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AMRITA SCHOOL OF ENGINEERING

21AIE211
INTRODUCTION TO COMPUTER NETWORKS
PROJECT REPORT
Raspberry Pi Alexa: Build your own Amazon Echo and Smart home

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ABSTRACT

Keywords - Raspberry pi, Sensors, Bread Board, API's - Application programming interface, Speech Recognition - Google Cloud Speech API

We are going to build a voice based home automation system from scratch using raspberry pi and some of the sensors. We have coded our program in python which helps to understand the voice commands given by the user and perform the respective actions and also the user receives some important messages through telegram bot which we have created. We will use different API's available in python to get various real time information like Google Cloud Speech API to convert the voice command into text, weather API to get real time temperature and weather and also some other libraries to get the present time and day.

So, in this project, we are going to build a Alexa kind of Raspberry-Pi based Voice Assistance that can listen, respond, and control a few things. We have directly performed Speech Recognition on Raspberry Pi, so we can directly connect a microphone to our Pi and speak into it and in this report we will be talking about how we will be implementing our project and the areas where we can improve our implementations.

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Chapter 1

INTRODUCTION

We have used different components to perform different activities. We have divided our implementations into two parts

1. Voice assistance based control
2. Message based control

So we have divided the implementations among two different raspberry pi's in order to not to make the pi overload. We will be mention separately about which software and sensors/component is integrated and used to which raspberry pi but most of the procedures will be same for both.

1.1 Components and Software's

1. **Raspberry Pi** : we are using Raspberrypi 3B.
2. **SD Card** : You need to insert an SD with an OS into the Pi which helps to store the data and perform some actions.
3. **Raspbian** : Raspbian is a Raspberry Pi OS software which you can download from their official website. You need to boot your SD card with the Raspbian you can even use different OS based on your requirement.
4. **Python** : We will use python language for coding the Voice Assistance logic.

5. **Mic** : There are different types of microphones. In our project, we will be using a USB microphone, so that we can directly connect it to the computer, in our case to a raspberry pi. you can even try to use a Bluetooth microphone.
6. **Speaker** : We are going to use a 3.5 mm jack pin to connect the speaker to our raspberry pi.
7. **Bread Board** : To connect different sensors to the pi.
8. **LED** : To symbolically indicate we can turn on the lights.
9. **Resistors** : To control the output power from the pi to the other sensors.
10. **Telegram** : Telegram is a communication software just like whats app. We can create some bot's in telegram. We will be using those bot's to send alert messages and also to remotely control the home appliances.
11. **USB Camera** : We have used a USB Camera picture which can be directly connected to the pi
12. **Jumper Wires** : To connect the breadboard and the sensors with the pi.

1.2 Integrating the components

Now we have all the required components in a basket but of no use unless they work together. So, lets try to integrate the components. Make sure that the Pi is having proper power supply and SD card is booted properly. We will be viewing the Pi's GUI using the VNC viewer software and note that Pi should have internet access.

1.2.1 Mic and the Pi

We can directly insert the Mic's USB cable into one of the ports available. To find whether the microphone is connected to the raspberry pi or not type the following command in the terminal:

```
alsamixer
```



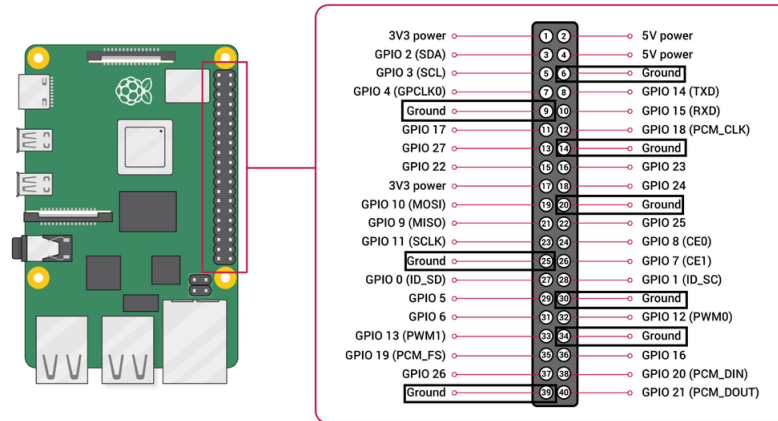
1.2.2 Speaker and the Pi

Even for the speaker we can directly connect it to the 3.5 mm jack and can cross check by using the same command whether it is connected or not.

