A
Project Report on

IoT Based Sensing and Security Management System

Submitted to the partial fulfillment of the requirement for the award of the degree of

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BONAFIDE CERTIFICATE

This is to certify that Project Report entitled "**IoT Based Sensing and Management System**", which is submitted by **Somil Sharma (1031330128)** in the partial fulfillment of the requirement for the award of degree **B.Tech** in **Department of Computer Science asnd Engineering** of **SRM University**, **NCR Campus, Modinagar, Ghaziabad** is a record of the candidate own work carried out by them under my own supervision. The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

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Somil Sharma (1031330128)

DECLARATION

I, Somil Sharma (1031330128) hereby declare that the work which is being presented in the project report **"IoT Based Sensing and Management System"** is the record of authentic work carried out by us during the period from January '17 to May '17 and submitted by us in partial fulfillment for the award of the degree **"Bachelor of Technology** in **Computer Science and Engineering"** to **SRM University, NCR Campus, Ghaziabad (U.P.).** This work has not been submitted to any other University or Institute for the award of any Degree/Diploma.

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ABSTRACT

The Internet of Things (IoT) is a system of interrelated computing devices, machines, objects and people that are provided with unique identifiers and the ability to transfer data over a network without requiring any human interaction. Thus making it a conduit for sensor interaction and fastest growing technology in various fields, including security systems.

While the data transfer in itself is an unequivocally straightforward process, tasks such as setting up the devices, establishing a secure connection, accessing and interpreting the transmitted information for further use demands backend knowledge and resources. Hence, debilitating the very goal of IoT by making it inaccessible to people with lack of technical intelligence.

The project purports to bridge this gap and enable users, even ones with no understanding of its functioning, to seamless take advantage of IoT's applications with the help of a desktop application designed with python, which converts every functionality into a GUI element and a System on Chip called Raspberry Pi through which IoT is implemented.

Keywords: - Internet of Things, Python, Raspberry Pi, Sensors, Desktop Application.

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LIST OF ABBREVIATIONS

- *IoT:* Internet of Things

- *SoC:* System on Chip

- *PIR:* Pyroelectric Infrared Sensor

CHAPTER 1

INTRODUCTION

1.1 ABOUT

In the digital era which has redefined the way most operations are carried out, the field of home security has also broken new grounds. Home owners can now monitor in-house activity and ensure its safety from any corner of the world, with a click of a button.

While these advancements are highly impressive, home security services will either cost a ton of money or offer substandard services at low costs. And in both cases, the user only gets to be an observer for the most part, with extremely limited control over the security system itself. These factors have pushed the thought of home security beyond the reach of an average citizen or rendered them unfit for practical usage.

These shortcomings in the current system lay the foundation of this project. With the use of following technologies, this project offers a more functional and user-friendly security system.

1.2 IoT

The Internet of Things (IoT) refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems. The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.

The term Internet of Things was invented in 1999, initially to promote RFID technology. It was coined by Kevin Ashton while he was working for Procter & Gamble. In its original interpretation, one of the first consequences of implementing the Internet of things by equipping all objects in the world with minuscule identifying devices or machine-readable identifiers would be to transform daily life.

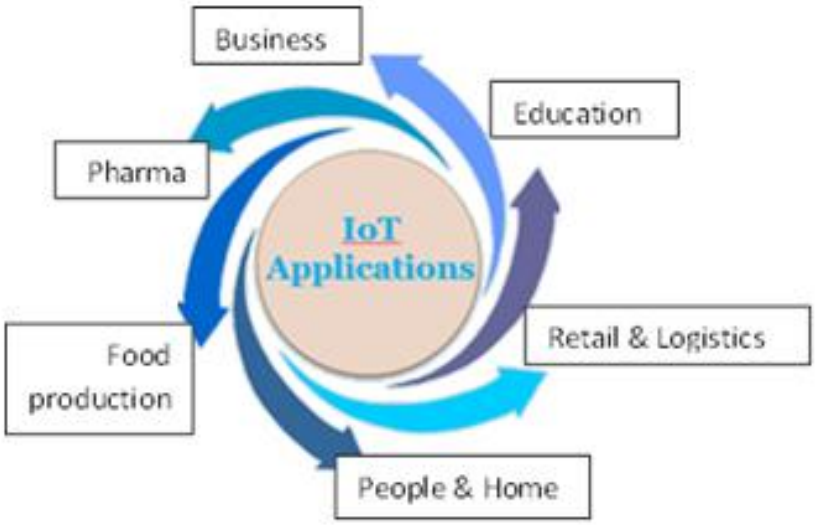


Figure 1.1 Applications of IoT

Since its conception, countless advancements have been made in the field of IoT and the technology has infiltrated almost every sector of significance out there with endless applications.

1. Smart home

Smart Home clearly stands out, ranking as highest Internet of Things application on all measured channels. The IoT Analytics company database for Smart Home includes 256 companies and startups. More companies are active in smart home than any other application in the field of IoT.

2. Wearables

Wearables refers to all those smart connected devices that you wear on your body or as an implant, and that collect personal data, such as your health. Especially with functionalities such as ability to control your blood pressure, stress levels, fertility, weight and sleep, wearables are the next big thing.

3. Industrial internet

The industrial internet is also one of the special Internet of Things applications. While many market researches such as Gartner or Cisco see the industrial internet as the IoT concept with the highest overall potential, its popularity currently doesn't reach the masses like smart home or wearables do. The industrial internet however has a lot going for it. The industrial internet gets the biggest push of people on Twitter (~1,700 tweets per month) compared to other non-consumer-oriented IoT concepts.

