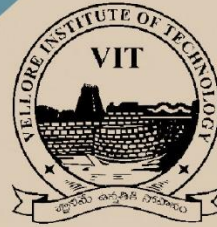


**ESC1002 -
ENGINEERING CLINICS**

FINAL REPORT



**VIT[®]
AP**



MULTILINGUAL VOICE CONTROL HOME AUTOMATION SYSTEM

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INDEX

CONTENTS	PAGE NUMBER
ABSTRACT	2
INTRODUCTION	3
BACKGROUND	4
PROBLEM DEFINATION	5
OBJECTIVES	6
COMPONENTS REQUIRED	6
BLOCK DIAGRAM AND GPIO CIRCUIT	7
METHODOLOGY	8
CONCLUSION AND FUTURE SCOPE	14
REFERENCES	15

ABSTRACT

Future homes will be designed and built using the smart-home concept, which has been around for many years. The major goals of home automation are the comfortable, efficient, and secure control, administration, and coordination of household equipment. In the project Controlling electrical devices like lamps, lightbulbs, and fans using voice instructions. The system has predefined voice instructions.

The appliances are connected to this board through relays, and the design is based on a standalone Raspberry Pi board. Artificial intelligence is being used to automate homes so that users can operate electronics devices with ease. Therefore, the issue of energy conservation may be solved, and the fundamental principle is to employ home automation without the usage of the internet. Nowadays, technology that automates tasks seems to be thriving. Technology firms are vying with one another to create an automation technology. A technology's practicality requirements end up serving as a standard for many other technologies that have been developed. This is inextricably linked to people's desire to simplify things. Home control system with incredibly clever features to make life simpler.

A home control system's major goals are to help parents and kids and to minimise human labour and electricity consumption. As wireless communication technologies advance, we may control or access home appliances from a distance. **Addition to this, we also bring the comfort of communication in one's mother tongue.** It simply makes the communication easy and fun for a person of any age and background to access the technology at their own comfort. This is because we feel people are most comfortable in their own mother tongue. This is an emotional touch added to the AI, making it more connected to the Human World. Humans don't evolve for the technology but the technology evolves itself for humans.

INTRODUCTION

Automation is a methodology, method, or system that uses electronic equipment to operate or control a process while minimising human involvement. Building automation systems for homes or offices is becoming more and more popular because of their many advantages. Industrialists and researchers are attempting to create automated systems that are effective and affordable and may be used to monitor and manage various machinery, such as lighting, fans, and air conditioners, depending on the situation. Automation uses electricity in a cost-effective and efficient manner, which substantially lowers wastage. Due of the comfort it offers, especially when used in a private house, homes of the 21st century will become more and more autonomous and automated.

A home automation system is a tool that enables consumers to operate different types of electric equipment. Home automation, which includes the control and automation of lighting, heating, appliances, and security, is the domestic extension of building automation. The majority of contemporary systems are made up of switches and sensors that are connected to a central hub, commonly referred to as a "gateway," from which the system is managed by voice commands. The elderly and disabled are the primary end users of home automation systems, which are increasingly gaining popularity worldwide.

The use of smart home technologies is spreading across the nation's houses. Almost every household has some sort of automated tool, whether it be a few smart appliances or a whole smart-home system. However, despite this, many people are still unaware of how useful this technology may be in our day-to-day activities. Discover some of the major benefits of having a voice-activated home automation system.

You'll have more control over how much energy your house uses at any one time if you have the voice control feature for your thermostat and lighting. You'll be able to live more affordably and save money as a result. Additionally, it will make it simple for you to keep informed about the general climate in your house and make adjustments.

BACKGROUND

People nowadays are looking for ways to make their lives better by utilising the most recent technologies. Over the past ten years, various home automation systems have become more and more popular since they increase comfort and quality of life. The proposed work investigates an intelligent home automation system (iHAS) that enables users to remotely monitor house electrical equipment. Using a laptop, Android smartphone, or tablet with internet connectivity, this system may be used to explain how all household appliances work together and control them. Without making any infrastructure adjustments, the home automation system can be implemented in current home environments. In this study, the design and implementation of a voice enabled microcontroller-based individual control home automation device were investigated. Using simply a microphone and an internet connection, the user can have total control over the equipment and appliances in the home from any location.

