SPEECH CONTROLLED HOME AUTOMATION WITH RASPBERRY PI USING IOT TECHNOLOGY

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Abstract
Home automation has been increasingly important in people's daily lives in recent years. We will not be able to live in this world without home automation. This study is very important just because unnecessary utilization of home appliances involves huge cost and it helps to reduce substantially the cost of the resources. The home automation process facilitates physically challenged persons to operate the appliances using voice recognition with speed control so that independently handle the devices in an efficient manner. The major limitation in utilizing the home automation is that the illiterate people will not be able to use this opportunity of evolving home automation procedures. Rather than only switching activities, this article touches on sophisticated and safe life at a reduced cost and with ease to monitor, regulate, and schedule home appliances. The major purpose is to use IOT (Internet of Things) and an audio device to monitor and manage the speed of home electric devices. Electric devices are connected to the Internet of Things, allowing us to regulate the mixer grinder's tempo and monitor the item from anywhere. Instead of just being operated by several remote controllers, a transmitter will handle the item with just one. The operator is in charge of voice commands that are used to perform various tasks. The mixer grinder speed was automatically controlled from speed 0 to speed 5 utilizing speech recognition using English language. The numbers 0 and 1 signify ON and OFF, respectively, and the other represents the speed of the mixer grinder, which ranges from 2 to 5. The testing was completed, and half of the results showed 100% accuracy, with the remaining results showing well over 50% and above. It will provide correct function a quiet environment when it pertains to functionality.
Keywords: Raspberry Pi3, Voice controller, Android OS, Wi-Fi, AC Motor

1.Introduction

IOT is growing rapidly and efforts have been made in the area of Smart Home Automation. With the advent of IOT the devices are interconnected intelligently for the functionality of the operator. We do have small sensor operation to function the very high-cost devices which is not affordable for ordinary citizens and using Raspberry pi based on Android app voice recognition. There are many products available in the markets using the smart phone with android app. We can easily use the home appliances using voice recognition can able to operate which is affordable even for an ordinary citizen who would like to use this kind of voice recognition functionality. Under this concept it is very easy and simple to use voice-based command when compare to text-based commands to operate the appliances. The objective of this paper for there who are older and disabled can able to use their voice to operate the appliances. This study focuses on building a cost-effective system, easy to perform a task, and user -friendly.

The research being done on a monitoring platform that incorporates on Iot (Internet of things). The study's major purpose is to use moments based on speed systems for ceiling fans, mixer grinders, and light switches that can be instantly turn on and off via sensor inputs. This is a secure web-based application which can only be used with the operator's permission.

Several companies in the Philippines already use various engine speed control strategies mixed with speech - based control and communication devices to improve its efficacy and make life simpler for operators to manage the instrument. The process entails utilizing voice assistant to manage the speeds of a mixer.

To activate the AC motors, operators must use voice commands. This architecture allows for the remote management of electrical missies loads by utilizing voice instructions to connect with a gadget’s micro controller via a smart phone and a Wi-Fi adapter. This study aimsare to create a voice-command system for an electric mixer grinder. The mixer grinder will understand the command and carry out the operation in a balanced way. To assign the electric mixer a direction, the spoken command will be sent to the phone. It detects the command for voice recognition. It just analyses the keywords specified by the programmer and transforms things into already defined instructions. If the electric mixer is managed, it will follow the signal and react accordingly.

2.Related works

Michel Vacher et al. [1] developed PATCH, a voice recognition framework. The proposed method enables real-time voice command restructuring to manage SWEET-HOME, as researchers term it. They put this method to

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the test in a real-world Home System using three distinct different users: the aged, the visual impairment, and those with no special needs. The PATCH technique was found to be helpful for people with special needs, as per the findings.

Arthi et al. [2] used Software simulation for building automation, including speech recognition, to switch the lights on and off. The pace with which every equipment react was evaluated in their simulation model experiments. The findings demonstrate how their system knows input commands and reacts with 95% accuracy in speech recognition. Based on the results, they concluded that their technique might be employed in home appliances including fans, refrigerators, air conditioners, televisions, and so on.

Faisal et al. [5] designed a smartphone app that allows users to perform voice input to manage household appliances. The software tries to transform voice input into Text and transmit data over through the Gsm system, thereby contributing to the software's complexity.