4. Smart farming

Smart farming is an often overlooked business-case for the internet of Things because it does not really fit into the well-known categories such as health, mobility, or industrial. However, due to the remoteness of farming operations and the large number of livestock that could be monitored the Internet of Things could revolutionize the way farmers work.

But this idea has not yet reached large-scale attention. Nevertheless, one of the Internet of Things applications that should not be underestimated. Smart farming will become the important application field in the predominantly agricultural-product exporting countries.

5. Connected Health

Connected health remains the sleeping giant of the Internet of Things applications. The concept of a connected health care system and smart medical devices bears enormous potential, not just for companies also for the well-being of people in general. Yet, Connected Health has not reached the masses yet. Prominent use cases and large-scale startup successes are still to be seen.

6. Smart retail

Proximity-based advertising as a subset of smart retail is starting to take off. The field is expected to show promising growths in the upcoming years.

1.3 Raspberry Pi Model B:

The **Raspberry Pi** is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries.

Creator Eben 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.

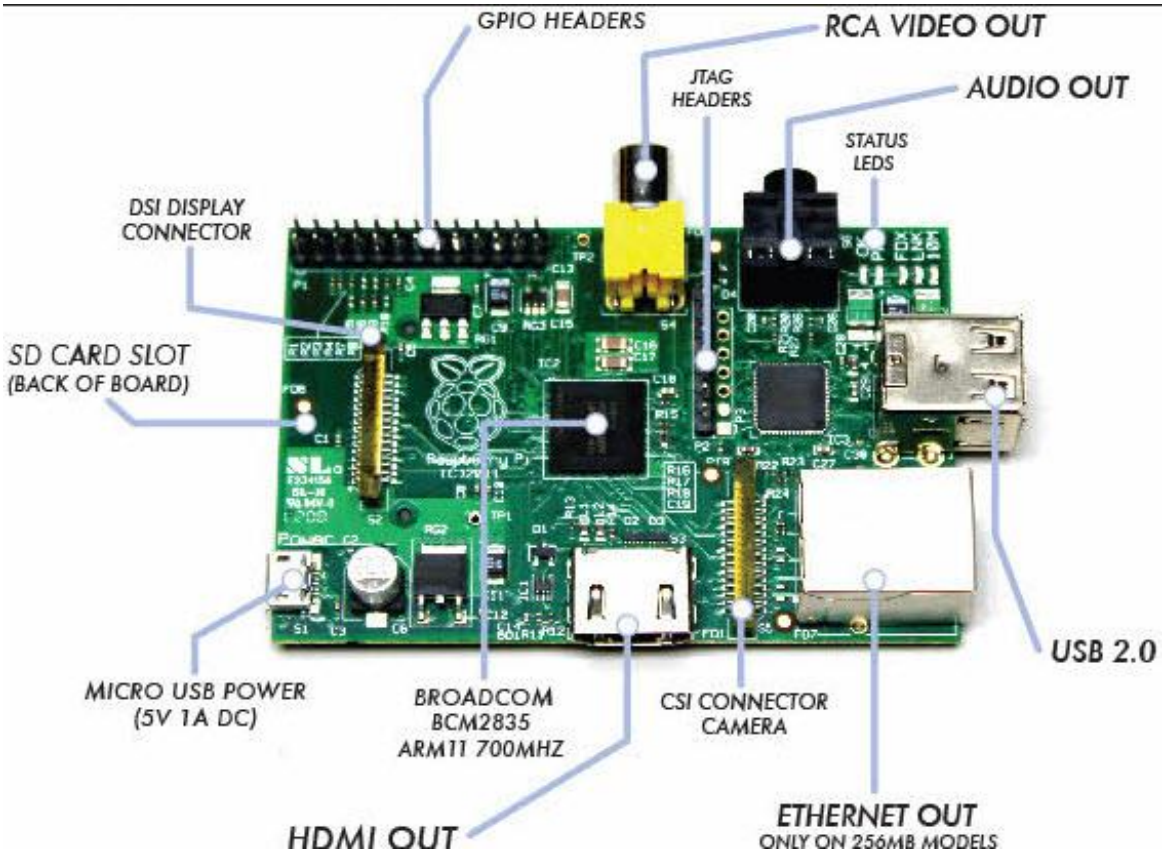


Figure 1.1 Raspberry Pi Model B

The Raspberry Pi is open hardware, with the exception of the primary chip on the Raspberry Pi, the Broadcomm 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.

The hardware configuration is as follows:

1. 900MHz quad-core ARM Cortex-A7 CPU
2. 1 GB RAM
3. 4 USB ports
4. 40 GPIO pins
5. Full HDMI and Ethernet Port
6. Camera and display interface

7. Micro SD card slot

8. VideoCore IV 3D gaphics core

The raspberry pi boards are used in many applications like Media streamer, Arcade machine, Tablet computer, Home automation, Carputer, Internet radio, Controlling robots, Cosmic Computer, Hunting for meteorites, Coffee and also in raspberry pi based projects.

1.4 Python 3.5 amd 2.7:

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level built in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together. Python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports modules and packages, which encourages program modularity and code reuse. The Python interpreter and the extensive standard library are available in source or binary form without charge for all major platforms, and can be freely distributed.

Python modules which have been used in this project significantly include PyQt5, requests, smtplib, sys, RPi.

We can conclude by saying that this project has been designed to act as a security system which can be accessed to keep a check on a computer/server from any corner of the world. It consists of a hardware component and a software application linked to it, in order to enable the most novice user to access it with ease. The secondary objective of this project is to further the use of budding Python modules in modern day projects (ones even beyond the scope of this one) and develop the most inexpensive personal security system possible.