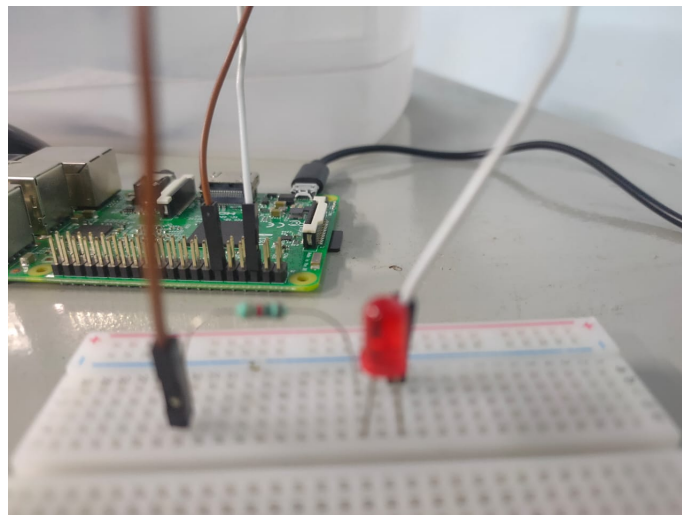


1.2.3 Connecting LED

Here we will be using RasperryPi's GPIO pins to control the Lights.



Here we are using a ground and GPIO 18(PCM_CLK) is used as our Output pin.



1. Take the LED and check the 2 legs. You will see that one is shorter than the other. You need to connect the shorter leg to the ground, and the longer to any other connector.
2. Plug one leg of the resistor to the same line as the longer leg of the LED, and the other leg of the resistor to a different line.
3. Finally, to close the circuit plug one wire between the same line as the other leg of the resistor, and to one of the GPIO pin.

1.2.4 Camera and the Pi

We have integrated a camera with the raspberry pi which send a live photo to the user when requested thorough a message via telegram. The first command helps to install the

required module and the second command helps to take a picture and save's the file with the given name

```
sudo apt-get install fswebcam  
fswebcam test.jpg
```

we can even customize the the location by passing the location.

Chapter 2

Voice Based Home Automation



2.1 Speech to Text and Text to Speech

We will be using few libraries available in python to convert our voice command into the text command and also the text into speech.

2.1.1 Speech to Text

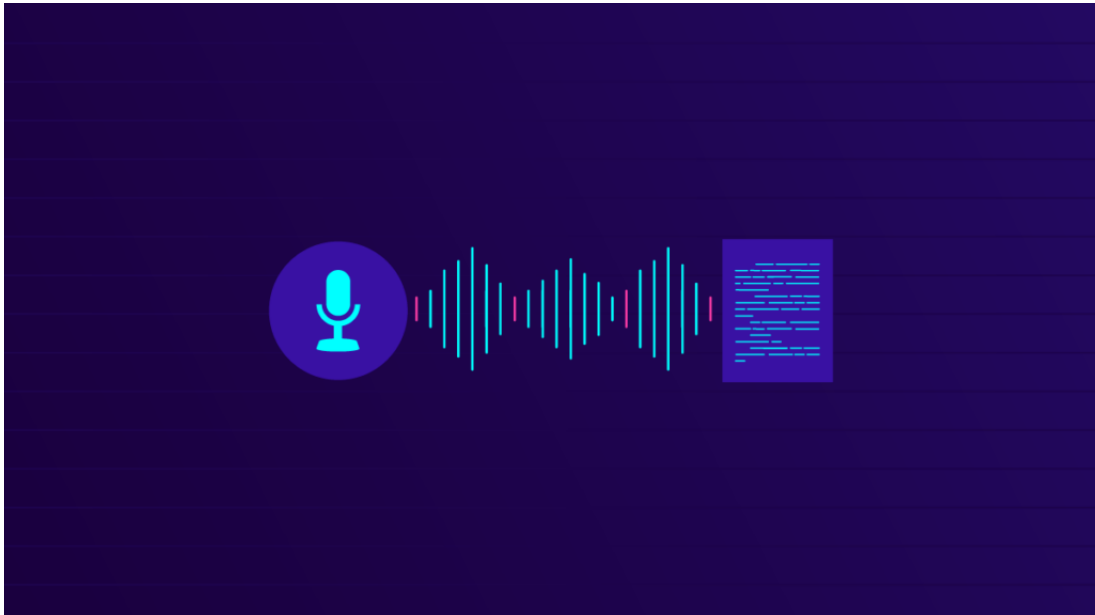
Speech recognition has its roots in research done at Bell Labs in the early 1950s. Early systems were limited to a single speaker and had limited vocabularies of about a dozen words. Modern speech recognition systems have come a long way since their ancient counterparts. They can recognize speech from multiple speakers and have enormous vocabularies in numerous languages.