Thoraya et al. [3] showed how a smart device for such elderly and disabled could well be implemented. Voice commands are detected using Software simulation, and the Wi-Fi model is implemented with ZigBee wireless units. Finally, the proposed technique is put to test with three most common household appliances.

Mohammed Akour et al. [8] built a technology that enables users can control doors, lights, and subwoofers via a speech-based remote control on an Android phone. We design systems that can detect human speech and react to commands with precision on the performance side.

Home Automation Controlled by Speech P. Raghupathy et al. constructed Using Raspberry Pi with Google Voice Assistance. The objective of [9] is to enable IoT to regulate and manage devices in the home with Google voice assistance. We built items in the household (fan, electric tubes, refrigerator, and washing machine) operated through Google voice assistance using the Raspberry Pi. A Networked Sensors can be made with Internet of Things technology. This technology is easier and also more secure.

3. Methodology

3.1. Proposed design

The figure shows the block diagram of a system containing various modules such as an Android application, voice recognition using English language, Raspberry Pi3, Electric Mixer Grinder using AC motor. A relay is used select the devices to operate. A voice signal is then converted into an electric signal given with the help of a microphone. For voice recognition,the mic signal is given to the processor. The instruction shall be given either as a single word or a sentence for which the voice used by the operator should be trained to recognize the command by the system and accordingly.

Voice command will be given is matched with the pre-set authorized tones and the system will respond asap. The acquired signal is transferred from the control

The sample voice tones of the operator have been pre-set in the system with the help of a database and

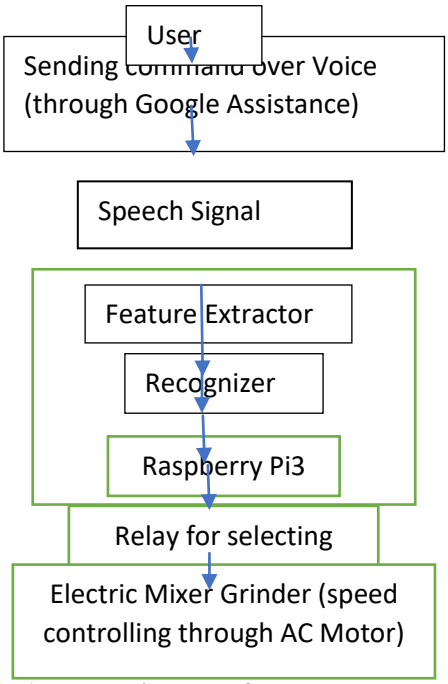

Fig.1. Block Diagram of a Proposed system

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3.2. Voice Recognition for Language

A device that turns sounds and spoken words into electric signals and then transforms these signals into language generator modelling is termed as voice recognition. This is known to that as sound recognition or speech recognition. The first step of natural language processing is the challenging period of operator information. Several speaking samples are being used to create a voiced language library, including all data with the necessary voice recordings collected and processed.

The sample information is converted to the audio Model by the pattern analyzer. As the adjusted data, one of most appropriate speaker info is selected and given.

The following criteria can be used to classify speech recognition technology.

• **Broadcaster**: All presenters have such a distinct type tone. As a reason, the models have been either developed fora specific presenter or a person who is not a member of a group.

• **Vocal Sound**: When it comes to speech recognition, every method a person talks are very important.

Some models can recognize either single utterances or separate utterance with a pause in between.

• **Vocabulary:** The size of the vocabulary plays an important role in determining the complexity, performance, and precision of the system.

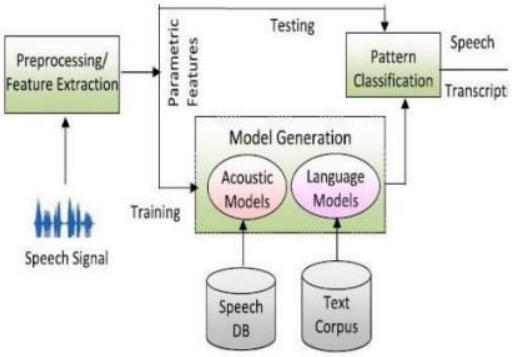

Fig.2.ArchitectureforSpeechRecognition System

3.3. Hardware Design

3.3.1 Raspberry Pi3

The Raspberry Pi 3 is a small single-board computer introduced by the Raspberry Pi Foundation that includes a CPU, GPU, USB ports, and I/O connectors and can perform basic computer activities.