CHAPTER 2

LITERATURE SURVEY

IoT is a relatively new and uncharted technology in today's day and age. Even though there's much to study and apply in this field, several accomplished authors such as Roy Paily, Sherali Zeadally, Chun-Cheng Lin and Andrea Kamilaris have published various research papers regarding the applications of IoT and Raspberry Pi. My project has been majorly influenced by two such research papers:

2.1 Research Directions for the Internet of Things written by John A. Stankovic

This research paper mainly focusses on the scope of IoT technology and the spectrum of research required to achieve them at a grand scale. While bringing these factors to light, it also discusses the new problems that arise for future IoT systems.

The author enumerates the following eight key research topics and research problems in his paper:

- Massive scaling

  Here, the paper discusses the issue of naming, authenticating access, maintaining and protecting every object/device that would now be on the internet because of IoT.

- Architecture and dependencies

  This topic discusses how it is necessary to have an adequate architecture that permits easy connectivity, control, communications, and useful applications.

- Creating knowledge and big data

  In an IoT world there will exist a vast amount of raw data being continuously collected. Here, the author discusses how it will be necessary to develop techniques that convert this raw data into usable knowledge.

- Robustness

  Author highlights how deploying various things/devices into the field would require node re-localization and other maintenance process will have to be discharged to keep the network intact.

- Openness

  In this topic, it's shown how most of the systems being developed till date are conventionally closed systems. And how the entire process and strategy would have to redefined and converted to open systems to include IoT.

- Security

  Here, it has been discussed how the minimum functioning capacity of "things" raises a lot of security concerns and makes these systems easy to breach.

- Privacy

  This topic discusses the various concerns regarding the security of the user's data fetched by the IoT based system.

- Human-in-the-loop

  Here, it is highlighted how every IoT system will involve participation by a human being and how this fact can be used to make advancements in various fields.

2.1 Smart Surveillance System using Thing Speak and Raspberry Pi written by Dr.S.A.K. Jilani, R.Chandana, Mr S.Javeed Hussain

This research paper maps out the implementation of a security system designed using Raspberry Pi. It utilizes two sensors, gyro sensor and raspberry pi camera.

In this research paper, the user utilizes the camera sensor on the raspberry pi and notifies the home owner every time the camera detects movement.

Taking these two as my base papers, my project takes the findings and implementations of both of them forward and makes it accessible to users who lack the technical knowledge to design something of this sort with the help of a platform independent desktop application.

CHAPTER 3

PROBLEM AND SOLUTION

➢ *Existing Problem:*

In a world where *information is power* and *security* is factually considered to be a *myth,* every person living on this planet is threatened by the fallout of getting hacked. We're a part of a civilization which is entirely founded on internet and its services. From every password and pin number you've ever created to your very private thoughts, all of it can be breached and accessed. And even though we're all aware of these threats, none of us ever take measures to safeguard this information with utmost gravity mainly for two reasons:

- Most security firms offer physical security that too marketed for big companies and organisations, not regular people.
- The security services designed for and acquired by regular people are high-priced, to be renewed regularly and only provide security in physical sense, not virtually.
- The apparatus provided by these companies mostly aren't upgradable. A newer model has to be bought in order to make changes to it.
- Sometimes, the user does not control the security system directly. They might be managed with the intervention of a 3rd party mediator (which is usually the company itself).

➢ *Proposed Solution :*

- This project eliminates the role of a third-party in the delivery of the service. This makes the users directly in charge of their own system's security, therefore simplifying the process and turning the security system into a one-time investment, no renewals.

- Secondly, it allows the user to keep track of the system wirelessly and monitoring it from any part of the world.

- The project also includes a platform independent desktop application which uses data abstraction to make the operation of the system easier for the user. There is zero knowledge of python, SOC, IOT or any form of coding required for someone to manage the security system.

- The apparatus for setting up this security system costs a fraction of what other companies charge for the same services.

- The system is fully upgradable to any extent. It can easily accommodate new sensors, connections and devices.

CHAPTER 4

METHODOLOGY

There are three primary cogs in the working of this project – *Raspberry Pi, open source IoT application server* and a *desktop application.*

The user is on the desktop application end and the background processing of all his requests and information are obscured from him. Raspberry Pi is on the server end and it's in direct physical contact with it. The IoT application server operates somewhere between the Raspberry Pi and the user while being bilaterally connected to both.

Here are in-depth details of the inner workings of the project:

➢ *InfraRed Motion Sensor:*

It is responsible for gathering information from the physical environment and handing it over to Raspberry Pi for interpretation. It has an adjustable range of 3-7 m. The motion sensor used for the project is PIR (Pyroelectric Infrared).

Whenever a movement is detected the sensor returns a true value (1) and if not, the sensor returns a false value (0).

➢ *Raspberry Pi:*

Raspberry Pi is a SoC (System on Chip) and a small single board computer which operates exactly like one. The model used here is 3 (b) and is also latest one.

In this project, Raspberry Pi acts as a feeder of information by being directly connected to the sensor(s). The data gathered is then analyzed to affirm whether there's an intruder present in the room or not. Concurrently, data is also uploaded to the IoT application server for further processing.

➢ *IoT Application Server:*

This server is hosted by a website which is an open data IoT platform with data analytics powered by MATLAB. It basically allows computers, sensors, machines and people to upload information online through dedicated channels and stores all the data transmitted to it.

Every channel has a channel id as well as pass keys for reading and writing information through it. The server uses HTTP1.1 protocols for data exchange. The project relies on *https://thingspeak.com* for this functionality.

➢ *Desktop Application:*

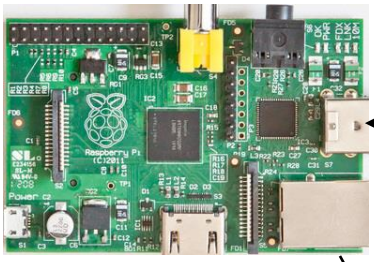
The desktop application, primarily designed for linux, is platform independent as well as light. It has been designed to curb the amount of effort required on user's end to operate the security system.