The first component of speech recognition is, of course, speech. Speech must be converted from physical sound to an electrical signal with a microphone, and then to digital

data with an analog-to-digital converter. Once digitized, several models can be used to transcribe the audio to text

To install these libraries type the following commands in the terminal:

```
sudo pip3 install PyAudio  
sudo pip3 install SpeechRecognition
```



2.1.2 Text to Speech

The **eSpeak NG** is a compact open source software text-to-speech synthesizer for Linux, Windows, Android and other operating systems. It supports more than 100 languages and accents.

FEATURES

- Includes different Voices, whose characteristics can be altered.
- Can produce speech output as a WAV file.
- Compact size. The program and its data, including many languages, totals about few Mbytes.
- Can translate text into phoneme codes, so it could be adapted as a front end for another speech synthesis engine.

To install the library type the following command in the terminal:

```
sudo apt-get install espeak
```

Use the following command to test espeak.

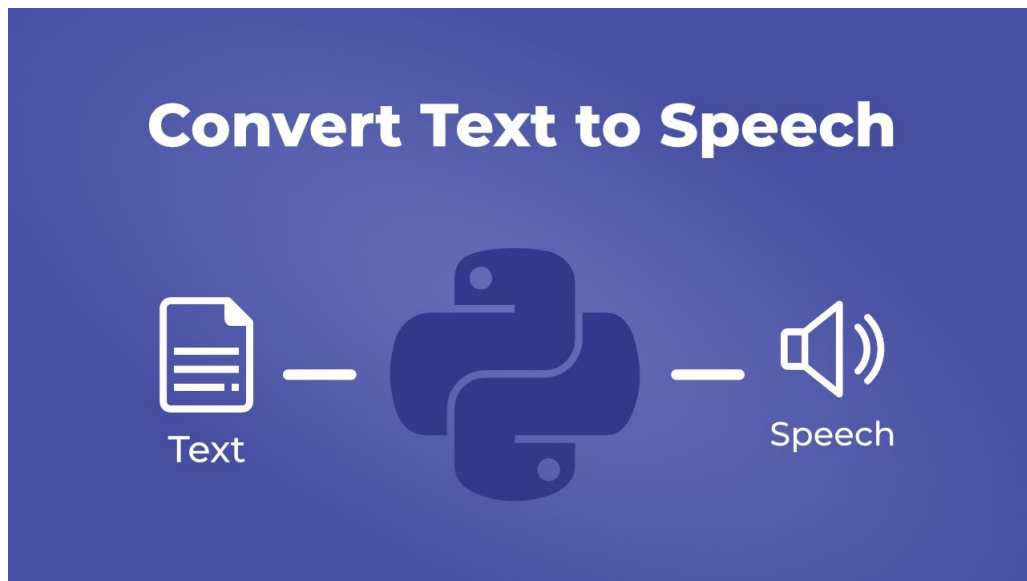
```
espeak 'hello world'
```

If it is installed correctly, you will hear 'hello world'.