In terms of peripheral device support and memory capacity, the Raspberry hardware has gone through a number of changes. Every new addition comes with a design upgrade, with advanced capabilities added to the device to allow it to perform as many functions as a traditional phoneWi-Fi and Bluetooth, which were missing in previous versions (Pi 1 and Pi 2), are now included in the current edition of this device (Pi 3), allowing users to keep in touch with their peripherals without the need for a physical connection.

The Raspberry Pi's row of GPIO (general-purpose input/output) pins down the board's far right side is a powerful feature. It has a 40-pin GPIO connector, just like every other Raspberry Pi chipset. General-Purpose Input/Output (GPIO) pins are a common interface for connecting a single-board computer or microprocessor to external devices. The software can be used to alter the GPIO pins, which do not have a specified function.

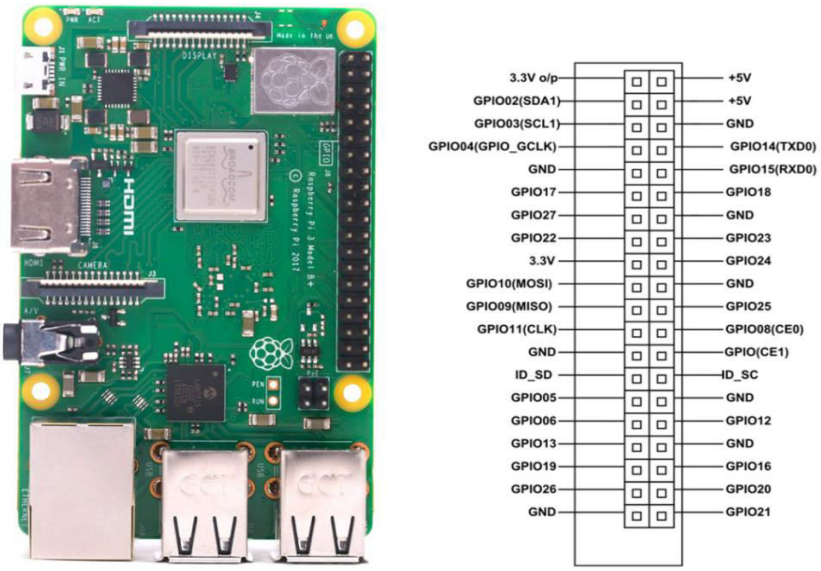

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Fig.3. Raspberry PI 3 Fig. 4. Raspberry PI3 Pin layout used in system.

