas others are completely free [14]. Free Software Foundation uses the name GNU/Linux, which has led to some controversy. Raspbian is based on the Debi an distribution with some customizations for the raspberry pi. More programming languages can be installed with proper support tools.

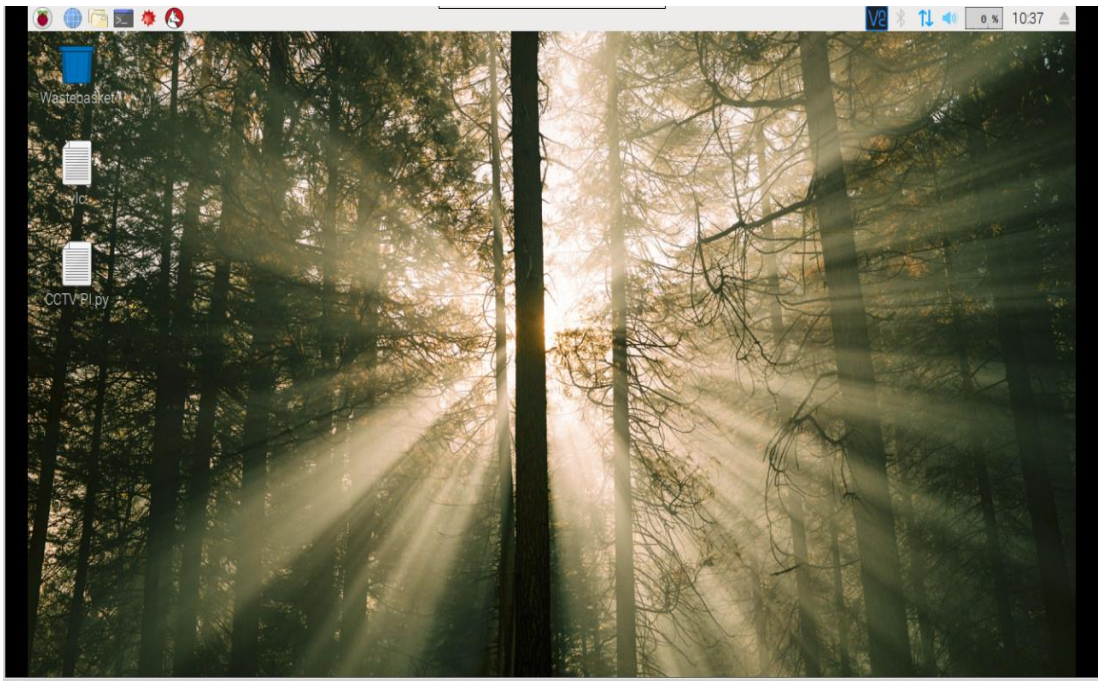

Figure (4.4) Raspbian GUI

4.4 Python

Python is high level programming language, widely used general-purpose. It’s supports multiple programming paradigms, including object oriented

program, imperative and functional programming or procedural styles and provides constructs intended to enable clear programs on both a large and small scale. Its syntax allows programmers to express ideas in minimal lines of code than would be possible in the high-level languages such as Java or C++.

The Python interpreter can be run in two ways: as an interactive shell to execute individual commands, or as a command line program to execute standalone scripts. The integrated development environment (IDE) bundled with Python and the raspberry Pi is called IDLE.

4.5 Software Implementation

The software implementation process followed these steps: used hardware peripherals like (Laptop, Screen, Keyboard and mouse) to communicate the raspberry pi. It was done by connecting the raspberry Pi to the internet using the Ethernet interface or WI-Fi- Dongle. Raspberry Pi take image and save it into raspberry pi memory. After that image is sent to the administrator email. At the final processing when the email is opened.