2.1.3 Importing Modules

We need to import the speech recognition and some other needed modules, which are used to convert speech to text and text to speech.

```
from subprocess import call  
import speech_recognition as sr
```



2.2 Day and Time

We are importing datetime into our python script and we will be using those libraries to get the data and time. So , it will read out the date and time.

2.3 Weather and Temperature

we are using an API called Open weather . which will give the climatic details of a particular city which we have entered. In this case we have used "Coimbatore". So the Openweather API give the resonances according to the Coimbatore City.



2.4 Light ON and OFF

In this home automation we are controlling the lights in the house using the Alexa based voice controller. It turns on lights when we speak "LIGHTS ON" and it turns Off lights when we speak "Lights off".

2.5 Playing Music

When we say "music" to the Alexa based voice controller , the music command will get executed and it will play some music for 10 seconds. we have created a function for the music alone which contains the code for playing the music. we have to import VLC to play the music.

2.6 Jokes

We have imported Pyjokes , which is a module for jokes. So when called , it send it some random jokes.

2.7 wikipedia search

When there is "Who is " in what we speak, it will search for that in the wikipedia and then the espeak module will speak it out.

2.8 News

When there is a word "news" in the voice command it reads out the latest new titles randomly from the web. We use *request* module to get a .json file which contains the latest new titles and selects a random news and reads it loud.

2.9 Stock Price

When there is "my stock" in the voice command it sends and reads the livestock price of the stocks present in the users portfolio. We have hard coded few stocks for easy use. We will be using *yfinance* module to get the live updates. We will be also sending a telegram message to the user with the current price and recommendation whether we could buy the stock or not.

In the next chapter 3 we will explain in detail that how we use telegram to send messages. Below is the message sent to the user when he commanded this request.



Figure 2.1: Message of current stock price

2.10 Telegram Messenger

In home automation we are using this telegram messenger to send the schedule of that particular day when we ask "Schedule" in the mic to the telegram chat.

This is a sample of Schedule which was sent on tuesday.



Figure 2.2: schedule

And this will also send messages to the **"MOM or DAD"** when spoken. And it will send the message what we have told to that particular person via the telegram.

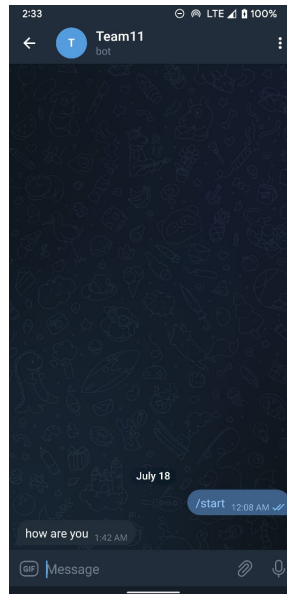


Figure 2.3: Dad's message



Figure 2.4: Mom's message

Chapter 3

Integrating Telegram

Telegram is a freemium, cross-platform, cloud-based instant messaging service like whatsapp. Telegram Bots is a program that behaves like a normal chat partner with additional functions. Due to the app's flexibility we can create our own telegram bot for free of cost. We will be using the bot to communicate with the user. We have created 2 bots one is for Voice based control and Message based control.

3.1 Creating Bot's

BotFather is a bot which is available in telegram which helps to create new bot's. You can normally start the conversation with it and follow the given instructions by the bot.

