# PARAIOT: A SMART IOT SYSTEM TO AID PARAPLEGIC INDIVIDUALS

**A PROJECT REPORT**

***Submitted by***

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# BONAFIDE CERTIFICATE

Certified that this project report "**PARAIOT: A SMART IOT SYSTEM TO AID PARAPLEGIC INDIVIDUALS**" is the bonafide work of **MOHAMED MUKTHAR (180071601115)** and **YUVANSHANKAR A (1800716001174)** who carried out the project work under my supervision. Certified further, that to the best of our knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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# VIVA VOCE EXAMINATION

The viva voce examination of the project work titled **"PARAIOT: A SMART IOT SYSTEM TO AID PARAPLEGIC INDIVIDUALS",** submitted by **MOHAMED MUKTHAR (180071601115) and YUVANSHANKAR A (1800716001174)** is held on _____ .

**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

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## ABSTRACT

As the technologies evolve day by day, there have been foreseeable advancements in home automation. A proper working and functional idea for smart homes for the disabled, namely paraplegic individuals, is still a challenge engineers face in this field. The term *paraplegia* is defined as the medical condition that affects an individual's motor functions, causing movements in the lower parts of their bodies.

There have been few working solutions such as Google Glasses, Amazon Echo based home systems, etc. These are proven to be expensive and thereby not affordable to every other paraplegic individual. In this thesis, we put forth a newer and an efficient approach; A smart-IOT home automation system is proposed to aid Paraplegic Individuals with the combination of IoT devices to ease inconsistencies faced by the individuals mentioned above.

An idea for a smart-IoT home automation system is proffered to mitigate the difficulties experienced by paraplegic individuals using IoT components available off-the-shelf, less expensive (i.e.) such as Raspberry Pi, Pi camera, NodeMCU ESP8266, and other required components). Initially, the QR codes are printed and attached under the required household items, which are to be operated as a parameter for the device to access the household items.

A handheld device is created using Raspberry Pi, and a camera connected with Raspberry Pi can be mounted onto the wearer's spectacles. A mini-OS (operating systems such as Raspbian) is installed into the device (Raspberry Pi), and a web application is created using modules in Python (i.e.) Python Flask, OpenCV and a database to keep track of their household items' on/off statuses and their details. An alert system is created using two sensors based on Raspberry Pi, which can alert the concerned recipients if there are abnormalities produced in the environment.

The parameters involved here for turning on/off the appliances are live Image recognition to read QR codes; there is a QR Code recognition system for the live image produced by the camera module present in the device accepted by the web application for accessing the household items. Based on the QR code recognized, the web application returns a GET response into an access point, thereby enacting the user's conscripted request.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| IOT | Internet Of Things |
| QR | Quick Response |
| OS | Operating System |
| OpenCV | Open-source Computer Vision |
| UID | Unique Identifiers |
| SBC | Single-Board Computers |
| GHz | Giga-Hertz |
| ARC | Advanced RISC Machine |
| HDMI | High-Definition Multimedia Interface |
| USB | Universal Serial Bus |
| MP | Mega Pixels |
| SDK | Software Development Kit |
| API | Application programming interface |
| NodeMCU | Node Micro-Controller Unit |
| IDE | Integrated Development Environment |
| SPDT | Single Pole Double Throw |
| AI | Artificial Intelligence |
| SQL | Structured Query Language |
| Wi-Fi | Wireless Fidelity |
| GSM | Global System for Mobile communication |
| LDR | Light Dependent Resistor |

| | |
|---|---|
| EEG | Electroencephalogram |
| ECG | Electrocardiogram |
| DHT 11 | Digital Humidity and Temperature |
| SDLC | Software Development Life Cycle |
| RAM | Random Access Memory |
| AC | Alternating Current |
| DC | Direct Current |
| TFT | Thin-Film Transistor |
| LCD | Liquid Crystal Display |
| HTML | Hypertext Markup Language |
| CSS | Cascading Style Sheets |
| DIY | Do It Yourself |

# CHAPTER 1
# INTRODUCTION

## 1.1 OVERVIEW

In this era, we are witnessing faster growth of technology. People's lives are intertwined with technology, so it is almost impossible to establish a livelihood without it. The development of faster, smaller and cheaper microprocessors had humankind establish a variety of systems that are able to comprehend human tasks and solve various problems. One of the vital systems where technologies are well utilized is the internet of things. The internet of things (IoT) is a system of interrelated computing devices that include mechanical or digital machines, objects, people etc., that are purveyed with unique identifiers (UIDs) and the ability to transmit data over the network without the need for personal interaction or human-computer. It is an advanced automation and analytics system that deals with artificial intelligence, sensor, networking, electronics, cloud message transmission etc., to deliver complete product systems or services. The system created by IoT has greater clarity, control, functionality and transparency at every stage of implementation and development. This project wholly depends on the usage and implementation of various IoT devices at varying stages of the development of the smart device.

## 1.2 IMPLEMENTATIONS

One of the vital implementations of the Internet of Things we can witness is its utilization in Smart Home Automation technology. Domotics or Smart-home-automation uses smart devices and wireless communications to perform tasks automatically, i.e., smart-automation. It also allows us to control smart devices using smartphones. Users can also configure these devices to control their home lighting, weather, water usage, safety systems, and electrical appliances. Smart homes can also contain one device, such as smart thermostats, to regulate the aforementioned uses. Generally, domotics refers to a network of multiple devices connected to a single control point or hub. It makes the operations of various home appliances more convenient and saves energy. With the energy-saving concept, home automation or building automation is very simple nowadays. It automatically controls all electrical or electronic devices in homes or even remotely through wireless communication. Our project aims to develop a Smart-home device to make the lives of the affected individuals safer, eco-friendly and self-sustaining at a fractional cost of an average smart device (smartphones etc.).

## 1.3 CHALLENGES

One of the few challenges present in smart-home technology is designing smart homes for people with disabilities. People with disabilities require a customized smart-home system to lead their lives effectively. Moreover, the application of smart-home technology can enrich the lives of such people, as they could lead life independently, without any help from others. Also, there are various devices and system proposals [18] to closely monitor the patient's vitals. Data can also be collected on such devices and analyzed by doctors for patients' health status. Thereby, it would be feasible and valuable to create a smart home system with such prospects, which this project aims to.

## 1.4 OBJECTIVE

Our project aims to develop a smart-home system to make the lives of the affected individuals safer, eco-friendly and self-sustaining at a fractional cost of an average standard smart household automation. In this project, we chose to solve the discrepancies produced in people with paraplegia. It's generally termed as the medical condition in which a person loses consciousness or movement in the lower part of the body. It has also been described as a spinal cord injury or partial disability in which the functions of the body's lower extremities are disrupted. Direct Injuries or diseases caused to the spinal cord, brain or both and sometimes on the measure of rarity, genetic spastic paraplegia are amongst the primary paraplegia causes in the hindrance of the bodily movements. Upon being struck with paraplegia, the brain or spinal cord cannot send or receive signals to the lower half of the body. Due to this, people with paraplegia cannot move their body parts below the waist but lose sensation in that area. Occasionally, there are bites or some tingling sensations in the legs and feet, which is probably a result of specific injuries and can also induce temporary paralysis in one or both legs.

Home-automation technologies have evolved vastly in the last few years; No longer a sign of novelty or relegated to home security systems, smart devices can help the elderly individuals; specifically, octogenarians and those with disabilities, young or old, live independently without having to pay a premium for products specific to their needs.
For instance, people with partial motor skills, paraplegia, or, at the extreme, cerebral palsy can find it increasingly arduous to be self-sufficient and self-dependent without external or Third-Party aid services.

## 1.5 COMPONENTS USED AND WORKINGS

Here In this project, We're building and developing a low-cost self-sustainable smart IoT device capable of eliminating the need for Third-Party Aid services to cater to the affected individuals at the maximum capabilities. In this project, we design smart-home systems mainly to solve the discrepancies of people with paraplegia. The design of this smart home is based on off-the-shelf components such as Raspberry Pi, NodeMCU ESP8266, Relay Module and other required components.

One of the most vital components we utilize here is Raspberry Pi. Raspberry Pi is a series of small single-board computers (SBCs) formulated and developed in the United Kingdom by the Raspberry Pi Foundation, a consortium with Broadcom. The Raspberry Pi project initially leaned toward teaching introductory computer science in schools and developing countries. The original or archetypal model developed became more popular than anticipated, selling outside its set target markets for uses such as robotics due to its inexpensive, modularity, customizable and open design. It is quintessentially used by computer and electronics aficionados due to its inclusion of HDMI and USB devices. Here in this project, The core component used is a Raspberry Pi 4-B equipped with a 1.5 GHz 64-bit quad-core ARM. Cortex-A72 processor, onboard 802.11ac Wi-Fi, Bluetooth 5, full gigabit Ethernet, two standard USB 2.0 ports, two USB 3.0 ports for faster data transmission, 2-8 G.B.s of RAM, and dual-monitor support via a pair of micro HDMI (HDMI Type D) ports for up to 2160p (4K) resolution as the required configuration.

Another Core component used in the construction of the smart IoT device is the Camera module, which helps capture and scan the QR codes to give out the corresponding actions befitted to the circumstances. The camera module can be utilized to take high-definition video and still photographs. It's comprehensible and intuitive for beginners but has plenty to offer expert and advanced users if they're looking to expand their horizons in knowledge. The camera's image sensor has a native resolution of five megapixels(5MP) with a fixed focus lens. The camera software supports full-resolution still images up to 2592x1944 and video resolutions of 1080p30fps, 720p60fps and 640x480p60/90fps.Another Core component used in the construction of the smart IoT device is the Camera module, which helps capture and scan the QR codes to give out the corresponding actions befitted to the circumstances.

### 1.6 QR-CODE

QR code is a barcode type based on a matrix, a machine-readable and identifiable optical label that could contain information about the item to which it is attached. QR codes often contain data for a locator, identifier, or tracker that directs the user to a website or an application. A QR code uses four standardized encoding modes (numeric, alphanumeric, byte/binary, and kanji) to store data effectively and efficiently; extensions may also be used. It usually consists of black squares arranged in a square grid on a white background, which can be read using an imaging device such as a camera, and processed using Reed–Solomon error correction until the perceived image can be appropriately translated and interpreted. The required data is then extracted from the patterns present in the image's horizontal and vertical components. In this project, the mode of action-response transmission uses a camera module to scan the QR codes corresponding to the smart devices or the respective appliances used to activate them.