It comes with a product key which will be required to create new login credentials for every user. These will then allow him/her to access the application. Once the user has successfully logged in, the application provides two choices, either to monitor the server or to defend it. The former would allow the user to corroborate whether the server in being accessed by an intruder at that point of time or not. And the second choice would enable the user to remotely shut down the server or notify all the other concerned users in case any unauthorized activity is suspected.

This application has been designed using python 3.5 libraries.

Here's a flowchart describing the general functioning of the project:

4.1 Operation Layout



(Raspberry Pi)

Server

Transmitting sensor data

Open source IoT online application server

Triggering server processes

Fetching sensor data

Flowchart-4.1 Operation Layout (User)

CHAPTER 5

IMPLEMENTATION

The implementation of the project is mainly divided into two categories – frontend and backend. The former consists of the user application designed to enable abstraction of data and operations. The latter is a series of python code constructed using various modules.

Two modes of operation at which the project functions as a whole are:

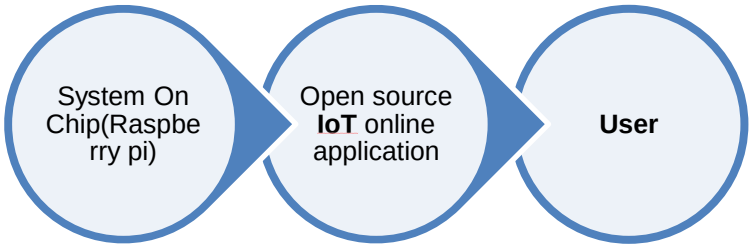


Figure 5.1 First Operation Mode

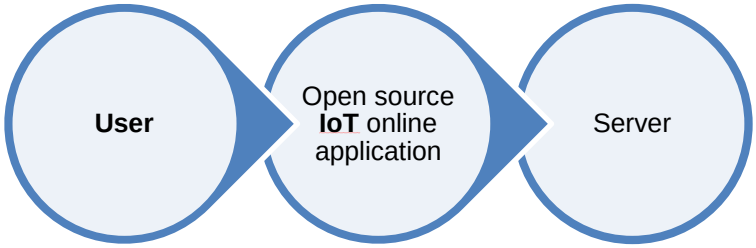


Figure 5.2 Second Operation Mode

Algorithm:

- Accessing open source IOT application to ping the sensors.
- Retrieving data for the sensor as it is stored on a JSON file on the open source application itself.
- Decoding the JSON file to access sensor data with the given time lapse.
- If the data from the sensor suggests foul play, the user can decide to defend the server.
- Server can be protected by completely shutting it down (utilizing shell scripting) and notifying all concerned users through an email.
- Even when the user isn't monitoring the server, the raspberry still warns the user via email whenever the sensor detects a security breach.
- The desktop application that allows user to manage the security system also requires the user to login with valid credentials stored in a database beforehand.

CHAPTER 6

RESULTS

The aforementioned algorithm was implemented on Python 3.5 (and partly on 2.7). The collection of files was then manifested into a Linux executable file using the module called pyinstaller. The User Interface of the application developed is given below in form of images from **figure 6.1** to **figure 6.**