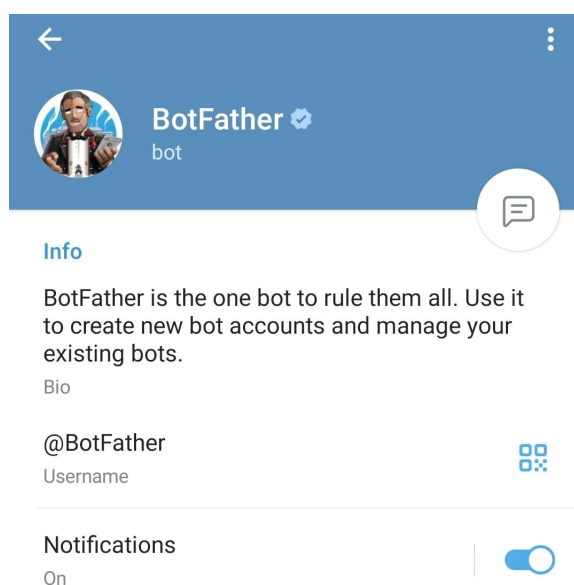


Figure 3.1: Information about Bot Father

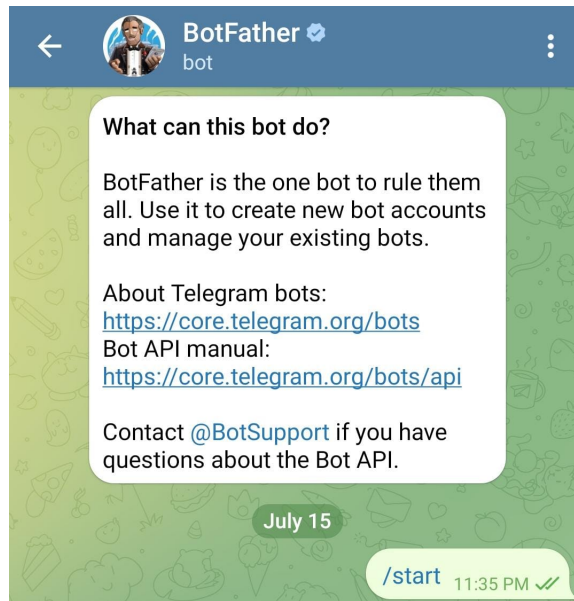


Figure 3.2: Starting the bot father

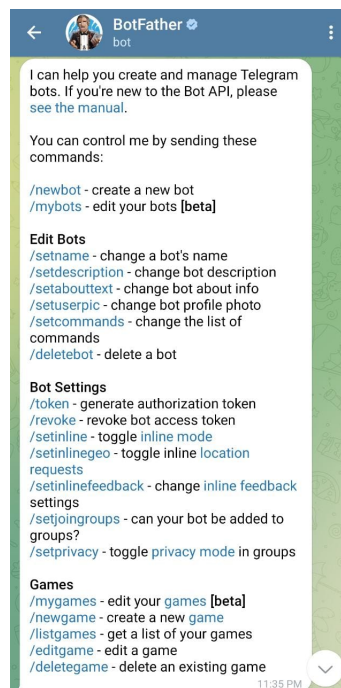


Figure 3.3: Bot Father options

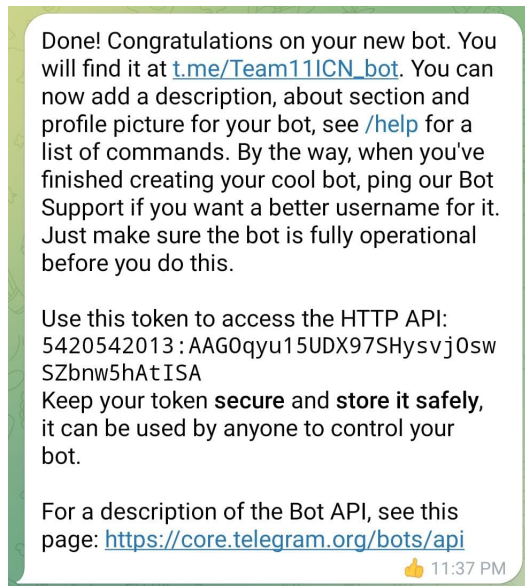


Figure 3.4: Bot successfully created message

Save the HTTP API token for later use. It helps to connect with the python codes.