All household appliances are connected to smart home automation systems that are based on the Internet of Things. Electronic devices such as a laptop is available for users to use to communicate with smart home automation systems. Users may converse with smart home automation, though, in their own language, which enables the command-and-control mechanism to work more swiftly. The steps required to incorporate a cloud-based voice recognition system into smart home automation are described in this paper. A cloud-based speech recognition technology enables voice commands in smart home automation. A voice control module has been added to process the output of the speech recognition system based on the established command sets.

A conversational AI technology called voice AI employs voice commands to hear and understand instructions. With the use of this technology, gadgets may communicate with one another and answer questions from users in natural language. Understanding the speaker's speech is the initial step in the procedure. To separate the speaker's sound waves into text fragments, they must be evaluated and analysed. The AI classifies the user's words into groups. The words are changed during this procedure into bits that the system can easily comprehend. There is a risk that the AI will take up some background noise in addition to the user's spoken words and also it can misinterpret the words. The AI can use a neural network to isolate the message from noise because it is sensitive to such pitches. To discover the best match, the system further breaks down the set of data that it receives. The AI reads and analyses every letter of the message in an effort to determine the content of the text and match it with the most appropriate responses.

Voice AI is now prepared to take action. The AI thoroughly considers the user's inquiry before drawing a certain set of conclusions. In order to locate the ideal match for the question, the algorithm filters the responses and further analyses the most promising solution. The user is informed of the chosen response in the final phase. In this case, the user gets the answer to their query as AI simultaneously turns the data into audio format. Additionally, the AI stores the response for later use.

PROBLEM DEFINATION

People nowadays are looking for strategies to improve their lifestyles by utilising the most recent technologies. The customers seize on any new amenity or hopeful item that promises to improve their way of life. It becomes inevitable to have simple and practical techniques and means to control and operate these appliances when more of these facilities and appliances are added. Traditional wall switches need to be manually turned on or off in order to operate multiple appliances because they are dispersed across a home. Monitoring the operation of running appliances and keeping track of them becomes nearly difficult.

It's important to take care of turning off the appliances in addition to monitoring how they're operating. Humans frequently make mistakes when turning off appliances when leaving a room or location, which results in higher energy usage even when it might have been reduced.

Home automation can proof to be a saviour for differently abled people as their voice command can enable them to use the appliances according to their needs, enabling them to be more independent.

OBJECTIVES

Innovation is a journey to be experienced; it is not a destination. Our daily lives are including smart home products, which have a very bright future. Many people are looking for new solutions to control these items. A Voice Controller based Smart Home Automation System has been introduced in this study work. The controlling brain, which relies on programming instructions, is a Raspberry Pi board. Hindi, Assamese and English have been incorporated into the programming. Having these automated and incorporated into a voice controller would make it easy to access from any corner of the house. With the comfort of using your own language, you can also take a step towards conservation of electricity. Furthermore, it would advance our ability to conserve electricity by allowing us to turn off equipment with simply a voice message. This would lower the cost of our electricity bill.