### 1.7 MICRO-CONTROLLER

Another part of the system utilizes NodeMCU ESP8266. It is a wi-fi-based IoT component micro-controller utilized mainly for IoT automation. It allows an application to be hosted by Wi-Fi or utilize the data received from another host to control various IoT devices. This module is not expensive and flexible, with many features. The component uses an ordinary mobile charger (onboard Micro USB connector). NodeMCU ESP8266 requires 2.5V to 3.6V operating voltage, Onboard 3.3V- 600mA regulator, 80mA Operating current. The NodeMCU memory comes with 32 Kb RAM, 80 Kb DRAM and 200 Kb Flash Memory for efficient usage of programming in the microcontroller. Some of the platforms where NodeMCU ESP8266 are developed are Espruino, UpyCraft, Mongoose OS, Espressif SDK, and Arduino Add-on. We propose using this microcontroller to control smart home IoT devices like tube lights and bulbs for this project. The web application will be hosted on another device with the common access point as the NodeMCU. Here, NodeMCU uses a GET request from the host to control the appliances. The development is done using Python's MicroPython using Upycraft IDE, as the debugging part of development involved here is unchallenging.

## 1.8 RELAY MODULE

A relay module is an electrical switch used for controlling IoT devices here. It is an off-to-shelf component mainly used to provide an interconnection between an A.C. power supply to the IoT devices using a digital signal. A few relay modules are simple, a 2-channel SPDT relay and a 4-channel SPDT relay. It uses a digital signal ((i.e.) 1/0) from NodeMCU ESP8266 and an analogue power supply to operate the smart IoT device connected to the module.

Household appliances are the essential devices involved in this IoT smart home automation. The appliances involved here are likely not smart (AI-enabled appliances). Instead, they are the ones used conventionally, day-to-day life. The household appliances utilized are based on a 240V A.C. supply, and they are powered and controlled using a relay module, as discussed before. The data of house appliances are stored in the database before the setup. Few QR codes are printed and pasted under the household appliance (pasted according to the viewability of the camera module attached with the user's glasses). The values of the QR code and the correlations of QR code and the appliance are noted and given to the database attached with the web application.

## 1.9 PYTHON

Python is an interpreter-based general-purpose, high-level programming language. It is a widely-used programming language around the globe due to its almost pseudo-code-based syntax. It is used mainly in artificial intelligence, data science and analysis, and image processing. It can also be used for the development of web applications. Flask is one of the modules of Python. It is a micro web framework that does not utilize particular tools or libraries and is simple to implement. Here, Python Flask is utilized to create a web application to provide a user interface. The video feed from the camera module can be viewed in this web application by the user, with the corresponding data based on the feed from the camera. The front-end is based on HTML and built on Bootstrap CSS. Few codes of Javascript scripts are also utilized to display the information on a timely basis. It also utilizes a JSON file to display the recognized data. OpenCV (abbreviated as Open Computer Vision) is an image processing Python module. Here, OpenCV is used to show the recognized area of the code visually. Another module, known as Pyzbar, is utilized to read the QR codes and send the signal to control the appliance to NodeMCU ESP8266 via a

standard router. An SQL-based database, known as MySQL, is connected with a Python flask to keep track of information on the IoT devices and their statuses.

### 1.10 MICROPYTHON

MicroPython is an open-source Python interpreter written using C and compatible with Python3. This software is created for the development of programs on small embedded development boards. It is mainly used to write clean and simple yet efficient Python code for controlling hardware instead of utilizing complex low-level languages like in Arduinos. This project utilizes all of the components aforementioned to create an active, efficient and reliant system.

# CHAPTER 2
# LITERATURE SURVEY

Internet of things is defined as the field of technology involving a plethora of concepts involving sensors and their connection with the internet [11]. Smart homes are associated with sensors, house appliances and smart devices that can be interrogated, assessed and supervised remotely using laptops, mobiles, PCs and so on [9]. A smart home system aims to increase home systems' comfort, productivity, accessibility, and automation from users' perspectives. Smart houses integrated with IoT systems can be considered a better alternative to provide an independent life for people with disabilities. Many smart systems can provide assistance to people's interaction with household objects [12].

There exists a need of smart-home IoT for people with disabilities. The internet of things plays a vital role in our daily life. At the moment, almost every human has utilized a device based on the internet of things. The internet of things is found everywhere, especially in the field of healthcare and medical sciences. Most of these devices fulfil the purpose of constant overlooking and monitoring of patients over a long period, which can be presumed by a survey presented in the paper [13]. The face-to-face survey study [14] done by faculties from the University of Ulsan College of Medicine found discrepancies produced in demand for Internet of Things services for older people and people with disabilities, caregivers, and health care providers. The study's conclusion states that the betterment of the internet of things applications for the disabled can be induced by establishing home IoT technology by combining the patient's priorities and assessments.

Earlier designs and architectures of internet of things- based home automation systems based on embedded systems, 3G and ZIGBEE technologies, as presented in this paper [17]. Paradoxically, most designs of IoT-based smart home systems proposed these days are based upon the ones presented in this paper. Sokullu et al. [1] describe the prototype and testing of simple IoT supported automated-assisted living systems and their architecture for assisting elderly and disabled people who live alone with available emergency connectivity to relatives and caregivers. This system is based upon off-the-shelf components, a cheaper alternative than one may find in the common market. The architecture of this project is created based on this paper.

Various concerns of privacy and security related to data handling in the implementation of Smart Home automation for disabled people. The discussion in this paper [8] is an introduction to Smart home automation for people with disabilities that comes with its flaws, especially in terms of privacy. So, there had been some implications on privacy concerns put forth by users. These include: receiving long-term services induces problems in their privacy and security present in private storage of data captured by the technologies [9] wherein malicious individuals can exploit their game as the home automation system is vulnerable to such attacks. Talal et al. [16] put forth a review for smart home-based IoT for remote health monitoring systems, stating a common swap between home security and privacy of users or disabled people as a key issue in cyber security systems.

In the provided concepts (smart home and IoT), security issues may persist as devices tend to store personal data of users, such as names, addresses, and information of their credit cards, which are connected to a standard Wi-Fi, invoking vulnerability as discussed in paper [10]. While designing a smart home for disabled people, this scenario must be considered vehemently. An approach to overcome the attacks based on the vulnerabilities present in voice-controlled user interfaces is also presented in this paper [15]. So, while a model is designed for such, engineers must assess security issues and the associated users' concerns and design the IoT system accordingly.

Various existing and proposed models exist to implement smart home technology for disabled people. Here [2], we discuss a system that uses smart IoT and automated devices such as smart plugs, smart power strips etc., which doesn't require any physical contact from the disabled individual to be operated on such that it can be done using voice commands via voice assistants such as Alexa, Google Assistant, Siri etc. This is much more feasible for paraplegic individuals unless they are Deaf/Mute. A Retinal control-based device constructed using Arduino microcontrollers, I.R. diodes, XBEE wireless sensors, and an accelerometer that helps the user control home appliances with the help of eye-blink movements without requiring any assistance operate it and can be done by the paraplegic individual. This is also a feasible option, but constant eye blinking or unwanted blink(s) may cause ineffective inputs to operate [3]. [4] A system that uses IoT devices such as Bluetooth module, GSM module, Temperature sensors, and Humidity sensors is operated via Voice Control and Wi-Fi/Bluetooth, which provides high security via facial recognition and uses temperature monitor control using LDR sensors to assuage it. These appliances can be controlled via voice commands.

Smart home IoT systems based on brain control are no longer a fictional paradigm. There have been proposals to automate and access Smart home objects using just the brain, and it relies on using the EEG and ECG waves of the brain as proposed in the paper [5]. A more portable version of the above concept is introduced as "NeuroSpy" [6]. Though proposed, they are still in the development stage and might take a few more years to be implemented in a commercial market. So, this technology cannot be feasible for effective and immediate implementation and may also cost a lot. In the field of smart home automation based on wireless technologies, sensor networks have the capability to transform the independent lives of people with disabilities [7]. For this field, a new system is proposed, known as E/D-WSH, with an enhancement of energy saving. The installation and maintenance are predicted to be costing around $8100 [7] initially for the basic model, which is not commonly affordable for the general elderly and the disabled population.

This literature survey shows how such solutions can be prominent among disabled individuals when implemented correctly. Therefore, we chose to solve the problem of a particular type of disabled individuals, i.e., individuals with paraplegia. This thesis can be seen as a simple yet effective solution for leading an independent life.

# CHAPTER 3
# PROBLEM DEFINITION AND METHODOLOGIES

## 3.1 PROBLEM DEFINITION

Home Automation or smart homes with the aid of domotics were once seen as a sign of luxury that was affordable to the wealthy as it only appealed to those who were able to afford such strenuous luxury in their midst, which meant that only a meagre amount of physically and mentally disabled were befitted with such technologies availing at their disposal and the rest of them being taken care of with the help of manual aides; issues such as this are a thing of the past concerning the advancement of technologies thrown at us in the present which makes it a lot easier for the common population regardless of their financial statuses can procure them at their disposal with lesser amounts of expenses involved, i.e. cheaper as the technologies go by.

Since the technologies used here are cheaper, unlike in earlier times, the only issue is whether the technologies satisfy all the strata of the disabled individuals, i.e., whether it applies to every individual in need of them varying types of needs. In this case, a paraplegic individual is a wheelchair user as they are paralyzed waist-down.

This project is aimed to mitigate such inconsistencies presiding them by designing and developing an eco-friendly, low-cost, affordable IoT device that's easier to use and is a very self-sustaining model that doesn't require any third-party aide to help them get on with their days with maximum ease-of-access. It is also aimed at individuals with speech impairments or auditory issues, i.e., deaf/mute paraplegics.