4.6 Flowchart

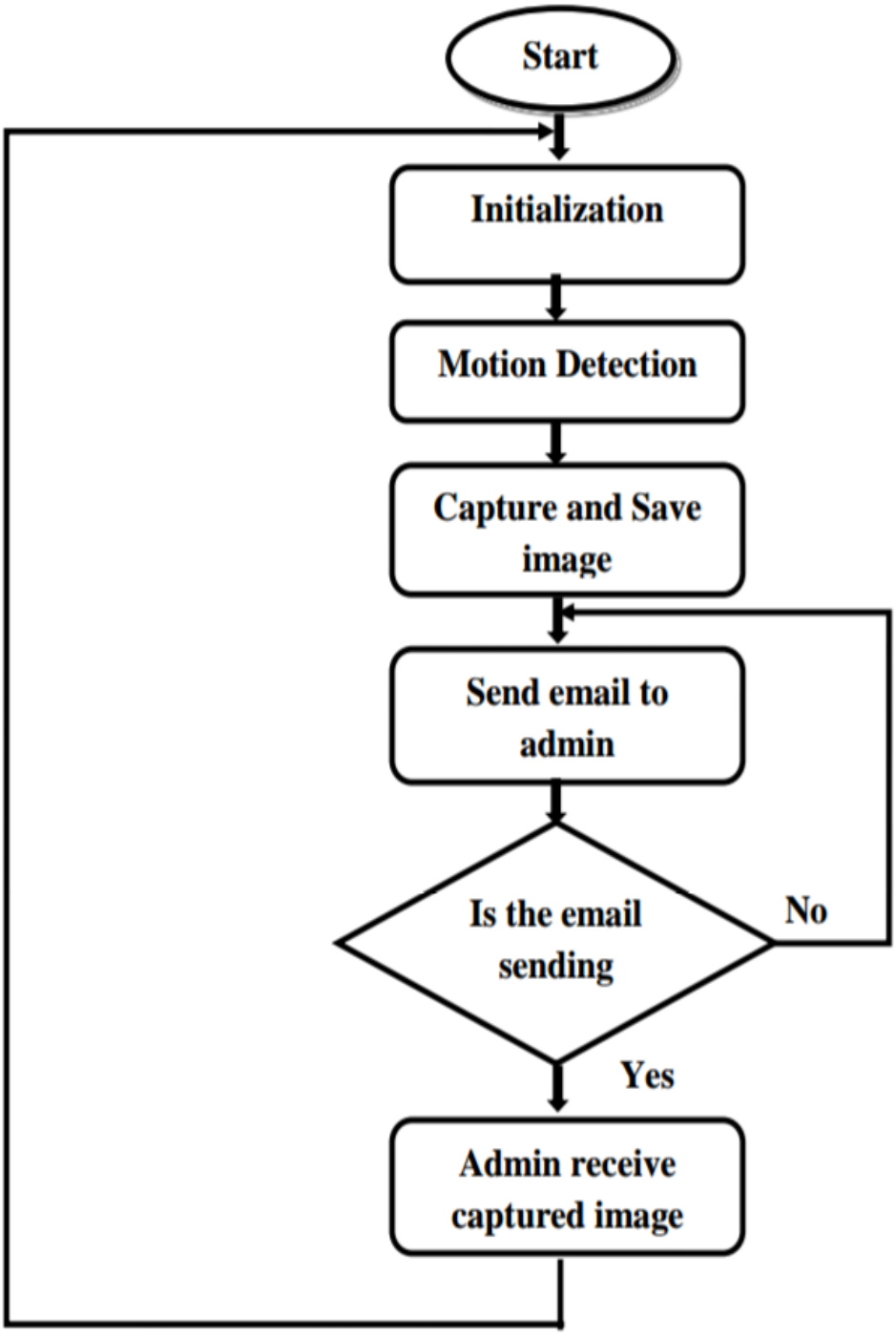

Figure (4.5) flow chart of camera surveillance system

4.7 Results

The motion is detected through the PIR sensor and the camera captures images and videos. After that the buzzer was sending sound message to indicate receiving massage. The raspberry pi is save images and videos in its storage unit, then the image is going to be displayed on the laptop or the monitor at same time sent to the user's email.