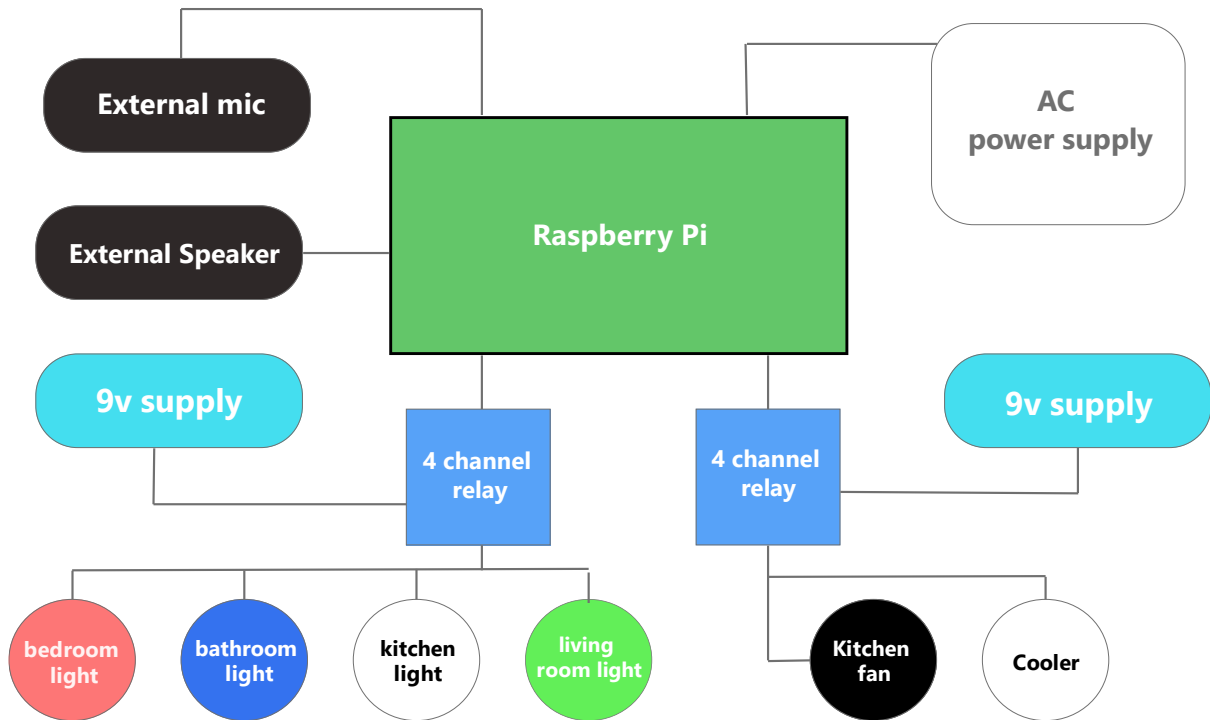
The purpose of adopting a voice-controlled system for home automation is to give the user access to a straightforward, safe, and easily customizable home automation system. The Raspberry Pi home automation project enables users to operate a variety of indoor electrical items. It would make the usage of appliances much more accessible to differently abled people for operating at their own ease instead of having to ask another person for help.

Our lives are made easier by the remote control for TVs and other electrical devices. The gadgets and electrical appliances in our houses can be protected in the same way. With the aid of a home automation project, we may effortlessly access our house appliances while sitting at home. Nowadays, every person in the house owns an Android-powered smartphone. Android phones enable us to control electrical appliances like lightbulbs, fans, and other machines. An additional benefit of Raspberry Pi is provided for the home automation project.

COMPONENTS REQUIRED

1. Raspberry Pi 4
2. SD Card
3. Mic
4. Speaker
5. (4 Channel Relay) X 2
6. Jumper wires
7. Breadboard

BLOCK DIAGRAM AND GPIO CIRCUIT



Raspberry pi GPIO pin descriptions

	Function	BCM	Physical Pins		BCM	Function
			pin#	pin#		
	3.3 Volts		1	2		5 Volts
	GPIO/SDA1 (I2C)	2	3	4		5 Volts
	GPIO/SCL1 (I2C)	3	5	6		GND
	GPIO/GCLK	4	7	8	14	TX UART/GPIO
	GND		9	10	15	RX UART/GPIO
	GPIO	17	11	12	18	GPIO
	GPIO	27	13	14		GND
	GPIO	22	15	16	23	GPIO
	3.3 Volts		17	18	24	GPIO
	MOSI (SPI)	10	19	20		GND
	MISO(SPI)	9	21	22	25	GPIO
	SCLK(SPI)	11	23	24	8	CEO_N (SPI)
	GND		25	26	7	CE1_N (SPI)
	RESERVED		27	28		RESERVED
	GPIO	5	29	30		GND
	GPIO	6	31	32	12	GPIO
	GPIO	13	33	34		GND
	GPIO	19	35	36	16	GPIO
	GPIO	26	37	38	20	GPIO
	GND		39	40	21	GPIO

METHODOLOGY

Installing Raspbian OS



The technique of this challenge design consists of implementation of the proposed approach. As part of the Methodology, there are a few fundamental steps involved. The first primary step is to download Raspbian Operating System into a SD card by using raspberry pi disk imager which then connected to raspberry pi.