## 3.2 EXISTING SYSTEM

Many domotic products (Home automation systems) are primarily aimed at the general population. For example, tailor-made domotic products for the intensely-disabled individuals such as people with paraplegia and those involving spinal damage can't utilize the said products' maximum intended capacities. Although some medically and professionally recommended domotic products are prescribed at the behest of the physicians, they mostly are inclined to be on the expensive spectrum or tier of the products that may or may not require additional expenses to accommodate the said liking and comfort of the disabled individual. Still, its fair share of issues

also stemmed from the greater acceptance of the individual and the suitability of the domotics to be installed within the residence.

### 3.3 PROPOSED SYSTEM

This project, "ParaIOT", proposes a new model of the Internet of Things-based smart-home automation system to help users with disabilities, especially those with paraplegia. This model aims to make the people, as mentioned earlier, lead their lives daily on their own, rather than relying on their relatives, caregivers, or any other personalities.
A handheld device is created using Raspberry Pi, and a camera module with all the required details of the house components or the household items is created. Then, the household components are connected to NodeMCU ESP8266, a microcontroller-based on Wi-Fi networking, through a Relay Module with a current supply. This microcontroller is connected to Raspberry Pi via a common access point like a router.

The components/household items are set with specific QR codes (preferably on the user's eye level), and this linkage is noted down in Raspberry Pi before setup. The setup also involves the culmination of a camera module with the spectacles of the user. When the user scans a QR code, the Raspberry Pi sends a signal to turn on/off the component (based on the component's status) using a GET request via the access point towards the NodeMCU ESP8266. This microcontroller, in turn, signals to turn on/off the component based on its state. The basic architecture of this project is based not only on smart IoT devices but also on components that are conventionally in use, with no features of Artificial Intelligence. So, the proposed model can be modified and adapted according to the users' needs and the components/devices of the user's current living environment. This architecture derives to be a more significant advantage as the cost of converting a conventional home to a smart home is much reduced and more reliant than the existing models previously discussed.

Furthermore, an alert system is also added as a component to the model. Two sensors, one based on Temperature and Humidity and another based on Flame detection, are utilized to detect the discrepancies produced in the environment and alert the concerned recipients via E-mail, SMS and WhatsApp message. The details of the recipients, i.e. the e-mail addresses and the phone numbers, are stored in the database present in the handheld model and alerted via the internet

# CHAPTER 4
# SYSTEM REQUIREMENTS AND MODULES

## 4.1 DESIGN PROCESS

The design of the system is based on off-the-shelf components. Various strategies and ideas were put forth while designing the system, and the system's final design can be seen in this thesis. One of the main challenges faced while examining the existing models is cost and flexibility. So, we aimed to reduce the cost produced and offer more flexibility for the users.
The proposed model is designed with Raspberry Pi as the main focus and additional subsidiaries. First, A web application is developed from a computer and tested with a webcam and database. Next, the software components are installed into Raspberry Pi and tested out. A handheld device is made out of it. The required software for NodeMCU ESP8266 is installed and tested.

The model is divided into two phases. Phase 1 involves the user, and Phase 2 involves the household appliances. The web application is installed into phase 1, a handheld device, created Raspberry pi and other required modules. Phase 2 is where the user controls the household appliance using the handheld device

Further additions to the proposed models are alert systems. The alert systems are based upon the two main characteristics surrounding the user's environment: Temperature and Humidity Flame Detection. The proposed model contains two sensors, DHT11 (for detecting Temperature and Humidity) and KY-026(For detecting flame). The alert systems notify alerts to the recipients, that is, the emergency contacts user depends upon, such as relatives, doctors, neighbours and other required personals

The proposed model costs around $130 (Approximately Rs 10000), which is said to be the least among the existing systems. The model's setup is based upon individual preferences as the proposed system is flexible and transparent.

### 4.1.1 SYSTEM REQUIREMENTS

The hardware requirements of the proposed model are divided into two phases, as described before. The first phase involves creating a handheld device using some handheld components

available off the shelf. The main off-the-shelf component is Raspberry Pi. They are small single-board computers, capable of running applications equivalent to an average computer. Here, it is mainly utilized to run a web application. Here, we use Raspberry Pi 4 Model B, 2 G.B. version (Fig. 4.1). The Raspberry Pi is connected to two sensors to monitor the environment. They are DHT11 (Fig. 4.2) - Temperature and humidity sensor and KY-026 (Fig. 4.3) - Flame detection sensor. They are utilized to take readings of the environment and alert the required recipients if any abnormalities are present.

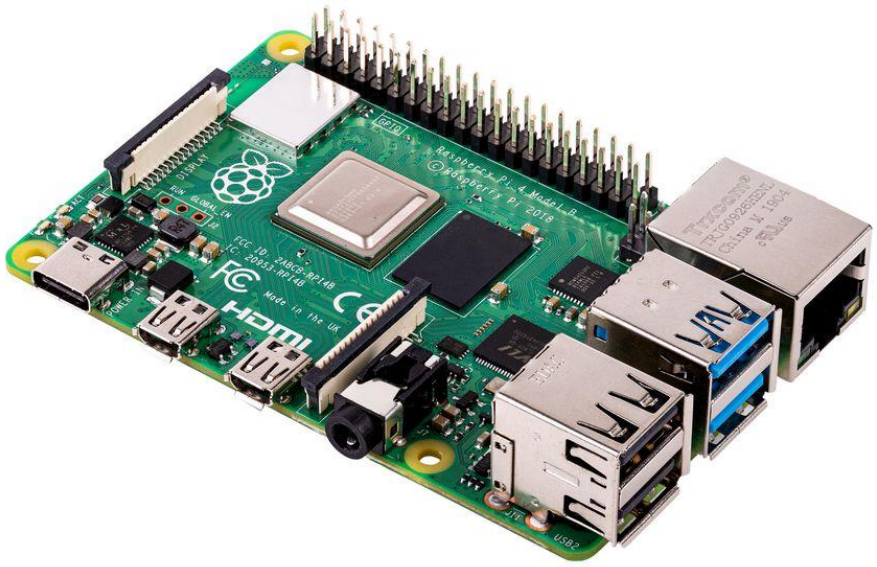

*Fig. 4.1 Raspberry Pi 4B*

A camera module is attached to Raspberry Pi and used to provide the video feed to the web application. Using the camera module, the user utilizes scanning of QR code and turning on the required appliances, similar to a digital switch. The Handheld device uses a Power bank of 10000 mAh as a power source. A standard router is connected between NodeMCU ESP8266, and a Wi-Fi module and Raspberry Pi are established.

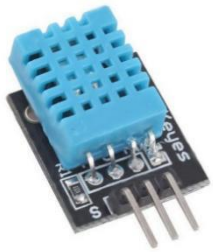

*Fig. 4.2 DHT11 Sensor*

*Fig. 4.3 KY-026 Sensor*

*Fig. 4.4 Camera Module*

The second phase involves setting up the home appliances with a Wi-Fi connection. The Wi-Fi connection is established using a microcontroller known as NodeMCU ESP8266 (Fig. 4.5). This is utilized widely in implementing the Internet of Things based on Wi-Fi and network connections. This microcontroller controls the home appliances through another module known as Relay Module. A relay module is used to control an A.C. appliance using a D.C. input, and it plays a vital role in controlling systems in a home environment. The relay module is connected to A.C. appliances in the circuit similar to the (Fig. 4.7). Some home appliances primarily include Phase-Neutral-based connections such as bulbs, fans, and tube lights. The usage of Phase-Neutral-Earth-based appliances such as Grinders and Air-conditioners is purely based on the model of the Relay module. Here, a 4-channel Relay module is used

*Fig. 4.5 NodeMCU ESP8266*

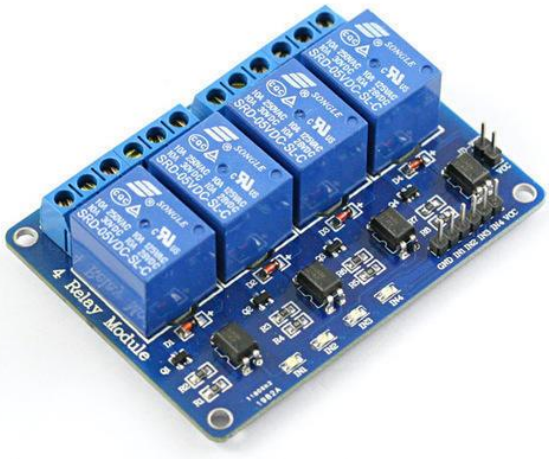


*Fig. 4.6 Relay Module*

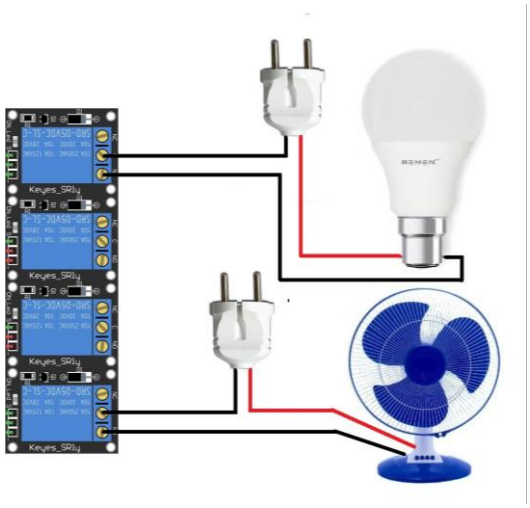

*Fig. 4.7 Circuit Diagram of relay module to A.C. appliances*

The software of the proposed model is based chiefly upon Python due to its simplicity, integrity and less sophistication of usage. Raspbian, a Linux-based operating system, is installed into Raspberry Pi. It is a 64-bit operating system with a Graphical User Interface, used mainly for running tasks for an IoT system. A web application is installed into Raspbian. It uses Python Flask as a backend. Python Flask is integrated with OpenCV. OpenCV is a module used for Image Processing tasks in Python. Here, it is used to scan QR codes and get the desired output. The video feed from the camera attached to Raspberry Pi can also be seen in the web application. Another Python script is run separately to use the sensors connected to Raspberry Pi. It uses GPIO (A particular Python module for Raspberry Pi) to measure sensors' readings and create alerts accordingly.