The detailed specification of the Raspberry Pi 3 is as follows.
Two 5V pins, two 3V3 pins, and nine unconfigurable ground pins are provided on the Raspberry Pi 3 board (0V).
5V: The 5v pins get the 5v supply directly from the main power adaptor. The Raspberry Pi, and many other 5v power devices can be charged by using pin.
For connecting devices and testing LEDs, the 3v port provides a steady 3.3v power.
GND: The term "ground" is frequently used. All variables are measured using the GND voltage.
The Raspberry Pi 3's input/output pins are as follows: The Raspberry Pi can receive a signal produced by a connected device to this socket if the GPIO pin is configured to only an input. A power between and would be detected by the microcontroller or down (1.5V) (0V). When this pin is set to HIGH, the power output is 3.3V, and when it is set at LOW, it is 0V.
When a GPIO pin is set as an output pin, the voltage signal is sent as either high (3.3V)
Pins for PWM (pulse-width modulation):
• On all pins, software PWM is available.
• Hardware PWM is only accessible on the following pins: GPIO12, GPIO13, GPIO18, GPIO19, GPIO20, GPIO21, GPIO22, GPIO23, GPIO24,
Pins for SPI:
SPI is another master-slave medium of communication (Serial Peripheral Interface). It's used by the Raspberry Pi board to quickly communicate through one or many surrounding. The data is linked mostly by slave (RPi) using a timer (SCLK at GPIO11), as well as the information is delivered from Pi into our SPI module through the MOSI (Master Out Slave In) connection. The SPI chip is using the MISO (Master In Slave Out) port to connect with the Pic Microcontroller. There are five pins in Serial communication:
• GND: Connect all of the GND pins.
In its whole, the Raspberry Pi 3 board.
• **SCLK:** The SPI's clock. All of the SCLK pins should be connected together.
• **MOSI** (Master Out Slave In): This acronym stands for Master Out Slave In. Data is sent from the master to the slave via this pin.
• **MISO** (Master In Slave Out): This acronym stands for Master In Slave Out. This pin receives data from a slave and sends it to the master.
• **CE:** Chip Enable is the abbreviation for Chip Enablement. Each slave (or peripheral device) in our circuit requires one CE pin to be connected. We take two CE pins by default, but we may add more CE pins using the other GPIO pins.
On-board SPI pins:
• **SPI0:** GPIO9 (MISO), GPIO10 (MOSI), GPIO11 (SCLK), GPIO8 (CE0), GPIO7 (CE0), GPIO9 (MISO), GPIO10 (MOSI), GPIO11 (SCLK), GPIO8 (CE0), GPIO7 (CE0) (CE1)
• **SPI1:** GPIO19 (MISO), GPIO20 (MOSI), GPIO21 (SCLK), GPIO18 (CE0), GPIO17 (CE1), GPIO16 (CE1), GPIO19 (MISO), GPIO20 (MOSI), GPIO21 (SCLK), GPIO18 (CE0), GPIO17 (CE1).
3.3.2. Wi-Fi Module

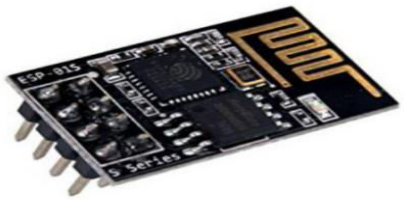

Fig.5. Wi-Fi Module

Wi-Fi modules provide a simple, hassle-free, and quick method for creating IoT devices. Adding the ability to interact wirelessly using the robust and stable IEEE 802.11 b/g/n protocol without having to worry about the TCP/IP layer because it is integrated into the unit and ready to use through AT commands.
3.3.3. AC Motor
An electric voltage motor (AC motor) is a type of electric motor that transforms switching current into mechanical revolution. AC motors have a wide range of uses, from industrial bulk power conversion to residential small power conversion. An alternating current (AC) motor is an electric motor that runs on alternating current (AC).

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Fig.6. AC Motor

An outside spindle holding electrical power coils provides a rotating magnetic field, while a secondary revolving magnetism is produced by an internal rotor coupled to the output shaft. Permanent magnets, resistive intensity, or DC or AC electrical windings can all create a magnetic field in the rotor.

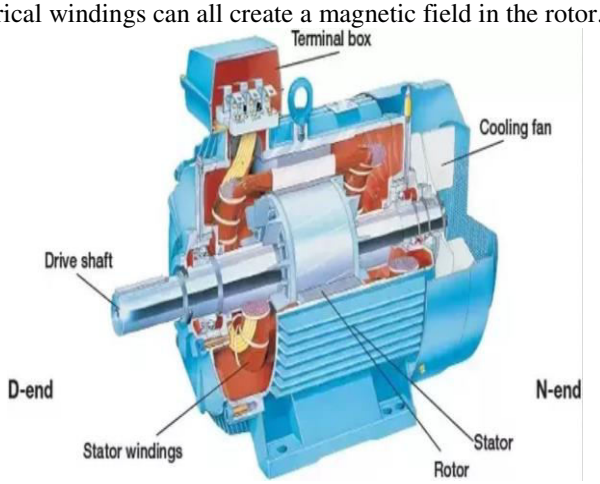

Fig.7. Inside AC Motor

3.3.4. Speech Recognition

Speech Recognition uses a combination of computer science and linguistics to recognize spoken words and convert them to text. It enables computers to comprehend human speech. Speech recognition refers to a machine's ability to listen to and identify spoken speech. The uttered words can then be converted to text, a query can be made, and a response can be given using Python's speech recognition. Some devices can even be programmed to respond to spoken speech. With the help of computer programmes that take in information from the microphone, process it, and convert it into a proper form.