3.2 Modules used to connect Bot and Python codes

There are some python modules which helps to establish a connection and also to communicate between the bot and the python script. We will be using 2 different modules:

- telegram - For one way communication (Voice based control part)
- telepot - For two way communication (Message based control part)

Mostly both of the modules will have same commands and works in the same way. You can normally import the both the telegram and telepot modules

3.2.1 Basic commands for telegram module

The below command helps to import the module

```
import telegram
```

Storing the Bot's API token and the telegram user's ID

```
api_key = '<your api key here>'
user_id = '<your user id here>'
```

The below first command helps to connect the bot and python scripts and the second command helps to send messages

```
bot = telegram.Bot(token=api_key)
bot.send_message(chat_id=user_id, text='Hello There!!')
```

3.2.2 Basic commands for telepot module

The below command helps to import the module and the required functions.

```
import telepot
from telepot.loop import MessageLoop
```

The below command helps to connect the bot and python scripts

```
telegram_bot = telepot.Bot(<BOT API ID>)
```

The action function invokes when a user sends messages to the bot and stores the user's ID and the text sent by the user.

```
def action(msg):
    chat_id = msg['chat']['id']
    commandIrregular = msg['text']
```

Chapter 4

Message Based Home Automation

We have used message based Home Automation i.e Telegram. So we will be controlling the Home appliances or interacting with people using the telegram.

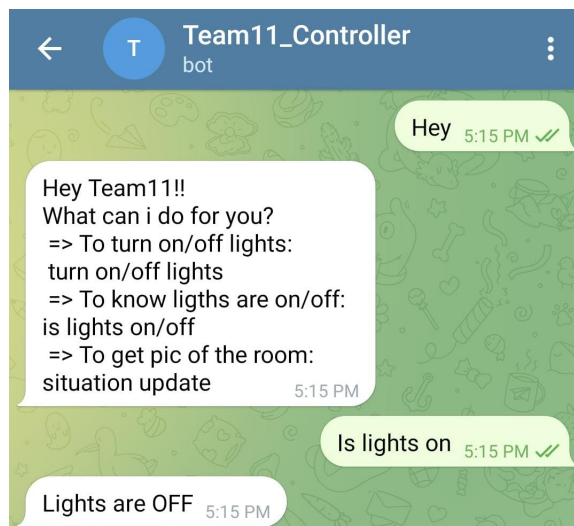


Figure 4.1: These are the commands to be used

4.0.1 Turn on/off lights

We are controlling the LED lights using the telegram bot. It switches on the light when we send and command to "switch On lights" and wise versa. It will also send us a message weather the light is switch on or off when we send a query in the telegram.

4.0.2 Situation Update

It will also send situation update of the house when we enter the command "situation update" it will send the snap shot of the house in our telegram bot.

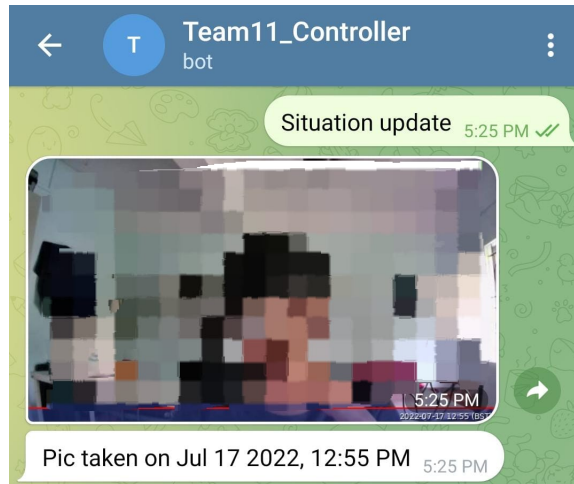


Figure 4.2: This is a sample pixelated image

Chapter 5

Conclusion

We have successfully tried to implement the some of the functions of Home automation and Voice assistance. Where we can turn on/off light through a voice command and also by a text command when you are away from the home. Using some of the python API's we can even have a funny conversation or you even know whats happening in world with the help of voice assistance we have build. But there some limitations n our project. So we have tried to predict some of the advantages and disadvantages of home automation systems in terms of security, convenience, and costs.