The alerts are sent using Twilio, a third-party application that provides an API for such utilities. The recipients are the people the user can rely on under emergency circumstances. Those recipients include the user's relatives, caregivers, doctors, and other emergency service agencies. Twilio alerts the recipients through SMS, WhatsApp and E-mail. The accurate data of the home appliances, the connections associated with them, and the details (phone numbers and e-mail ids) of the recipient are stored in a MySQL server inside Raspberry Pi and accessed to retrieve the required information.

In the second phase, the control program for NodeMCU ESP8266 is written using MicroPython. MicroPython is a variety of Python designed for controlling microcontrollers. Here, the microcontroller is used for receiving commands from the handheld device via router and controlling the appliances accordingly

### 4.1.2 MODULE DESCRIPTION

The development phase of the proposed model is divided into four modules. Each module contains a set of steps for implementation, ideal for developing the model, and other systems similar to the proposed model. The modules are Web application Development, ParaIOT gadget Development, Setting up the environment, Testing and Deployment. The SDLC of the proposed model is illustrated in (Fig. 4.8)

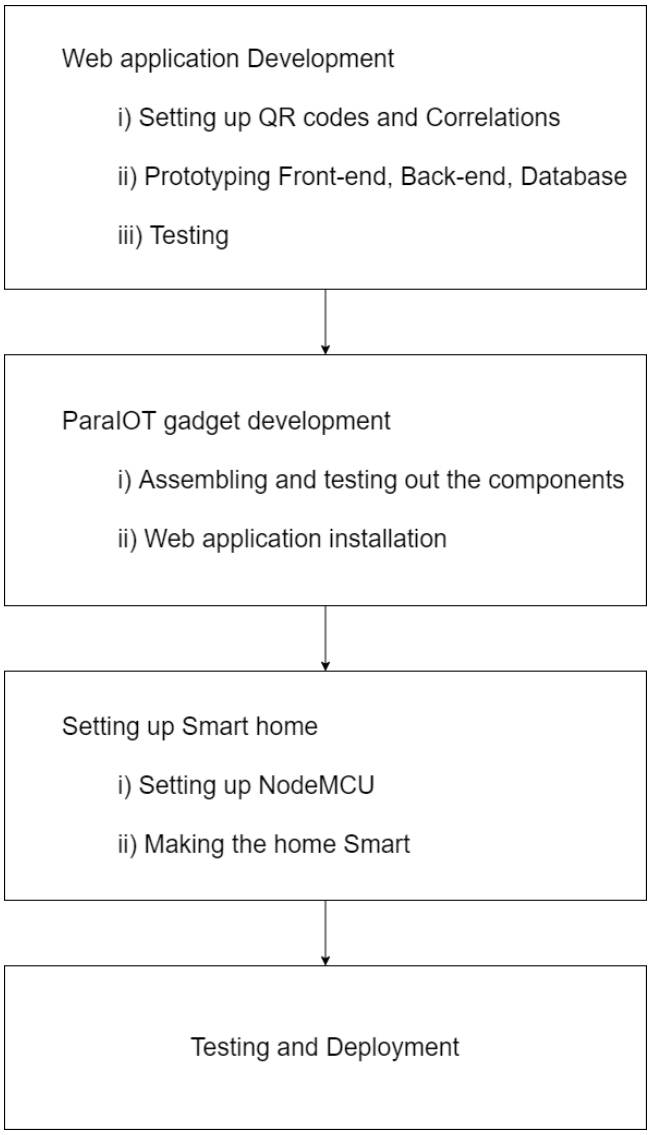


*Fig. 4.8 SDLC diagram*

The first module (Web application Development) developed an essential website using Python Flask. Additional modules for QR codes are developed using OpenCV. The values required in QR codes and their correlation with the concerned appliances are set and stored in MySQL. The website is also developed to acquire recipients' phone numbers and e-mails and store them on a MySQL server.

Another Python script is also developed to keep track of sensors using the GPIO module of Raspberry Pi and alert systems (using Twilio APIs), which is then tested using simulators before deployment. The database is furnished and set according to the website requirements. Then the website is tested from a common access point like routers before deploying into Raspberry Pi, which can be overlooked in the upcoming phases. The website was initially developed on an ordinary computer to clear out the errors and bugs raised.

In the second phase, the handheld gadget is being developed. First, the components required for developing the component are acquired. As the components are off-the-shelf, they can be acquired easily from the market. Each component is bought and tested out separately to reduce the probability of failures and errors and get replacements if things occur.

The brain component, Raspberry Pi, is bought first and an S.D. card. Here, Raspberry Pi 4 Model B (4GB RAM version) is being used, with an S.D. card with a memory of 64GB. The Raspbian OS of 64 bit is installed into the S.D. card and inserted into Raspberry Pi. The proposed model's minimum requirements are 2GB RAM, but we use the recommended requirement of 4GB. The Linux-based Raspbian OS is installed first, and the recommended version of Raspbian OS is 64-bit. Then the web application and the required Python scripts are also installed into the Raspberry Pi.

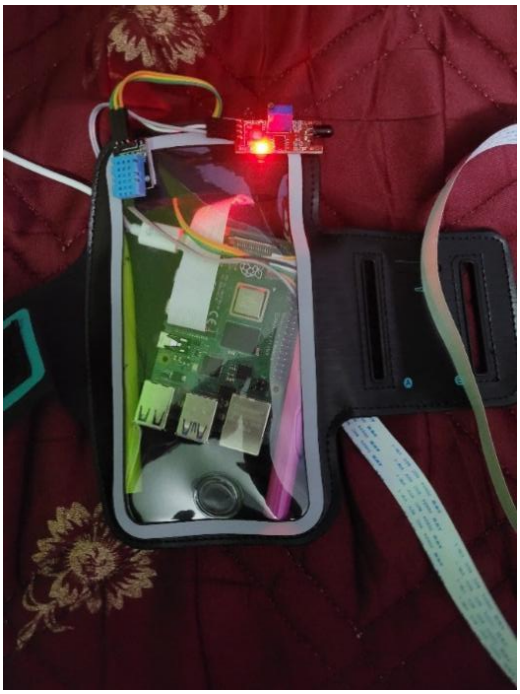

*Fig. 4.9 Raspberry Pi Gadget*

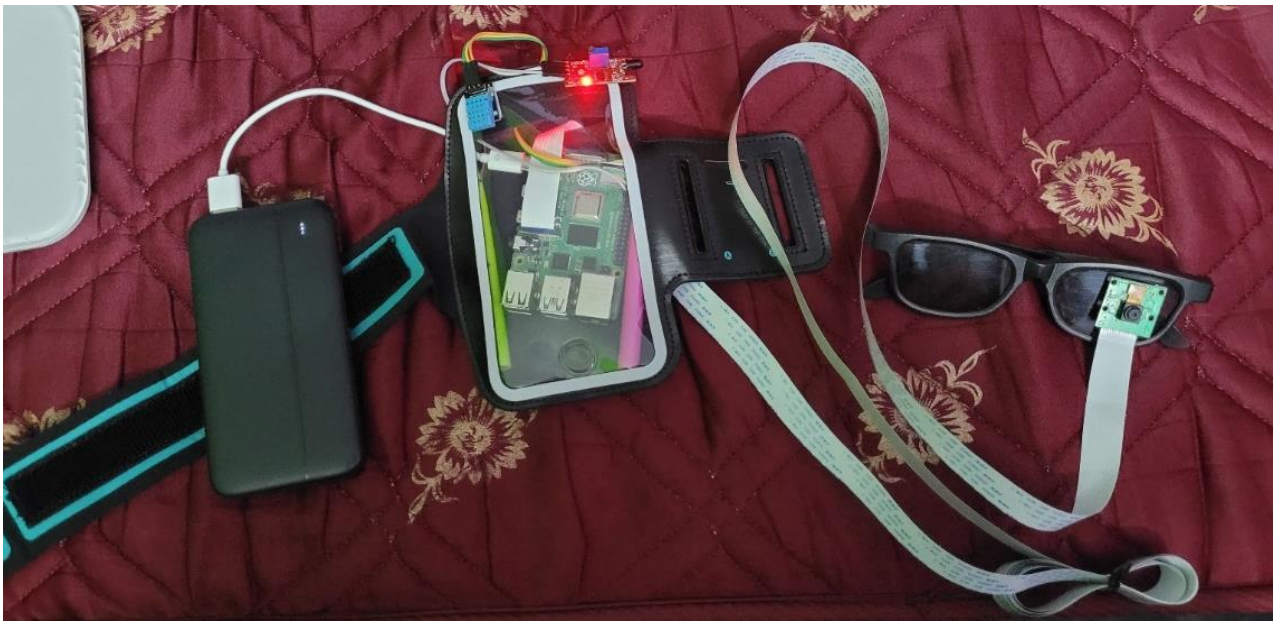

*Fig. 4.10 Raspberry Pi Gadget Full setup*

The required sensors, such as the Flame Detection sensor (KY-026) and Humidity Temperature sensor (DHT11), are installed as required in the circuit, and the camera module is also installed. Then, the Raspberry Pi is connected to a power bank to provide a power source.

Then the above setup is tested out for deployment. Let's call this setup from now on a gadget (as seen in Fig. 4.10)

The smart home for the gadget (discussed in the previous module) is set up in the third module. First, the required python script to accept the command from the gadget is installed into NodeMCU using MicroPython. After enslaving the Raspberry Pi with NodeMCU, the Relay Module is connected with NodeMCU and the required house appliances as described in (Fig. 4.11) thus making the household items smart.