USB Microphone

In our project, the USB microphone, which we are using, does this (A/D) precise operation and it also has an inbuilt amplifier which makes it unnecessary to use an external preamplifier circuit. So, by using a USB microphone, we can directly connect it with a computer, and in our case to a raspberry pi.

Connecting USB Microphone with Raspberry Pi

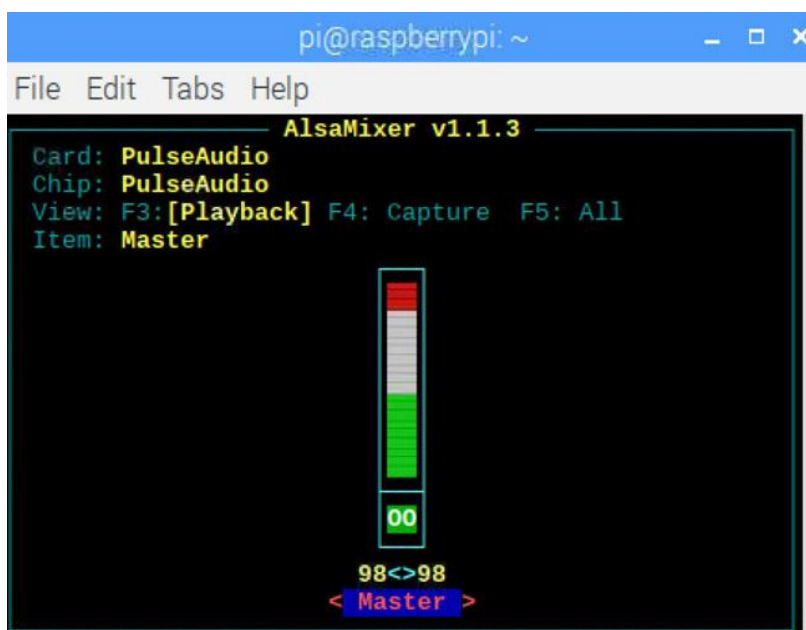
We need to find whether the microphone is connected to the raspberry pi or not. The following command is used in LX-terminal to check it.

```
alsamixer
```

After entering the command, you will get the following dialog boxes.

From there, access the UI by controlling the arrow keys (up/down arrow keys). Select the microphone from the given list using F6 and set the recording volume by using the arrow keys.





To test the microphone, use the LX-terminal and record your clip.

Use the following command to start recording. The recording will be saved in the test.wav file.

```
arecord -D plughw:1,0 test.wav
```

To play the test.wav file, enter the following commands in the terminal.

```
aplay test.wav
```

This way, you can check if the microphone is connected and working properly with your Raspberry Pi.

Speaker

The speaker works on the same mechanism as a microphone but in reverse. A microphone converts the sound waves to electrical signals while the speaker converts the electrical signals to soundwaves. Cone, an electromagnetic coil, and a permanent magnet are the main components of the speaker. The permanent magnet is fixed to one end while the electromagnet is movable. The electromagnet is placed in front of a permanent magnet. The electromagnet is attached to a cone made of flexible material (paper or plastic), which is used to amplify the vibrations. When pluses are given to electromagnet, it gets attracted and repelled from the permanent magnet. As the electromagnet is vibrating to and fro, the cone attached to it also produces vibrations, thereby producing sound. The pitch of the sound produced depends upon the frequency of vibrations, and the volume depends on the amplitude of the vibrations. Here, we are going to use a 3.5 mm jack pin to connect the speaker to our raspberry pi. The speaker shown below has an AUX option, you can use any speaker that works with raspberry pi.