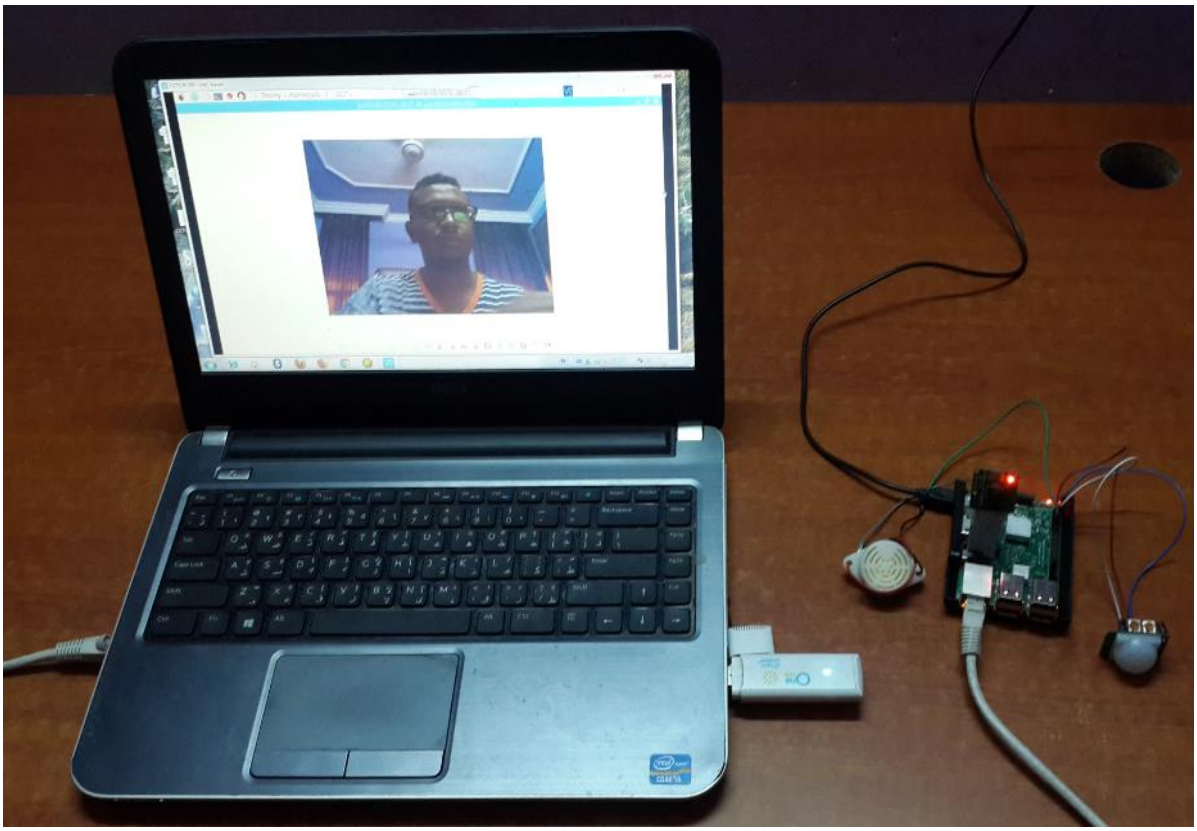

Figure (4.6) Raspberry Pi final installation setup

Chapter five

5.1 Conclusion

The system that monitoring the surrounding area with camera was design based on raspberry pi that programming using python language and pir sensor for sensing the motion that detects in environments.

5.2 Recommendation

- It’s advocated to use the cctv system because it supports using multiple cameras at the same time.
- Using servomotors with cameras to cover all directions.

Reference:

[1]www.wecusurveillance.com

[2]Eric fullerton ,'The history of video surveillance' A Milestone systems Whitepaper, September 2008

[3]Ethernet Cables and How They Work www.lifewire.com/what-is-an-ethernet-cable-817548