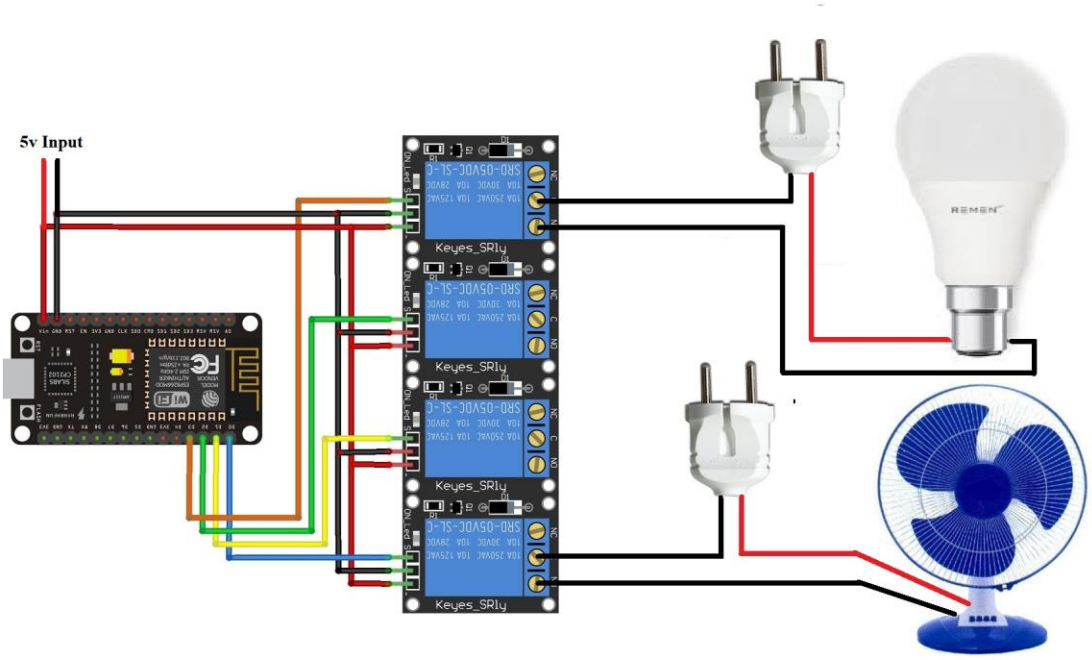


*Fig. 4.11 NodeMCU setup with Relay Module*

After following all of the modules described previously, the proposed model is tested in the development phase, similar to an alpha testing procedure. Then the proposed model is tested with a user, and the discrepancies that arose during those tests are solved. After this testing phase, the model is complete. When deployed as a product, the model requires special instructors or staff to set up the model according to the individual user needs.

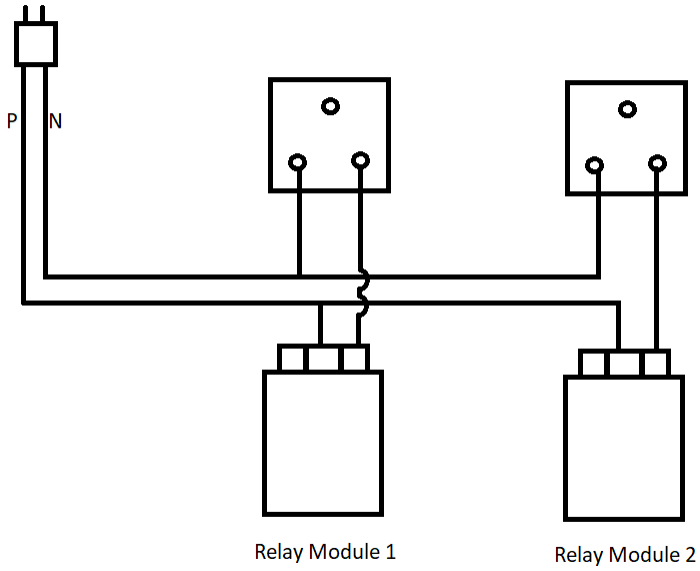


*Fig. 4.12 Relay Module setup with Switch Board*

The implementation shown in Fig. 4.7 can be also done for a switch board. The circuit diagram to set the Relay Module with a switch board can be seen in Fig. 4.11. Here, P stands for Phase and N stands for Neutral, which are the nodes required for accessing Alternating Current (or) AC. The two Relay modules are then connected to NodeMCU. Based on the signals given by the microcontroller, the relay module acts accordingly and switches on the concerned application. Fig. 4.12 shows a real time image of such implementation

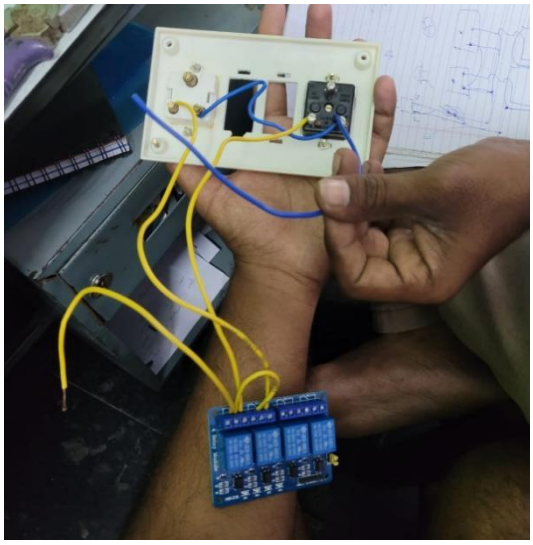

*Fig. 4.13 Real-time image of the implementation*

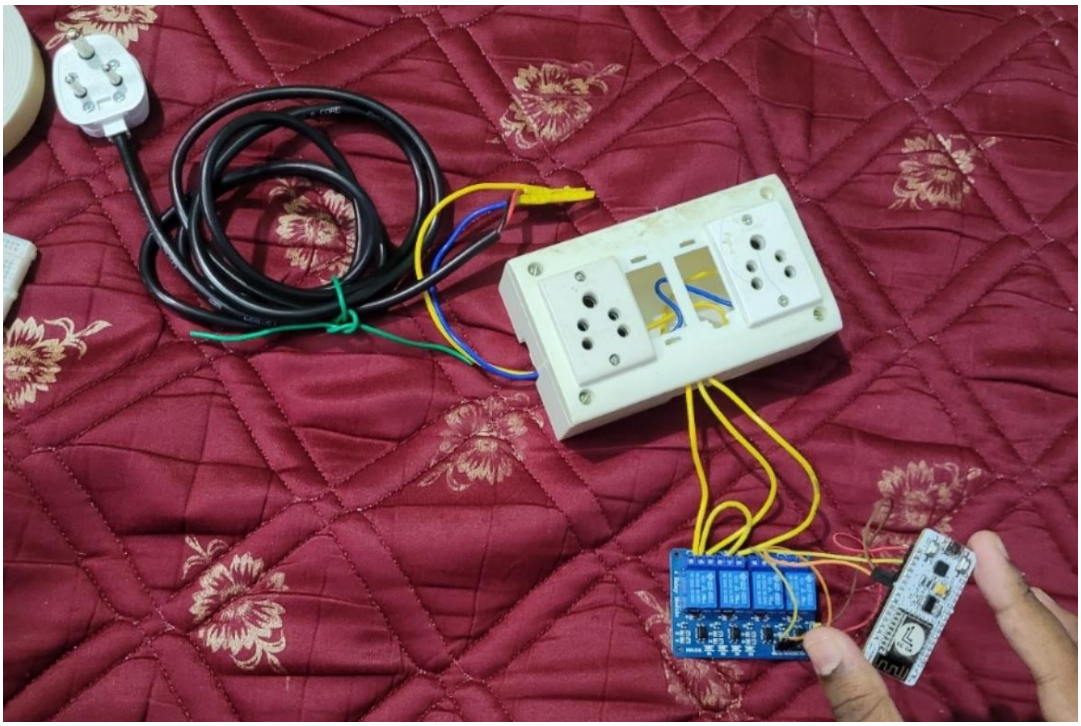

*Fig. 4.14 Real-time image of the implementation*

The Fig. 4.14 shows the real-time image of implementation based on the circuit shown in Fig. 4.12. As one can see, the switch-board is set up with a socket, another external cord to connect to another socket as a power source, then set up with Relay Module and NodeMCU Module. This implementation is usually done for demonstration purposes.

# CHAPTER 5
# IMPLEMENTATION

## 5.1 OVERVIEW

This smart-IoT system device, after the design process, is implemented as a handheld device that's either befitted to either hand of the user or attached to a wheelchair armrest with an ample amount of space that's connected to the camera sensor wirelessly wherein the former captures the QR-Code fixed near the required and corresponding appliances to automate and use as per the user desires.

The camera sensor is attached to a pair of goggles or eyeglasses, whichever the user deems comfortable, with no wearer's malaise or discomfort, which is essential to capture and scan the QR-Codes.

The camera angle or the line of sight for the camera is also optimized to capture the middle-most of the QR-Codes to automate the appliances; this is done in a way to eliminate any corroboration or the fringing of the QR-Codes to better capture and scan it with no much hassle, i.e., only the middle-most of the line-up of multiple QR-Codes will be scanned. The corresponding action will be reflected upon the user.

The NodeMCU device is then attached to a power outlet consisting of various switches to automate the corresponding connected devices to it so that every device that's automated via this system is connected to it. The signals, i.e., the GETS Request upon scanning the corresponding QR-Code, will be transmitted to the NodeMCU device via an access point or a router. The corresponding device or appliance to the scanned QR-Code will regulate and function as the user intends.

Additionally, the constructed handheld device also includes various other sensors to regulate the usage and better translate it to the safety and security of the users by incorporating sensors such as DHT11 Temperature and Humidity sensor to measure the room and surrounding Temperature and also the humidity to regulate the user's comfort as they desire to do so—a KY-026 Flame Detection sensor to detect any potential flame that may inadvertently happen.

The above sensors, besides detecting, are also coded to receive alert messages via E-Mails, SMS messages, or WhatsApp messages in real-time using a free sandbox tool called Twilio sandbox, which transcripts the alerts whenever any of the sensors are being triggered.