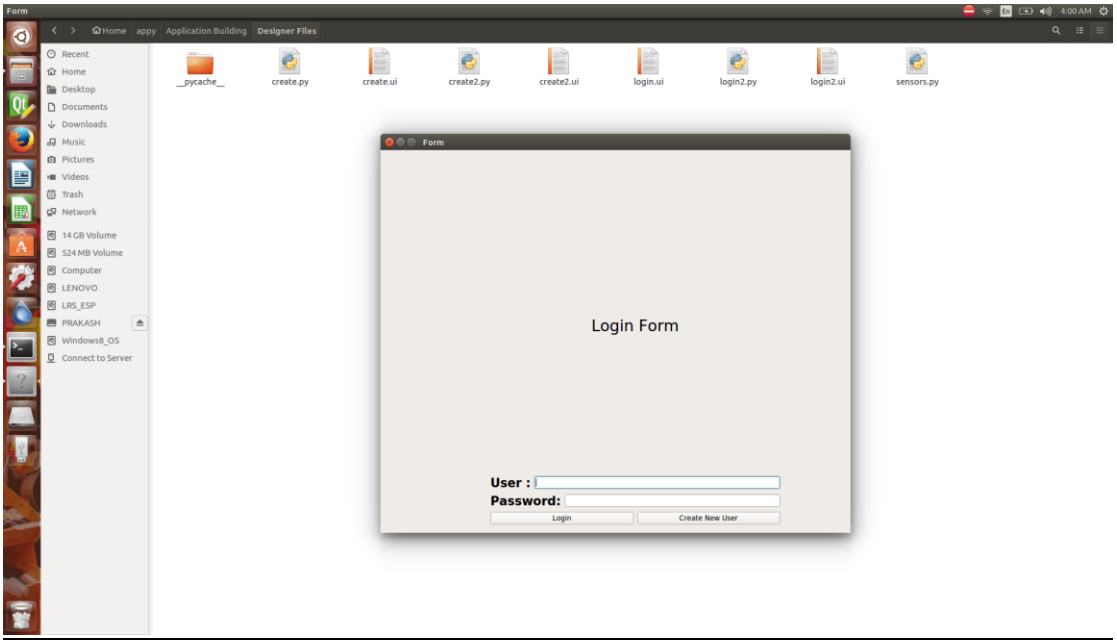


Figure 6.1 Login Window

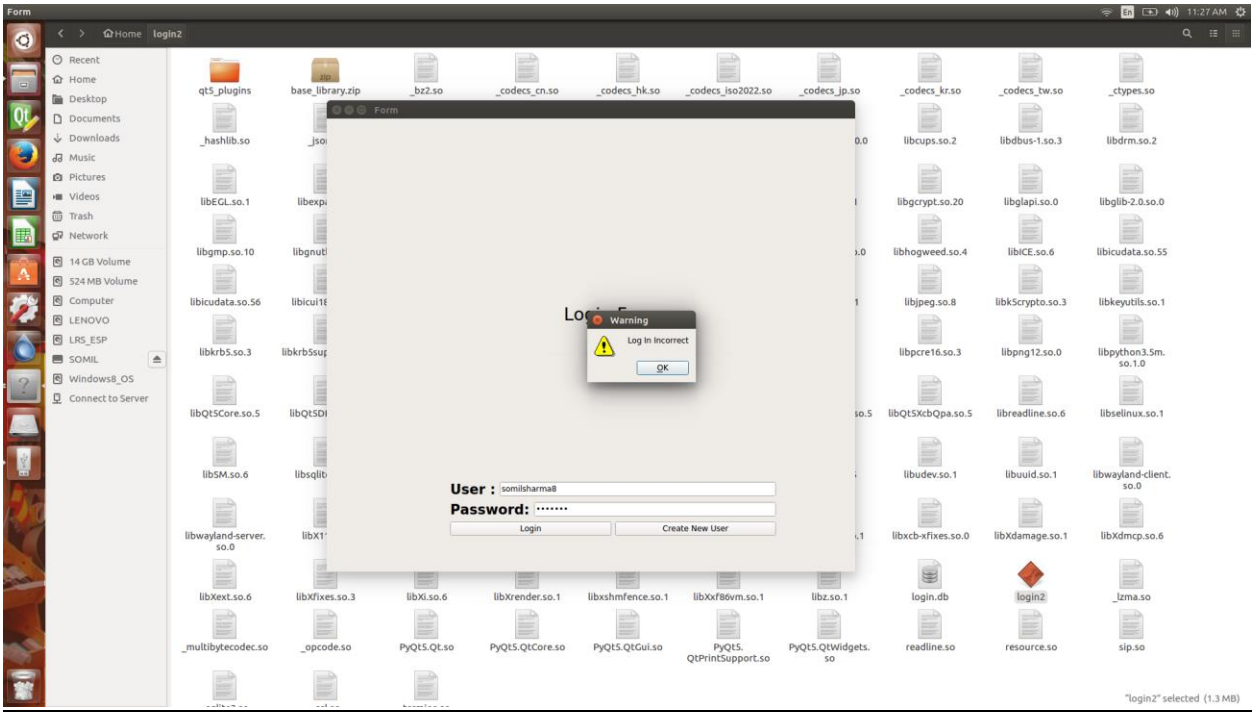


Figure 6.2 Login Failed

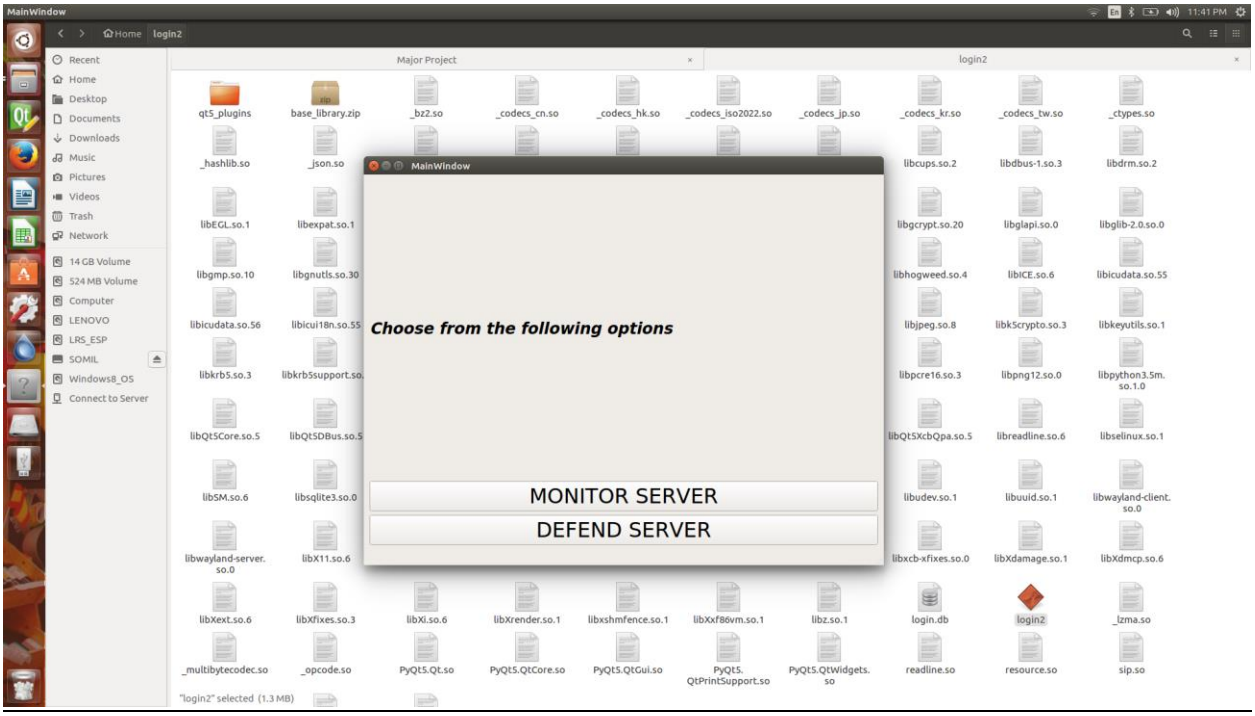


Figure 6.3 Main Window

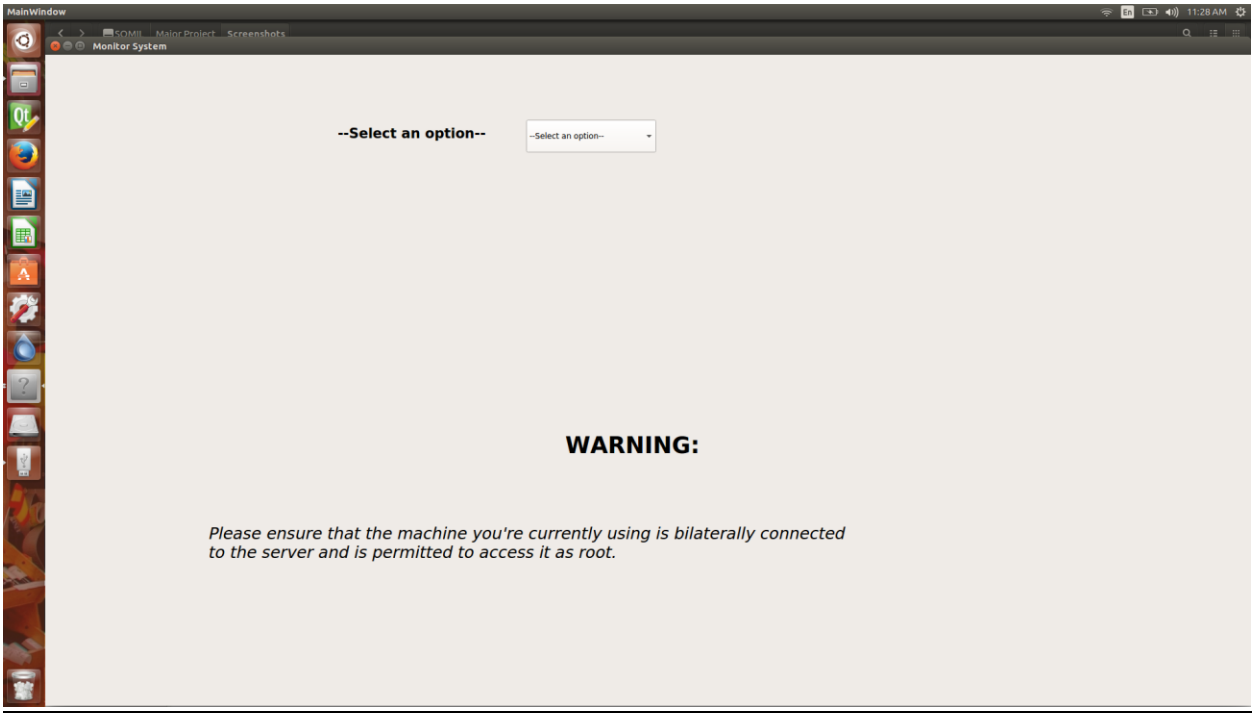


Figure 6.4 Monitor Server

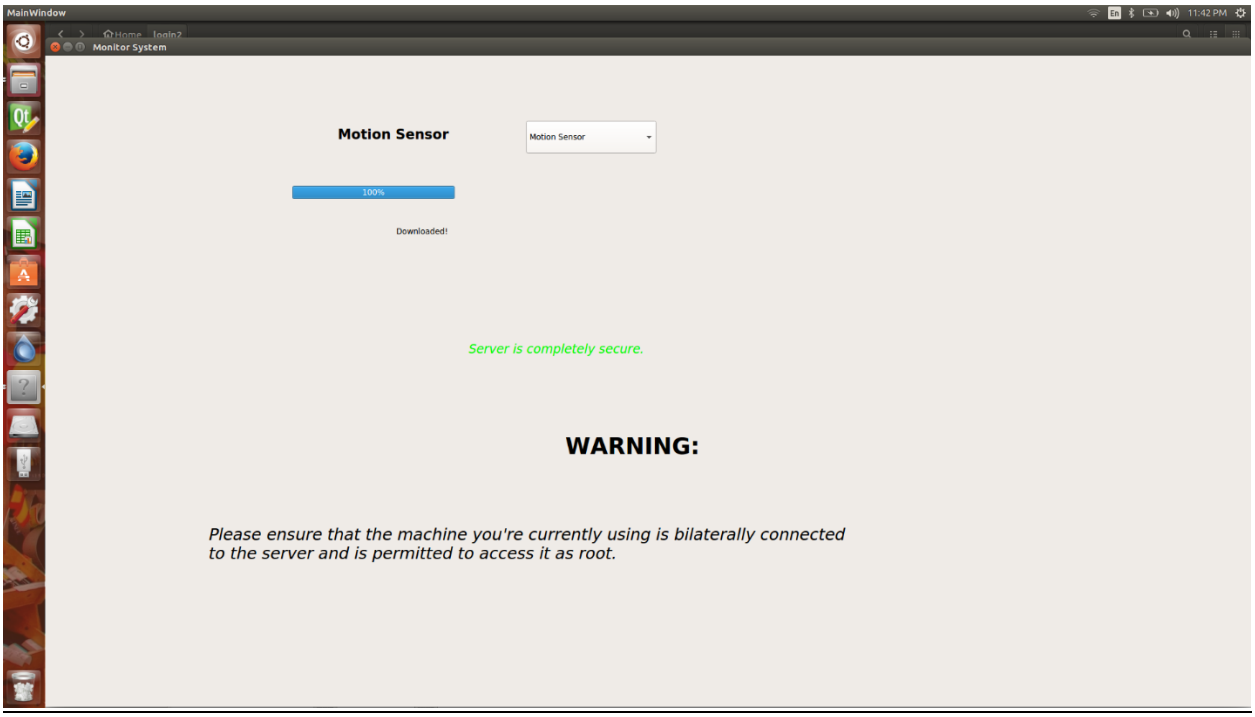


Figure 6.5 Motion Sensor

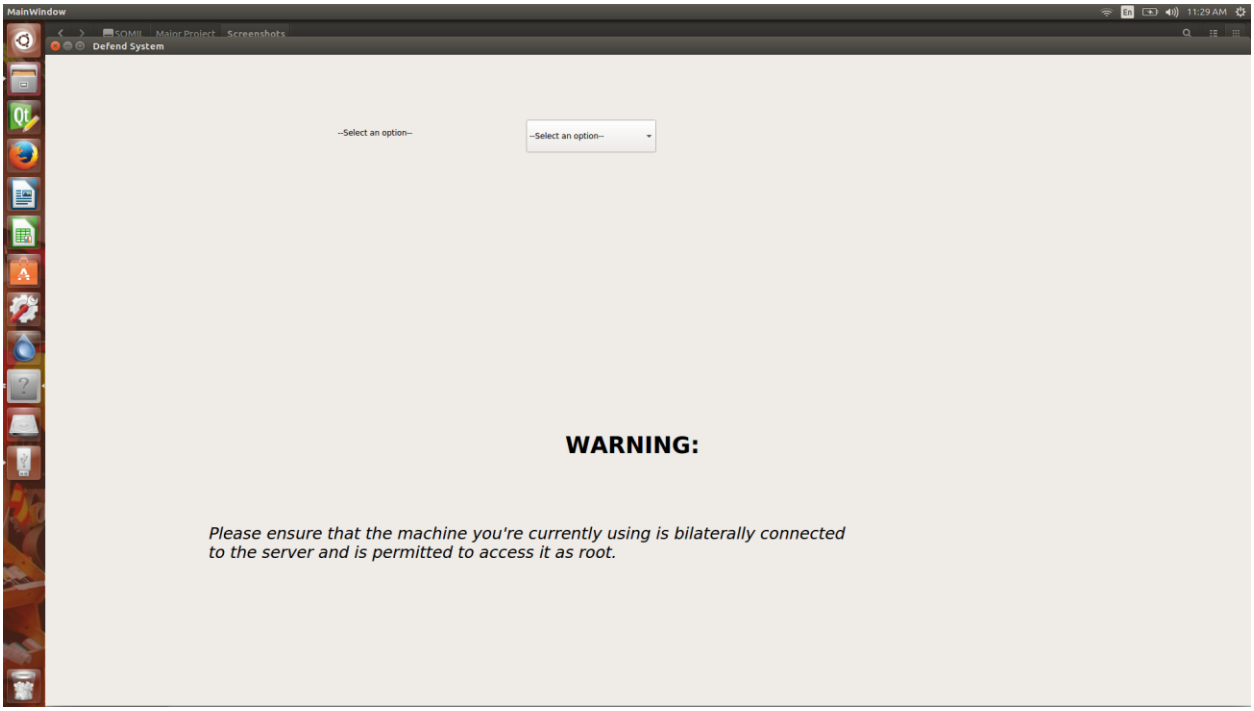


Figure 6.6 Defend Window

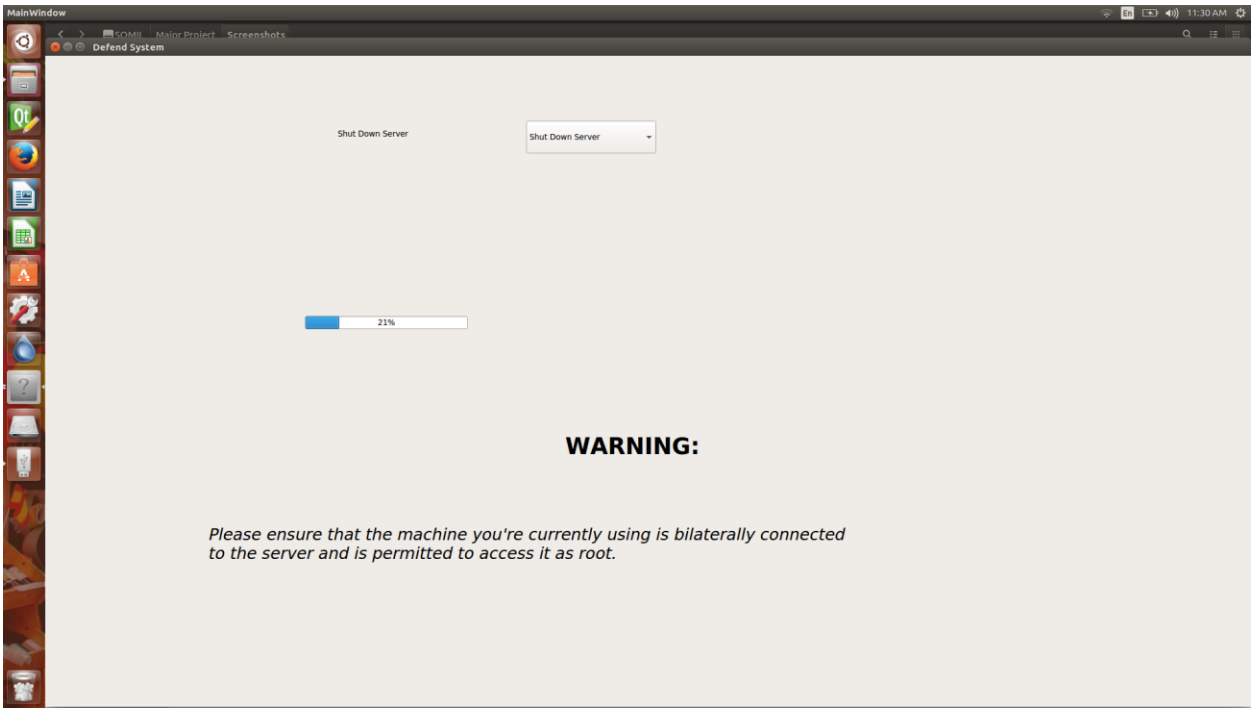


Figure 6.7 Shut Down Server

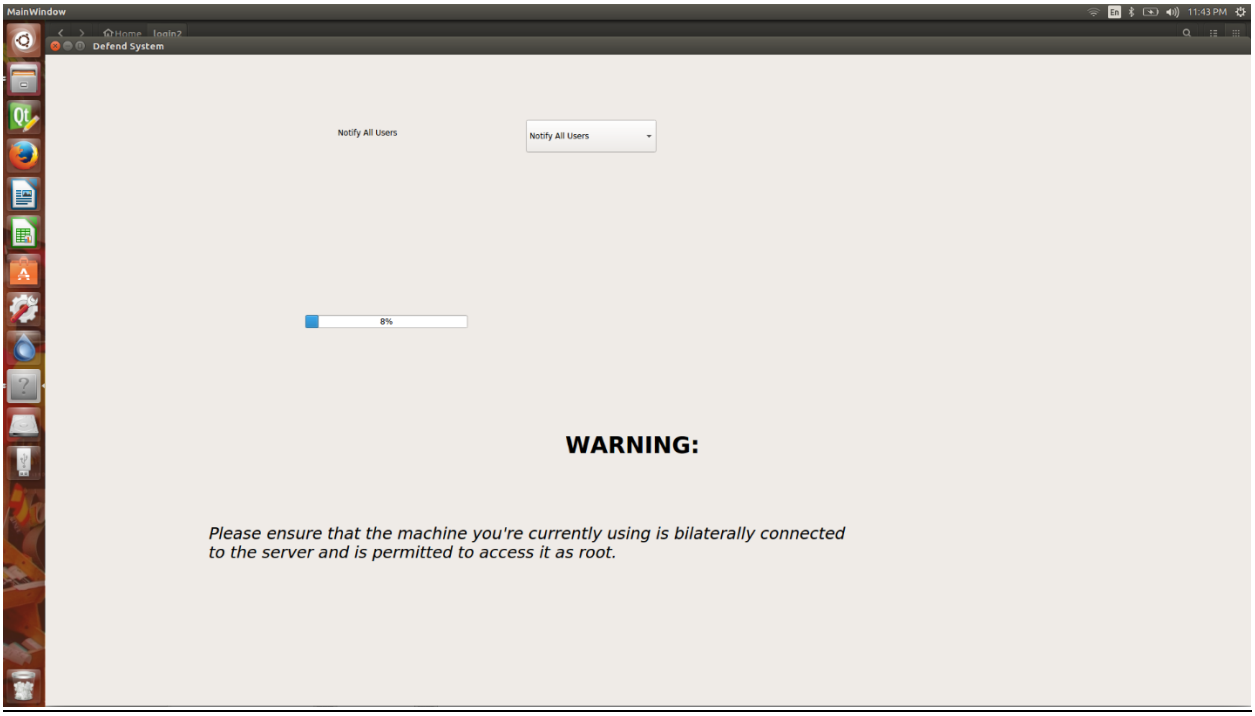


Figure 6.8 Notify Users

CHAPTER 7

CONCLUSION AND FUTURE WORK

6.1 Conclusion

Internet of Things is a revolutionary ever expanding technology which is still being adapted to nurture future applications. The project takes the contemporary