Libraries required for Speech Recognition on Raspberry Pi

Before we enter into the coding, we need to install certain libraries that will ease our coding. The Espeak library is used to convert **text to speech on Raspberry Pi** and the Speech Recognition library is used to perform **Speech to Text with Pi**. The PyAudio library is needed to get data from the USB microphone. The following commands are used to download the necessary libraries.

```
sudo apt-get install espeak  
sudo pip3 install SpeechRecognition  
sudo pip3 install PyAudio
```

Use the following command to test espeak. If it is installed correctly, you will hear 'hello world'.

```
espeak "Hello world"
```

Raspberry Pi Speech Recognition Program

The complete **program for speech recognition with Pi** can be found at the bottom of this page, an explanation of the code is as follows. We begin by importing the speech recognition modules and other needed modules, which are used to convert **speech to text** and **text to speech**. After importing these modules, we have to import the GPIO module, which controls the pins of the raspberry pi.

```
import speech_recognition as sr
```

The code given below is a function, which deals with the listening of the phrases that we speak. This program waits until the user gives input (speech). When the user says something, it stores that information in the “audio” variable and returns that information.

```
def listen1():  
    with sr.Microphone(device_index = 1) as source:  
        r.adjust_for_ambient_noise(source)  
        print("Say Something");  
        audio = r.listen(source)  
        print("got it");  
    return audio
```

The below code is a function that accepts the audio1 variable. It recognizes our voice using **google speech API** and then prints our speech in string format on the screen.

```
def voice(audio1):  
    try:  
        text1 = r.recognize_google(audio1)  
        print ("you said: " + text1);  
        return text1;  
    except sr.RequestError as e:  
        print("Could not request results")  
        return 0
```

The code which is written in the main function is used to deal with the listening of the phrases, which is then converted to text using speech to text module, and then gives feedback using Espeak.

```
def main(text):  
    audio1 = listen1()  
    text = voice(audio1);
```

The if and elseif conditions given below are used to check whether the string in the text variable is either “light on” or “light off”. If the string inside the text variable is light on, then the if function gets satisfied.

The code inside if function is used to send high value to the pin name led (PIN 27). After sending the high value to the pin, we use espeak that transfers text to speech, which is used as feedback. If the string inside the text variable is light off, then if condition will not be satisfied leading the program to check for the elif condition. If the elif condition gets satisfied (if the string inside the variable “text” is light off), the program enters the code which is written inside the elif condition. The code inside the elif function is used to send low value to the pin named led (PIN 27).

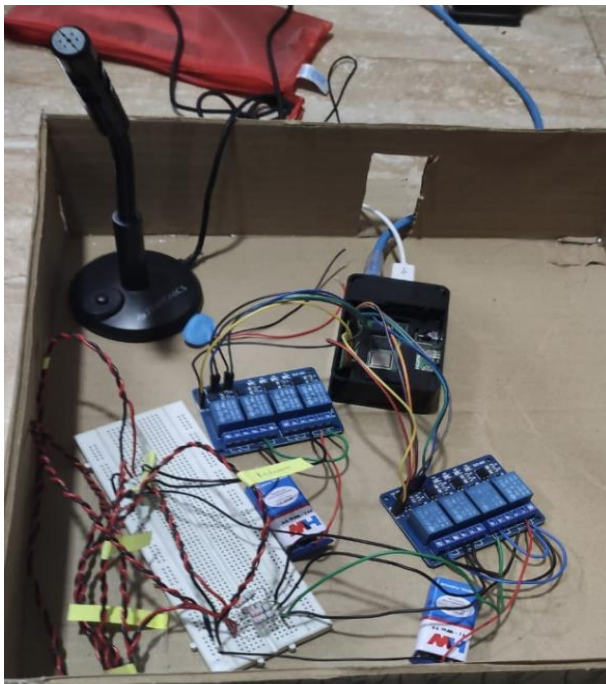
```
if 'bedroom light on' in text:
    GPIO.output(led1 , GPIO.LOW)
    call(["espeak", "-s140 -ven+18 -z" , "okay Sir, Switching ON Bedroom
Lights"])
    print ("bedroom lights on");
elif 'bedroom light of' in text:
    GPIO.output(led1 , GPIO.HIGH)
    call(["espeak", "-s140 -ven+18 -z" , "okay Sir, Switching Off
bedroom Lights"])
    print ("bedroom Lights Off");
```