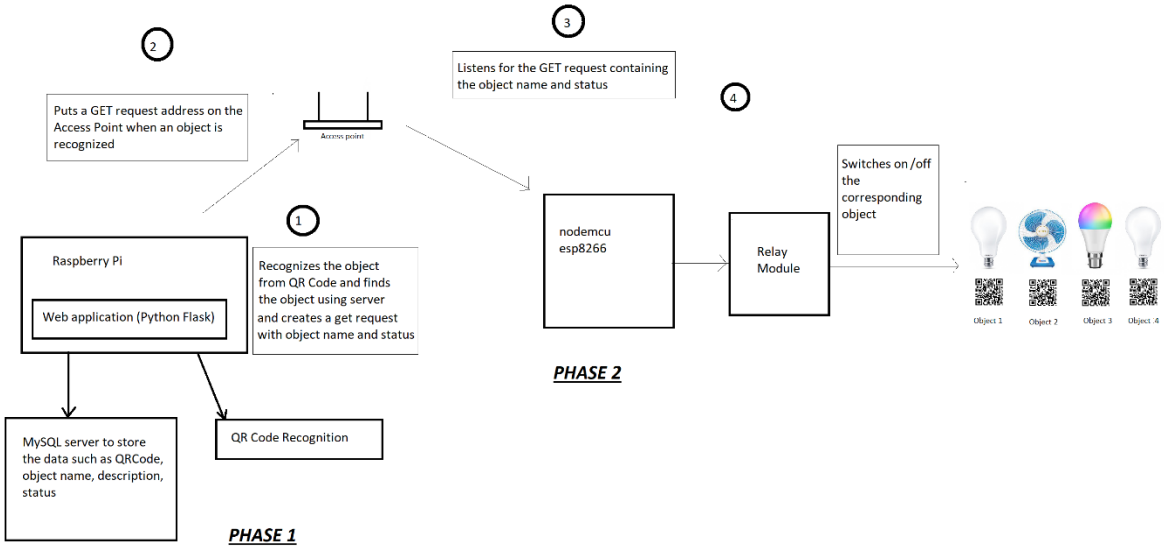


*Fig. 5.1: Working of the model*

The prototypical model in its core devised as shown in the above Fig. 5.1, which is wholly divided into two individual phases with varying degrees of functioning that are interconnected which is also essential for the whole functioning aspects of the device. The phases are namely termed as phases 1 & 2 respectively.

### 5.1.1 CONTENTS OF PHASE 1

- HARDWARE MODULES
    - Raspberry Pi
    - Camera Module
    - Power bank (10000 mAh)
    - Router (as a common Access Point)

- SOFTWARE MODULES
    - IDE: VS code Insiders
    - Python
    - Flask
    - OpenCV
    - HTML, CSS (Bootstrap studio)
    - MySQL server
    - JavaScript

### 5.1.2 CONTENTS OF PHASE 2

- HARDWARE MODULES
    - NodeMCU ESP8266
    - Relay Module
    - Live A.C. Supply
    - Home appliances

- SOFTWARE MODULES
    - MicroPython

## 5.2 WORKING

In Phase-1, the Raspberry Pi device along with the O.S(Raspbian) is installed with a web application using Python flask which is used for recognizing the object from the QR CODE and finds the object using a server and creates a get request with the object name and its conscripted status which is retrieved upon chance request from the MySQL server database ie, the QR CODE, object name, description and its status.

After the data request retrieval, the raspberry pi Puts out a GET request address on the access point or a common router wherein both the phases are used for communicating and give out the necessary output.

Once after the GET request is transmitted, it is then interpreted by the NodeMCU ESP8266 module upon retrieval, and is again transmitted to the relay module in which all the home appliances are connected to it, thereby switching ON/OFF of the corresponding device as per the user's wishes.

### 5.3 WORKING OF ALERT SYSTEM

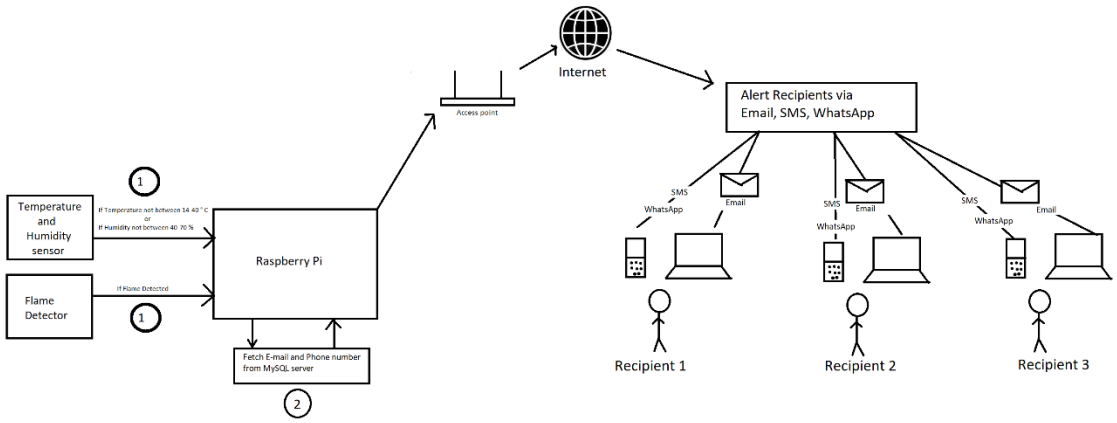


*Fig. 5.2 Working of the alert system*

An alert system refers to as a device or series of devices, which emit or transmit an audio/remote audio or electronic signals, that are intended to call the corresponding authorities for any sort emergency or risks. This term refers to systems that are connected to the radio frequency signal such as cellular or private radio signals, and includes Local Alarm Systems, but do not include car alarms, personal or any other system that will not emit any audio or visual signals outside of a building, residence or any other housing structures, but is designed only to alert the residents of a building or residence of any malfeasance or obstructions.

This prototypical model also incorporates the alert system which is simple yet effective using readily available DIY components that are also pocket friendly to the users, which in retrospective is also essential for the proper and safer functioning of the prototype that comes in handy to the paraplegic individuals and the medical professionals or caretakers alike to keep track and monitor the paraplegic individuals activities at their behest as a sense of common morality and obligation to tend to these specially-abled individuals. The sensor used in the proposed model is as follows:

- Flame Detection sensor (KY-026) - This Sensor module detects infrared light emitted by fire. This module has both digital and analog outputs and a potentiometer to adjust the sensitivity. Commonly used in fire detection systems.

- Humidity Temperature sensor (DHT11) - This temperature and humidity sensor comes with a dedicated NTC to measure temperature and an 8-bit micro-controller to output the values of temperature and humidity as serial data.

With the above-mentioned sensors being incorporated into the prototypical device in such a way that it's easy to modify or upgrade or remove the component as per the user's desires. These sensors are primarily attached or connected to the raspberry pi device along with establishing the required APIs to connect and calibrate with the system and function aptly and infallibly.

It's then given user defined presets for temperature to function by detecting the abnormalities and then give out the user specified alerts to the nearest connected smart devices ie, the devices that are fed and specified into the databases used by the prototypical device.

For instance, in the case of the temperature and humidity sensor, the conscripted user preset temperature is to be 14 - 40'C which is the prescribed average room temperature of the individual exceeding at the maximum of 40'C; if any issues were to arise such as if the sensor detects an abnormality in the room temperature as in if the room temperature exceeds beyond 40'C, the user, the caretaker and medical professionals over-seeing the paraplegic individuals activities etc., all get alerted by it and the required actions comply with the corresponding emergencies.

The same is applicable for the humidity sensor as well wherein the conscripted user preset humidity level is of 40 - 70% and if any abnormality is detected when it exceeds above the 70% level and the user, the caretaker and medical professionals over-seeing the paraplegic individuals' activities etc., all get alerted by it and the required actions comply with the corresponding emergencies.

For flame detection, if the prototypical device with the help of the flame detection sensor, detects any spark of fire near or the resultant smoke or flame of an accidental fire in the residence regardless of the presence of the individual at stay, the user, the caretaker and medical

professionals over-seeing the paraplegic individuals' activities etc., all get alerted by it and the required actions comply with the corresponding emergencies.

The process of attaining the alerts of such adversities and mishaps regarding the possible calamitous situation/s is achievable by at first alerting it to the all the conscripted users found in the database stored earlier by fetching all the possible users E-mail ID's and phone contact numbers from the MySQL Server and transmitting it via an access point i.e., a local router and is then transmitted to the corresponding users through E-mails and a personalized sandbox communication tool that is pertained as various chatbot applications across social media services i.e., as a chatbot detailing all the alerts and information of the events that transpired in the household based on its severity the required actions will be taken by the local emergency first responders at their disposal and dispatch.

For this project, an API service provided by Twilio is utilized for alerting the recipients through WhatsApp and SMS. This service is used for free, at this prototype stage, for the purpose of alpha testing. When extended among larger customer set and established in market, investments are required for provision of this API service, as suggested by Twilio's subscription plans to implement. E-mail alerts are done for free using a free service done by Google's Gmail. No investments are required for this as of now.

The scripts required for sending alerts by using APIs are preprogrammed and written into Python Scripts, and installed with the web application of the gadget, utilized by user.