5.1 Advantages

In USA there are around 22 million homes either use IoT or smart technology to make life easier.

5.1.1 Ease of Access

Ease of access is a huge advantage if you have a smart home. If you forget to turn off your geyser after a warm shower or leave the AC remote somewhere and can't find it, you can make things work remotely via the voice-activated system or an app. Home automation technology is an effective way to get things done easily, even if you are not at home.

5.1.2 Energy Savings are the advantages of Home Automation worth mentioning

You can save more on your electricity and utility bills as your home is equipped with automated monitoring systems that let you use the technology efficiently. Most smart devices are based on human technology and power off automatically after sensing your absence. So, from heaters to Air conditioning systems, you contribute to save energy sources.

5.1.3 Home Automation is Necessary for patients

Doing basic things is cumbersome for people with disabilities. One of the greatest advantages of home automation is you can get things easily. You can turn lights or fans on/off, close the blinds or even lock your home from the comfort of your couch. Home automation benefits you, especially when you live on your own.

5.1.4 Better Home security

Advanced security systems are one of the main reasons why homeowners opt for automation. Technology is your best option, especially when you live in a neighbourhood with a bad reputation. The electronic locking mechanism generally operates through biometrics and voice recognition. Home automation doubles your security against thefts and break-ins.

5.1.5 Instant Notifications

Most smart homes have internet-based security systems which have their security apps. You can receive alerts on your smartphone about any mishaps or incidents in an emergency and take remedial actions to circumscribe the damage. From fire alarms to panic buttons, a smart home is the way to protect yourself and your family members from unknown dangers.

5.2 Disadvantages

Now that we have known about the major benefits of smart homes, there are many disadvantages of smart homes as well. Just as disadvantages of home appliances, your smart home system also has some disadvantages

5.2.1 Upfront Costs

Upfront costs of equipment and installation are the leading disadvantages of home automation systems. Although smart technology can help you save on your bills, it's the initial cost that can leave you surprised. The average cost of automating your simple home ranges between 1,00,000 and 5,00,000. The cost also varies based on the type and structure of your home, which can easily jump to around 15,00,000.

5.2.2 Security Concerns

Smart Homes are based on the internet technology; it's vulnerable to hacking. In addition, most systems require password-based authentication, and in case your credentials are leaked, anyone can misuse this technology and compromise your security. Getting started with private WiFi is also costly to add more to the pain.

5.2.3 Maintenance costs add more to disadvantages of Home Automation

The maintenance costs can be high as you may also need a professional to repair and look after your system from time to time. Make sure maintenance is done properly by a professionally licensed agency. If your system is not installed properly, you may have to deal with many problems, from device malfunctions to system failure. If it happens, get ready for more expenses ahead.

5.2.4 Power Supply

Devices in an automated Home require a constant power supply, which must be uniform and uninterrupted. Electricity is next to the internet to make your home perfectly smart. Before installing the home automation devices, ensure that your home is not affected by

power outages or fluctuation, which can damage smart home appliances or even put your home into a lockdown

Chapter 6

Networking Concepts Used

1. Our project is based on the Internet of Things(IoT) concept, where the devices with the sensors and software's communicate each other and exchange data over the internet.
2. To Establish communication between our Telegram bot and Python Script we have used http protocol. To communicate between the Telegram and the Raspberry pi we are using Telegram bot's which helps to connect with the python scripts and it communicates based on the HTTP, Hyper Text Transfer Protocol communication between web browsers and web servers.
3. The communication software, Telegram uses its own protocol known as MTproto where it uses SHA-256 Cryptographic Hash Algorithm.
4. The API's like weather and news works on the HTTP protocol.

Chapter 7

CODE FILES

The code files are available in the below give One Drive Link:

`https://amritavishwavidyapeetham-my.sharepoint.com/:f:/g/personal/cb_en_u4aie20027_cb_students_amrita_edu/EvJrSxL3MpNBjFYVky5X3I0BCNkBI-tfxrdFNkUCFKP5e=rjJ1td`

– END –