Python uses linguistic and acoustic modelling methods to accomplish speech recognition. Acoustic modelling is a technique for identifying phenones /phonetics in speech in order to extract the most important parts of speech, such as words and sentences.

With the use of a microphone, speech recognition begins by transforming the sound energy produced by the person speaking into electrical energy. The electrical energy is then converted from analogue to digital, and finally to text.

It takes the audio data and breaks it down into sounds, then uses algorithms to analyze the sounds to identify the most likely word that fits the audio. Natural Language Processing and Neural Networks are used to do all of this. In addition, hidden Markov models can be used to improve voice recognition by detecting temporal patterns.

Fig 8: Speech Recognition

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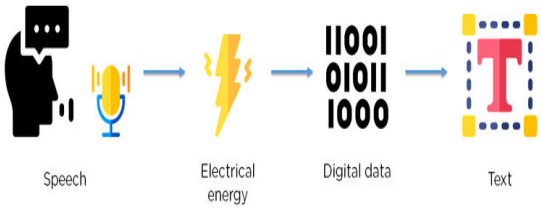

Fig 9: Working of Speech Recognition

The Voice Command Module is a tiny and handy voice recognition device. It's a speaker-dependent module with the ability to take up to 80 distinct audio signals. Any sound can be made to function as a command. Before any user input can be recognized, users must first train the module. Voice instructions are grouped together like books in a library. Any of the library's 7 voice commands could be input into recognizer. It implies that seven commands are present simultaneously.

There are two ways to control this board: Serial Port (full function) and General System (part of function). In addition, the board's General Output Pins could emit a variety of waves when a voice command was recognized. The table below highlights the many ways for converting Speech-To-Text and Text-To-Speech.m

Table -1: The conversion model for speech to text

TECHNIQUE	ADVANTAGE	DISADVANTAGE
Linear Predictive Coding (LPC)	LPC is a static method for extracting features. The idea behind LPC is that it can take a voice sample and combine it with previous acoustic features to create a linear combination. The vocal signal is divided into N frames, which are subsequently transformed into text.	Uses spectral analysis with a set resolution and a subjective frequency scale.
Mel-Frequency Cestrum Co-efficient (MFCC)	MFCC is a technique for STT transition that seems to use steps like framing, windowing, and Discrete Fourier Transform to extract features of a signal using a filter bank. The issue with MFCC is that it necessitates Normalization since MFCC values are inefficient in the presence of ambient or additive disturbances.	The challenge with MFCC is that it requires Normalization since MFCC values are inefficient in the presence of ambient or additive disturbances.
Dynamic Time Wrapping (DTW)	Using dynamic programming, the DTW algorithm is used to detect the analogy in two-time series events that differ in speed. Its goal is to loop over a pair of feature vector sequences in order to find a plausible match between them.	The problem occurs when deciding on a reference template to use for comparing time series events.
Hidden Markov Model (HMM)	For STT conversion, HMM is a statistical model. • HMMs have their own framework and self-learning, makes them perfect for STT translation.	• The voice command is viewed as a stable signal or a short-term time stable signal in this method. • HMM is a serial programme.
Neural Network (NN)	A neural network is a statistical model that is visualised as a graph. • For state operations, neural networks use link objective functions and connection strengths.	• ANNs are concurrent in this neural network model.
Hybrid Approach	When voice frequencies are parallel, whereas syllable patterns and words are serial, the developed hybrid approach is used for Speech to Text conversion. This demonstrates that both strategies are applicable in a variety of situations. The techniques of HMM and Neural Networks are used in tandem.	

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	As neural networks perform well in evaluating probability from concurrent speech input, Markov models can use the phoneme observation probabilities provided by neural networks to generate a probable phoneme sequence or word.	