## 5.4 DATA FLOW OF THE PROPOSED MODEL

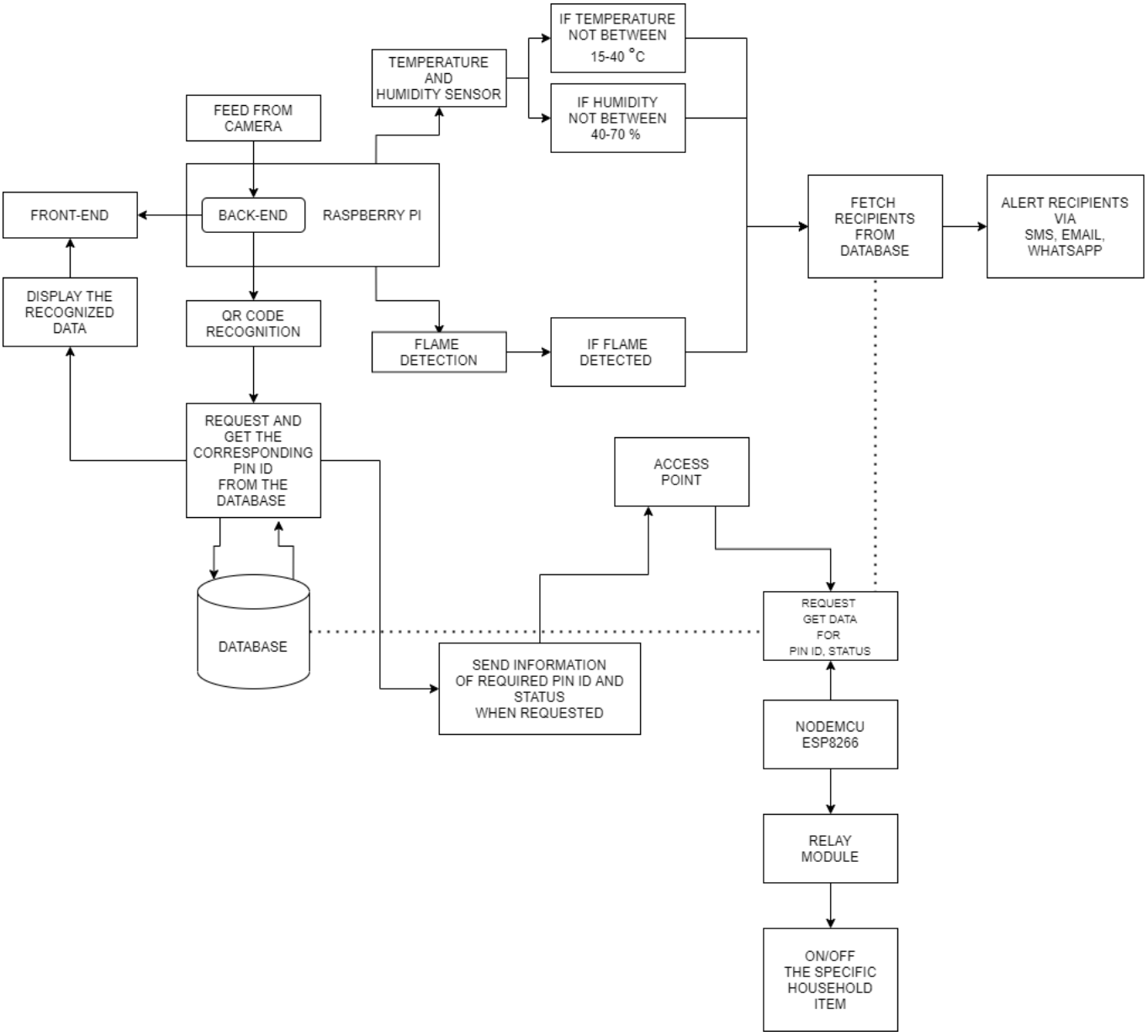


*Fig. 5.3 Data Flow diagram of the proposed model*

The proposed prototypical model as a whole is operable right when the user scans the QR CODES using the camera sensor which in turn based off of the code type scanned, fetches the corresponding PIN IDs from the local database of the prototypical model by putting out a request ID to it; this is all done via the back-end of the prototype that is stored in the system.

After data-pin retrieval, the front-end of the prototype i.e., a web-page is used to display the details and the status of the home appliances to its corresponding PIN ID's alongside with flame, temperature and humidity levels, no. Of objects present and the whole list of emergency contacts present in the database. The webpage also allows the user to add, update or delete the user information and the list of emergency contact details.

Post data retrieval, the corresponding information is then transmitted as data-packets and GET request ID's via an access point i.e., a common wi-fi router through which the home appliances are switched ON/OFF as per the wishes of the user.

As for the alert system using the temperature and humidity sensor and flame detection sensors, the user alongside the emergency contacts gets alerts utilizing the e-mail ID's and phone contact details that's fetched from the local database and giving out alerts via e-mails, SMS messages and Whatsapp messages illustrating details of the said alerts describing the presence of the anomalies ie., if the room temperature exceeds 40'C or is below 14'C or if the humidity level's not within the user preset 40 - 70% range or if flame were to be detected etc. The abnormalities were it be hazardous and dangerous to the individual; the caretaker and medical professionals over-seeing the paraplegic individuals activities etc., all get alerted by it and the required actions comply with the corresponding emergencies.

The GET request ID for the conscripted PIN ID's that leads to the functioning of the home appliance/s and is accepted by the NODEMCU ES8266 device which interprets the information and then transmits the info via the relay module wherein the appliances are all interconnected to it, and functions as per the user's wishes.

# CHAPTER 6
# CONCLUSION AND FUTURE ENHANCEMENT

## 6.1 CONCLUSION

This project describes the essential workings and functions of the handheld smart-IoT device, which is developed at the prototypical stage to eliminate the need for a 3rd- Party aid to assist the paraplegic individuals in performing the average daily tasks at a more manageable and notable pace, thereby helping them to be self-dependent and self-sustaining, this system is built from the ground-up using off-the-shelf components and sensors that are readily available to the common individuals' needs in such a way that the entire build costs less than 150$ to implement at the recommended level to operate and is also reasonably easy to install and maintain with no much hassle.

This system is also fitted with a custom alert system consisting of thermal and humidity sensors and a flame-detection sensor that alerts the users, caregivers, medical professionals, etc. Of any impending mishaps and probable causalities, if in any case that ever happens, via automated alerts that can be accessed through e-mails, Whatsapp texts and SMS messages.

## 6.2 FUTURE ENHANCEMENTS

Some of the possible future enhancements to make this project more viable enough for it to be widely accepted and implemented is to add voice automation and detection to communicate with the devices to automate the required appliances. But this could be a disadvantage, if the user is mute i.e., lacks the ability to speak. An AI system can also be added to monitor the requirements of individuals and assist them accordingly while also doing the earlier activities to mitigate the issues better.

A surveillance-based A.I. can also be added with the proposed model in order to notify the recipients of the patient through e-mail, phone number if a abnormal event is detected, as discussed in paper [19]. This paper uses a deep learning approach on image processing to keep track of any abnormal event in a surveillance capture.

A heart-rate sensor can be attached with the proposed model to keep track of heart rate and notify the required recipients if the heart-rate is found abnormal. Further, in the proposed model, a night-vision camera can be utilized in place of the normal camera to implement the working of proposed model even in darker environment. QR Codes can also be replaced by barcodes, texts or any other thing the computer vision can pick up as a hint or a code. A chat system can also be attached with the web application of the proposed model to communicate with required recipients if any discrepancies arose.

The proposed model can be modified with EEG headset. EEG headset can keep track of brainwaves produced by the patient and can be programmed to control the appliance using their brain.

# CHAPTER 7
# REFERENCES


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## CHAPTER 8
## APPENDIX- A1 SOURCE CODE

1) main.py

```
#Main python file to be run to deploy web application locally
from flask import Flask,render_template, Response, jsonify, request,redirect,url_for,flash
from _opencv import qrcode as qsimport cv2
from pyzbar.pyzbar import decode
import numpy as np
from flask_mysqldb import MySQL
import json
import os

app = Flask(__name__,static_folder='templates/assets')
camera= cv2.VideoCapture(0)
app.config['MYSQL_HOST'] = 'localhost'
app.config['MYSQL_USER'] = 'root'
app.config['MYSQL_PASSWORD'] = ''
app.config['MYSQL_DB'] = 'mindiot'
mysql=MySQL(app)

@app.route('/')
def index():
    return render_template("index.html")
ard_cnxn_status=ard_cnxn_port=ard_cnxn_err=mind_cnxn_status=mind_cnxn_port=mind_cnx
n_err=qr_code_rec=obj_dec=blink=attention=obj="N/A"

@app.route('/_stuff',methods=['GET'])
def stuff():
    #contains the python function to make run a js to for displaying a content in webpage without
refreshing
    #first part to recognize the barcodes
    barcodeData="N/A"
```

```
obj="N/A"
success, frame = camera.read()
gray_img = cv2.cvtColor(frame,0)
barcode = decode(gray_img)
min_center=10000000
xc=(frame.shape[1])/2
yc=(frame.shape[0])/2
for obj in barcode:
    points = obj.polygon
    (x,y,w,h) = a1 = obj.rect
    pts = np.array(points, np.int32)
    xe,ye=qs.center(pts)
    pts = pts.reshape((-1, 1, 2))
    gin=qs.find_distance(xc,yc,xe,ye)
    if len(barcode)==1:
        barcodeData = obj.data.decode("utf-8")
    else:
        if min_center>=gin:
            min_center=gin
            barcodeData = obj.data.decode("utf-8")

#second part to recognize arduino
if barcodeData!="N/A":
    trigger_rec_obj=barcodeData
    cur=mysql.connection.cursor()
    cur.execute("SELECT * FROM objects WHERE qrcode=(%s)",[barcodeData])
    obj_dec1=cur.fetchone();        obj_id=obj_dec1[0];        obj_name=obj_dec1[1]
    filename = os.path.join(app.static_folder, 'data.json')
    if obj_dec1[5]==0:
        cur.execute("UPDATE objects SET status=1 WHERE id=(%s)",[obj_id])
        mysql.connection.commit()
        with open(filename, 'r+') as f:
            data = json.load(f)
            data['qr_code_rec'] = barcodeData
```

```
                data['obj_dec'] = obj_dec1[1]
                data['obj_status'] = 1
                f.seek(0)
                json.dump(data, f, indent=4)
                f.truncate()
            return redirect(url_for("_pin_id"))
        else:
            cur.execute("UPDATE objects SET status=0 WHERE id=(%s)",[obj_id])
            mysql.connection.commit()
            with open(filename, 'r+') as f:
                data = json.load(f)
                data['qr_code_rec'] = barcodeData
                data['obj_dec'] = obj_dec1[1]
                data['obj_status'] = 0
                f.seek(0)
                json.dump(data, f, indent=4)
                f.truncate()
            return redirect(url_for("_pin_id"))
    else:
        filename = os.path.join(app.static_folder, 'data.json')
        with open(filename, 'r+') as f:
                data = json.load(f)
                data['qr_code_rec'] = 'N/A'
                data['obj_dec'] = 'N/A'
                data['obj_status'] = 'N/A'
                f.seek(0)
                json.dump(data, f, indent=4)
                f.truncate()
        return redirect(url_for("_pin_id"))

@app.route('/video_feed')
def video_feed():
    return Response(gen_frames(), mimetype='multipart/x-mixed-replace; boundary=frame')
```

```
@app.route('/read')
def _pin_id():
    filename = os.path.join(app.static_folder, 'data.json')
    with open(filename) as f:
        data=json.load(f)
        barcodeData=data['qr_code_rec']
        obj_status=data['obj_status']
        if barcodeData!='N/A':
            print(str(barcodeData)+" "+str(obj_status))
            return str(barcodeData)+" "+str(obj_status)
        else:
            return "-1"

if __name__=='__main__':
    app.run(host='192.169.1.9’)
```