[4]learn.adafruit.com/pir-passive-infrared-proximity-motion-sensor/how-pirs-work

[5]www.quora.com/What-is-the-purpose-of-a-buzzer-in-a-circuit

[6]opensource.com/resources/raspberry-pi

[7]www.raspberrypi.org/documentation/usage/camera/

Appendix A

Project's codes

```
from gpiozero import MotionSensor
from gpiozero import Buzzer
from picamera import PiCamera
from datetime import datetime
import time
from email.mime.multipart import MIMEMultipart
from email.mime.base import MIMEBase
from email.mime.text import MIMEText
import email.encoders
import smtplib
import os
import email
import sys


camera = PiCamera()
pir = MotionSensor(4)
buzz= Buzzer(17)
camera.resolution = (640, 480)
#camera.resolution = (1024, 768)
camera.rotation = 180
h264Codec = ".h264"
mp4Codec = ".mp4"
```

```
while True:

    # record h264 video then save as mp4
    pir.wait_for_motion()
    print ("Motion Detected")
    buzz.on()
    FileName = datetime.now().strftime("%m-%d-%Y_%H.%M.%S")
    camera.start_recording('/CCTV/Video'+FileName + h264Codec)
    camera.capture('/CCTV/pic'+FileName+'.jpg')
    pir.wait_for_no_motion()
    buzz.off()
    camera.stop_recording()
    os.system("MP4Box -add " + '/CCTV/Video'+FileName + h264Codec + " "
+'/CCTV/Video'+FileName + mp4Codec)
    os.system("rm " '/CCTV/Video'+ FileName + h264Codec) # delete h264 file
    vid = '/CCTV/Video'+FileName+mp4Codec
    pic='/CCTV/pic'+FileName+'.jpg'

    # Email Configuration
    FormatTime = datetime.now().strftime("%A %B %d %Y @ %H:%M:%S")
    message = MIMEMultipart()
    message["Subject"] = str('UST CCTV: '+FormatTime)
    message["From"] = "UST CCTV Monitor"
    message["To"] = "woxi.net@gmail.com"
    Context = MIMEText("From UST CCTV: WARNING! Motion Detected!")
```

```
    message.attach(Context)


    # attach taken picture to email
    payload = MIMEBase("application", "octet-stream")
    payload.set_payload(open(pic, "rb").read())
    email.encoders.encode_base64(payload)
    payload.add_header("Content-Disposition", "attachment; filename= %s" %
os.path.basename(pic))
    message.attach(payload)


    # Setup Gmail account and send email



    server = smtplib.SMTP("smtp.gmail.com:587")
    server.starttls()
    server.login("woxi.net@gmail.com","i123760687")
    print ("Sending Picture to Email.....")
    server.sendmail("woxi.net@gmail.com", "orwa1994.os@gmail.com",
message.as_string())
    server.quit()
    print ("The Picture Was Sent to Your Email Succesfully")



    #os.system("rm " + pic)
```

Appendix B

PIR Sensor

The PIR (Passive Infra-Red) Sensor is a pyroelectric device that detects motion by measuring changes in the infrared (heat) levels emitted by surrounding objects. This motion can be detected by checking for a sudden change in the surrounding IR patterns. When motion is detected the PIR sensor outputs a high signal on its

output pin. This logic signal can be read by a microcontroller or used to drive a transistor to switch a higher current load．

•Key Specifications

1. Power requirements: 3.3 to 5 VDC; >3 mA (may vary).
2. Communication: Single bit high/low output.
3. Operating temperature: 32 to 122 °F (0 to 50 °C).
4. Dimensions: 1.27 x 0.96 x 1.0 in (32.2 x 24.3 x 25.4 mm).

• Connection and Testing

Connect the 3-pin header to your circuit so that the minus (-) pin connects to ground or Vss, the plus (+) pin connects to Vdd and the OUT pin connects to your microcontroller's I/O pin. One easy way to do this would be to use a standard servo/LCD extension cable, available separately from Parallax (#805-00002). This cable makes it easy to plug sensor into the servo headers on our Board Of Education or Professional Development Board. If you use the Board Of Education, be sure the servo voltage jumper (located between the 2 servo header blocks) is in the Vdd position, not Vin. If you do not have this jumper on your board you should manually connect to Vdd through the breadboard. You may also plug the sensor
Directly into the edge of the breadboard and connect the signals from there. Remember the position of the pins when you plug the sensor into the breadboard ．

•Calibration

The PIR Sensor requires a 'warm-up' time in order to function properly. This is due to the settling time involved in 'learning' its environment. This could be anywhere from 10-60 seconds. During this time there should be as little motion as possible in the sensors field of view．

•Sensitivity

The PIR Sensor has a range of approximately 20 feet. This can vary with environmental conditions. The sensor is designed to adjust to slowly changing conditions that would happen normally as the day progresses and the

environmental conditions change, but responds by making its output high when sudden changes occur, such as when there is motion. Note: This device is designed for indoor use. Operation outside or in extreme temperatures may affect stability negatively