Table -3: The numerous methods for converting text to speech

METHOD	ADVANTAGE	DISADVANTAGE
Rule Based Machine Translation (RBMT)	For text to speech conversion, RBMT utilizes syntactic and semantic analysis. The model consists of a series of grammatical rules. To execute a TTS translation, it performs a lookup of each word contained in the input text using the Grammar and Dictionary basis of the given language.	• For large systems, the RBMT is inefficient.
Statistical Machine Translation (SMT)	SMT is a probabilistic technique that uses the Bayes Theorem to assign a probability to each sentence in the input. • The higher the probability value, the more efficient the conversion of that sentence into voice format.	The disadvantage of this strategy is the high cost of participation, as well as the fact that it does not work well for diverse languages.
Hidden Markov Model (HMM)	HMM is a probabilistic approach comparable to SMT, but with higher TTS conversion accuracy. HMM can be used to generate an audio from text input in both voice recognition and text-to-speech synthesis systems. One of the advantages of using HMM is that it is a network that is automatically trained.	

We found that HMM gives the most efficiency for STT and TTS conversion by analyzing various approaches for STT and TTS. The neural network also provides an optimal level of efficiency for STT. As a result, We suggested a hybrid technique for STT conversion that incorporates both HMM and Neural networks, and the HMM model outperforms the others in terms of TTS accuracy.

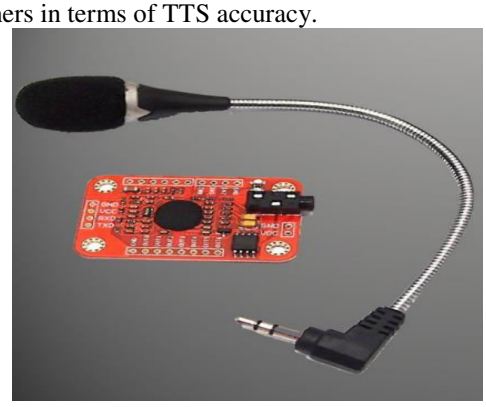

Fig.10. Voice Recognition

Voice recognition module specifications

1. 4.5-5.5V voltage
2. 40mA current
3. Digital Interface: UART interface with a 5V TTL level.
4. 3.5mm mono-channel microphone connector + microphone pin interface Analog Interface
5. The accuracy of recognition is 99 percent (under ideal environment)
6. Support up to 80 voice commands, each lasting 1500 milliseconds.
7. There are a maximum of seven voice commands that can be used at the same time.
8. UART/GPIO control is simple.

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9. General Pin Output with User Control

4.Software Specification

a) Raspbian OS

Raspbian is a Debian-based operating system for the Raspberry Pi. Raspbian has progressed in a Windows environment.

b) Working Principle

The operation of the project is simple. We can control the loads by using a Raspberry PI3 and using voice recognition to give commands to it. The Microcontroller will use Wi-Fi connectivity to switch on and off the loads based on the selection commands.

Application

This method is used in residences, businesses, and industrial units.

Advantages

Controlling devices in the home from all over the world is smart and secure.

Sample coding for speech recognition in pyhthon

```
import speech_recognition as SR
import pyttsx3
r=sr.recognizer()
def SpeakerText(command):
engine.runAndWait()
with sr.Microphone() as source2:
r.adjust_for_ambient_noise(source2, duration=0.2)
audio2=r.listen(source2)
MyText=r.recognize_google(audio2)
Mytext=Mytext.low()
print (“did u say “+MyText)
SpeakText(Mytext)
engine = pyttsx3.init()
engine.say(command)
```

5. Testing and Implications

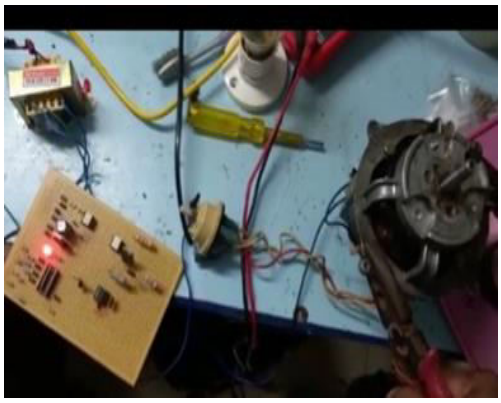

Fig.11. Working Environment

To control the AC Motor, the user can login to the Android application. Through the AC Motor of the Mixer Grinder the motion can be controlled based on the desire of the owner. Furthermore, for the Mixer Grinder speed, the speech chosen in this work would be the universal language. The value of off signal is one, while the value of the ON instruction is zero. Low signals are used for 2, moderate instructions are being used for 3, strong commands are being used for 4, as well as very strong commands are being used for 5. The following is a list of sources tabular column shows the results in an accurate manner.