2) boot.py

```
# This file is executed on every boot (including wake-boot from deepsleep)
#import esp
#esp.osdebug(None)
import uos, machine
#uos.dupterm(None, 1) # disable REPL on UART(0)
import gc
def do_connect():
    import network
    sta_if = network.WLAN(network.STA_IF)
    if not sta_if.isconnected():
        print('connecting to network...')
        sta_if.active(True)
        sta_if.connect('internet1', 'a1z5h1a0g6u9')
        while not sta_if.isconnected():
            pass
    print('network config:', sta_if.ifconfig())
```

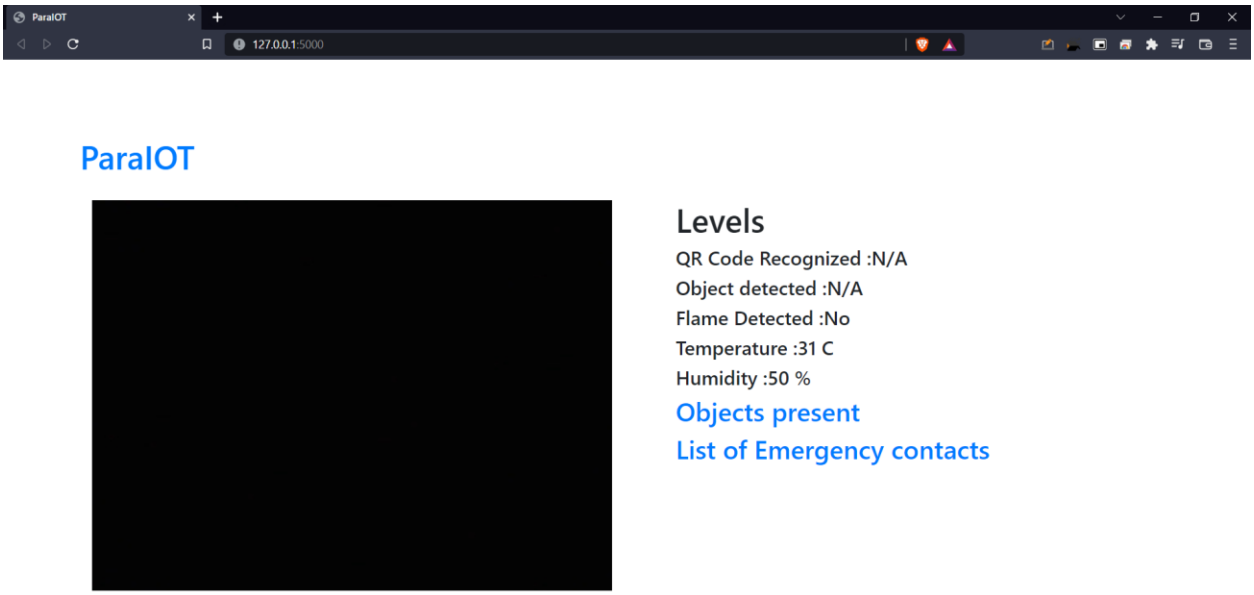
```
#import webrepl

#webrepl.start()
do_connect()
gc.collect()
```

3) main.py

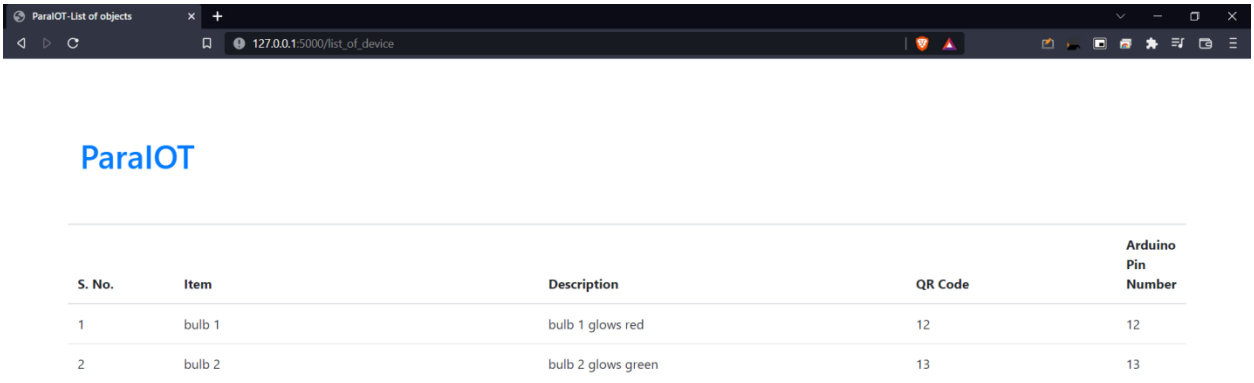
```
from machine import Pin
import time
import urequests
print(urequests)

print("Hi")
while True:
  resp=urequests.get("http://192.168.1.9:5000/read")
  print(resp.text)
  if resp.text!="-1":
    pin,status=resp.text.split()
    led=Pin(int(pin),Pin.OUT)
    led.value(int(status))
  else:
    pass
```

## APPENDIX- A2 SCREENSHOTS

1) Home webpage

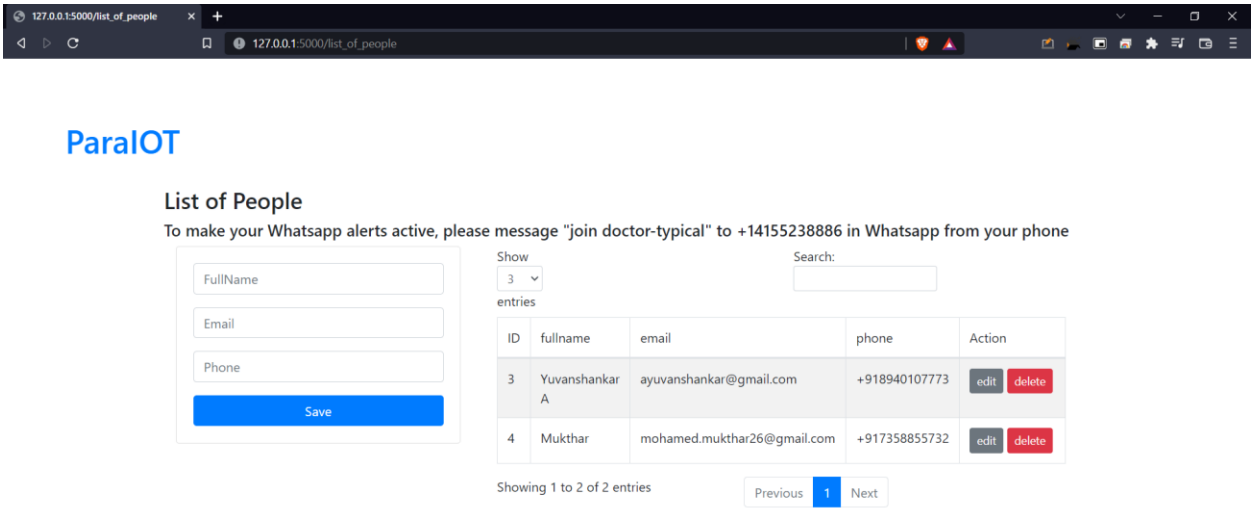



2) Webpage to show the objects present

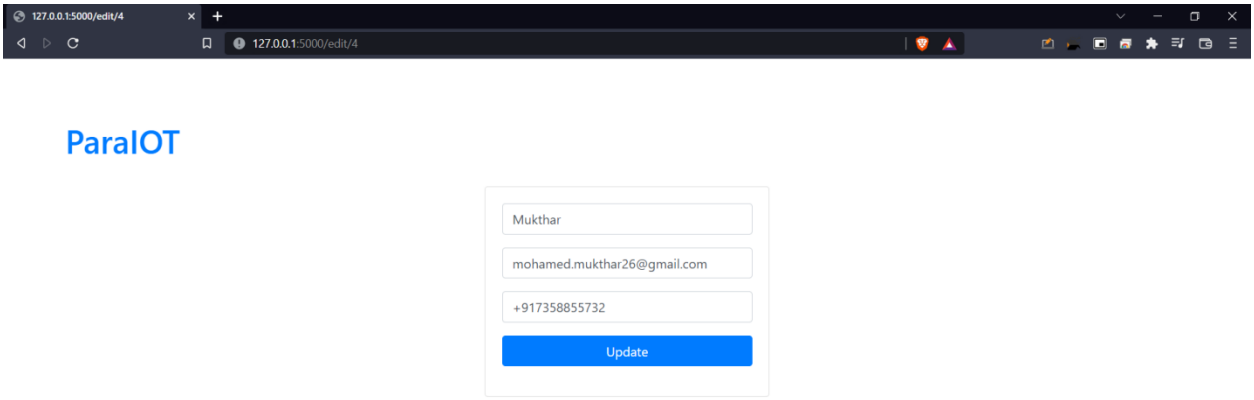



| S. No. | Item | Description | QR Code | Arduino Pin Number |
|---|---|---|---|---|
| 1 | bulb 1 | bulb 1 glows red | 12 | 12 |
| 2 | bulb 2 | bulb 2 glows green | 13 | 13 |

3) Webpage to show the list of emergency contacts




4) Webpage to edit the details of contacts



# CHAPTER 9
# TECHNICAL BIOGRAPHY

**MR MOHAMED MUKTHAR (180071601115)** was born on 26th June 2000, in Dubai, UAE and is currently pursuing his Bachelor's Degree (B. Tech) in Computer Science and Engineering Department at B. S. Abdur Rahman Crescent Institute of Science and Technology. His areas of interests are Internet Of Things and Database Management systems. His E-mail ID is mohamed.mukthar26@gmail.com and his contact number is +917358855732.

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