technology of IoT and couples it with a python based desktop application, hence enabling the most novice of users to take advantage of its applications. And unlike every other security system in the market, it is inexpensive and easy to update/reconfigure as per requirement.

The user only needs valid login credentials to operate the application and to fully access the raspberry pi apparatus. The application follows a simplistic button-click functionality and directly interacts with the IoT online application to fetch real time data and keep the user updated (along with timely email notifications whenever an intruder is detected)

6.2 Advantages and Disadvantages

- Advantages:

    1. Puts user in charge of the entire operation and management process of the security system.
    2. Costs a fraction of money compared to its competitors in the market right now.
    3. Easily upgradable without any inhibiting terms or conditions.
    4. Power consumption is almost nil.
    5. Server/home can be monitored and managed from anywhere in the world.

- Disadvantages:

    1. Requires prior knowledge at the time of setting up.
    2. Yet to be ported to Windows operating system.
    3. Requires technical knowledge when upgrading the security system (adding more sensors to it).

6.3 Future Work

- I intend to commercialize this project buy adding a few more sensors to it (such a camera module and a temperature sensor).
- Coupling my knowledge of Red Hat Linux with the project, I also intend to backtrack the intruder's IP Address and offer the feature to fetch details about the attacker trying to breach the system.
- In addition to that, I would also like to enable user to attack the intruder and not just defend himself/herself by pinging a batch/shell file based on the type of operating system of the person.
- In order to expand the scope of the project, I want to learn about Arduino chipsets and combine them with raspberry pi for greater range and mobility.
- I would also want to build an application for raspberry pi os in order to allow the user to have complete control of the setup of the apparatus as well.
- With some minor changes, the desktop application can also be shaped to run on Windows OS.

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