The code given below is the one that runs first. When the python interpreter is running the module, it sets the `__name__` variable to a value “`__main__`”. The below code deals with listening and comparing the “text” variable. The code is given below acts as the code to keep the main program in standby mode until the raspberry pi listens to the triggering phrase. When the raspberry pi captures the triggering phrase, it allows the program to enter the main code, which is defined in another function named `main()`.

```
if __name__ == '__main__':
    while(1):
        audio1 = listen1()
        text = voice(audio1)
        if 'alexa' in text :
            text = {}
            call(["espeak", "-s140 -ven+18 -z" ," Hello sir, waiting for your
command"])
            main(text)
        elif 'Alexa' in text :
            text = {}
            call(["espeak", "-s140 -ven+18 -z" ," Hello sir, waiting for your
command"])
            main(text)
```


Controlling electrical appliances through Voice Commands on Pi

At idle conditions, the raspberry pi keeps on checking for the phrase which triggers the code. In our case, our triggering phrase will be “Alexa”. We wrote our code in such a way that when the user speaks the triggering phrase- Alexa, it triggers the remaining part of the code. The program will further run, which deals with the listening of the audio and executing the commands (which turns on/off the lights depending on the commands it listens).



The complete working is also shown. If the user says the predetermined phrase, the function to switch on/off the lights will be satisfied and runs the inner code and the output will be either switching the bulb on or off, which depends on the command. After raspberry pi performs an action to switch on or off, we can hear feedback in the form of audio from the speaker. On listening to the first phrase after the triggering phrase, the raspberry pi will again get back to its initial condition and wait for the triggering command and the same process gets repeated again and again. By this, we can add this voice-controlled system using raspberry pi to our project arsenal. It may not be the same as google home mini, but it is good to have our own voice-controlled device, which can even give feedback in the form of voice.

CONCLUSION

In this project, voice commands are given to the voice assistant. The voice commands for the voice assistant were introduced using a Python-based NLP (Natural Language Processing) speech to text recognizer. In this home automation, user have given commands to the Voice assistant using external mic in English as well as in regional languages (Hindi, Assamese), Home appliances including bulbs, fans, and motors are operated in accordance with the commands provided. The instructions given via the voice assistant are decoded and then despatched to the GPIO pins in Raspberry pi and it control the relays. The tool connected to the respective relay grew to become On or OFF as according to the customer's request to the Voice Assistant and the utility is installed thru Wi-Fi (Internet). There has been high-quality growth inside the home automation zone, and plenty of reputed groups utilizing their possibility to work with IFTTT (If This Then That) to supply a fashionable manner to attach families to their houses. It can be utilized to create smart homes in all different kinds of residences. This home control system is particularly practical in daily life because it lessens the burden on humans, conserves electricity, and allays working people's concerns about home security. As a result, it solves numerous issues like expenses, rigidity, security, and so forth. Additionally, it will offer more benefits that make it impossible to resist while lowering our energy costs and enhancing home security. It is also quite convenient to use and might improve the comfort of our home lives. A creative IoT prototype for home automation is provided by connecting relays and other devices to a Raspberry Pi board, which enables remote control of the gadgets in a practical setting. Raspberry Pi demonstrates to be a wise, economical, and environmentally friendly platform for imposing home automation. The device is adaptable and programmable, supports a wide range of peripherals and add-ons, and offers a big selection of programmes. The device can be accessed from any internet-based device, including mobile devices.

FUTURE SCOPE

There are a variety of enhancements that could be made to this system to achieve greater accuracy in sensing and detection.

- 1) A pressure sensor can be used outside the house to determine when someone is coming in to increase the home's security and control.
- 2) The solenoid door lock will operate if the user commands it to be locked.
- 3) An automated garage that can measure the length of a car and choose the best block to put it in, and then automatically navigate the car through the garage for the homeowner to make parking easier.
- 4) Change the temperature from your phone when driving home from work or while lying in bed.
- 5) Setting the thermostat to warm the room, gradually increasing the brightness of the lights, making sure the coffee is brewing, and turning on the television.

REFERENCES

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