Table 1:

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Instruction	Voice Input	Expected Output	Actual Output	Result
ON	0	On	On	Success
OFF	1	Off	Off	Success
Low	2	Low	Off	Fail
Low	2	Low	Low	Success
Low	2	Low	On	Fail
Low	2	Low	Low	Success
Low	2	Low	Off	Fail
Accuracy = 50%				

Table 2:

Instruction	Voice Input	Expected Output	Actual Output	Result
MODERATE	3	MODERATE	MODERATE	Success
MODERATE	3	MODERATE	MODERATE	Success
MODERATE	3	MODERATE	MODERATE	Success
MODERATE	3	MODERATE	MODERATE	Success
MODERATE	3	MODERATE	MODERATE	Success
Accuracy = 100%				

Table 3:

Instruction	Voice Input	Expected Output	Actual Output	Result
STRONG	4	STRONG	STRONG	Success
STRONG	4	STRONG	STRONG	Success
STRONG	4	STRONG	STRONG	Success
STRONG	4	STRONG	STRONG	Success
STRONG	4	STRONG	STRONG	Success
Accuracy = 100%				

Table 4:

Instruction	Voice Input	Expected Output	Actual Output	Result
VERY STRONG	4	VERY STRONG	MODERATE	Fail
VERY STRONG	4	VERY STRONG	VERY STRONG	Success
VERY STRONG	4	VERY STRONG	VERY STRONG	Success
VERY STRONG	4	VERY STRONG	STRONG	Fail
VERY STRONG	4	VERY STRONG	VERY STRONG	Success
Accuracy = 60%				

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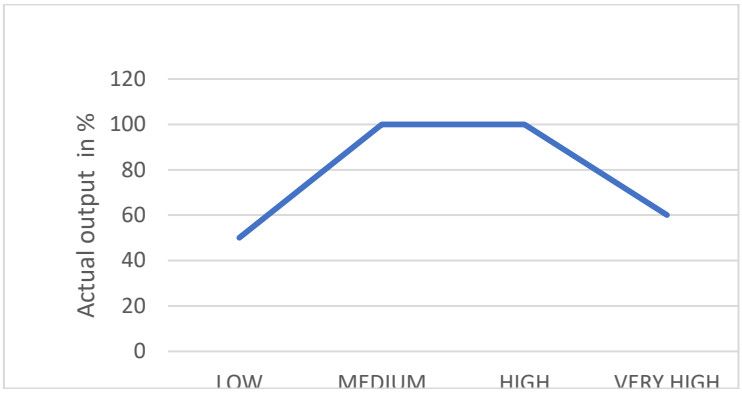

Fig.8. The Graphical representation shows the result between Instruction vs Actual Output

6. Conclusion

Synthesis of STT and TTS can be performed in a number of ways. Using the Hidden Markov Model technique, the rate of STT and TTS operations can be increased, and better-quality voice and text must be generated. Google's Speech Recognition API module can be used to create a Hidden Markov Model in Python, is the most suitable technique for STT conversion. When converting speech to text, this technique can be improved by taking into account punctuation marks. The most accurate way for TTS conversion is to use the HMM model, which may be implemented in Python using the pyttsx3 modules. This Text-To-Speech and Speech-To-Text system can be used with a variety of languages, including English, Hindi, and Punjabi. Voice recognition is more efficient when compared to writing or typing. Large amount of data can be collected in voice recognition which is better than physical mobility.The system can recognize speech speeder/ faster going to mixer Grinder alone. It helps to give notations directly and simply.The accuracy rate is higher when there is ausage of speech recognition technology. Since speech technology is accurate and automatic facilitates job reduction and time-saving for everyone. The structure is apt for people who could talk with disability. It provides a safe usage for disabled persons with the help of universal language have to be concerned by not knowing the other language.

Future Scope for Research

We found that HMM works well for both STT and TTS after evaluating the various approaches for TTS and STT.A web-based application can be created using HMM's STT and TTS.
be developed for the purpose of sending and receiving voice-based messages. we can enhance this project in electric home gadgets like washing Machine, Microvan, etc with an android application using IOT Technology.

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