

VOICE CONTROL PERSONAL ASSISTANT USING RASPBERRY PI

Submitted in partial fulfillment of the requirements
of the degree of

Bachelor of Engineering

in

Electronics and Telecommunication

by

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2018-19

CERTIFICATE



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This is to certify that the project entitled **VOICE CONTROL PERSONAL ASSISTANT USING RASPBERRY PI** is a bonafide work of **Yadav Brijesh (15ET48), Sha Faisal(15ET40), Jaiswar Ranjit(15ET23), Majgaonkar Alsiddique (16DET60)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of Bachelor of Engineering in Department of Electronics and Telecommunication Engineering.

Supervisor

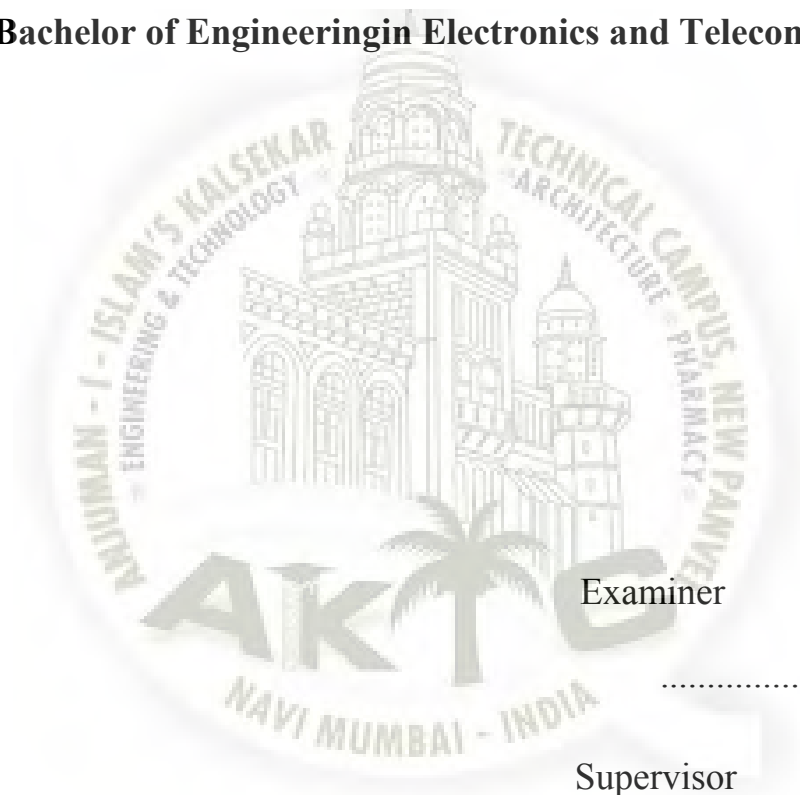
Examiner

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Project Report Approval for Bachelor of Engineering

This project entitled "**Voice Control Personal Assistant Using Raspberry Pi**" by **Yadav Brijesh (15ET48), Sha Faisal(15ET40), Jaiswar Ranjit(15ET23), Majgaonkar Alsiddique (16DET60)** is approved for the degree of **Bachelor of Engineering in Electronics and Telecommunication**.



Examiner

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Date:

Place:

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We My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities.

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CONTENTS

1	ABSTRACT	2
2	ACKNOWLEDGEMENT	3
3	INTRODUCTION.....	4
4	OBJECTIVES.....	5
5	SCOPE.....	6
6	SYSTEM ARCHITECTURE.....	7
7	LITERATURE REVIEW.....	8
8	TECHNICAL DETAILS.....	10
9	METHODOLOGY.....	12
10	SOFTWARE REQUIREMENT SPECIFICATION.....	13
11	HARDWARE REQUIREMENT SPECIFICATION.....	14
12	SYSTEM DESIGN.....	17
13	FLOW DIAGRAM.....	18
14	MODULUS IMPLEMENTATION.....	19
15	IMPLEMENTATION.....	21
16	RESULT.....	22
17	APPLICATION.....	23
18	CONCLUSION.....	24
19	FUTURE SCOPE.....	25
20	REFERENCE.....	26

ABSTRACT

The aim of this project is to demonstrate the implementation of a Voice Command System as an Intelligent Personal Assistant (IPA) that can perform various tasks or services for an individual. It based on the concepts of Internet of Things, Speech Recognition, Natural Language Processing and Artificial Intelligence. Using Rasp- berry Pi as a main hardware to implement this model which works on the primary input of a users voice. . The device will respond to the user in a casual manner so that the user has a friendly experience with the device and feels it like his or her own assistant.

The Internet of Things (IoT) means learning and interacting with millions of things including services, sensors, actuators, and many other objects on the Internet. This project enhances on how far IoT can connect devices on different platforms. This will effortlessly help humans in various fields like Home automation, network- ing, data monitoring and others. The evolution of human- machine user interface has drastically changed over the years. The path of advancement has been through key- board, mouse, touch and now it is Voice. This new user interface can be achieved by Alexa Voice Service. Currently, we have very few devices that can be controlled us- ing Alexa. Some of the examples are Philips Hue, WeMo, and Wink. But these are limited to certain hardware. The initial installation and maintenance is expensive. The proposed system connects and controls most of the IoT devices connected to it using Voice.

Acknowledgement

We are extremely fortunate to be involved in an exciting and challenging project like **“Voice Control Personal Assistant using Raspberry Pi”** It has enriched our life, giving us an opportunity to work in field of programming and automation. This project increased our thinking and understanding capability and after the completion of this project, we experience the feeling of achievement and satisfaction.

We should like to express our greatest gratitude and respect to our guide Pro. for his excellent guidance, valuable suggestion and endless support. He has not only been wonderful guide but also a genuine person. We consider ourselves extremely lucky to be able to work under guidance of such a dynamic personality. Also we would like to thanks our HOD **Prof. SHAIKH AFZAL** For guiding us with the designing and helping us to improve our project. Actually, he is one such genuine person for whom our words will not be enough to express.

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INTRODUCTION

Over the years, humans have progress in inventing new technologies for reducing human efforts and saving human life. since the development of iot reduce the human labour to nill The development of IoT (Internet of Things) had been advanced in several study fields like home automation, personal assistant AI , smart city, smart farming etc. so the personal assisstant help reducing the manual effforts being input by human in their day to day task. The voice controlled personal assistant receive the voice command as input to perform the numerous task. Any voice command system need three basic components which are speech to text converter, query processor and a text to speech converter. Voice has been a very integral part of communication nowadays.

These innovations have attributed to the technology industry using deep learning methods in making and using some of the speech recognition systems, Google was able to reduce word error rate by 6 to 10 relative, for the system that had the word error rate of 17 to 52. Text to speech conversion is the process of con- verting a machine recognized text into any language which could be identified by a speaker when the text is read out loud. It is two step processes which is divided into front end and back end . First part is responsible for converting numbers and abbre- viations to a written word format. This is also referred to as normalization of text. Second part involves the signal to be processed into an understandable one. Speech Recognition is the ability of machine for instance a computer to understand words and sentences spoken in any language . These words or sentences are then converted to a format that could be understood by the machine e. Speech recognition is basi- cally implemented using vocabulary systems . A speech recognition system may be a Small Vocabulary-many user system or a Large Vocabulary- small user system .

OBJECTIVES

The aim of this project is to develop a voice controlled personal assistant that will run commands of the users primarily the elderly and disabled perform various operations through voice commands, and in so doing simplify basic operations such as information about weather , checking the time, opening websites, playing music etc.

The main objective of this system is to control any devices (it should be any type of device as like IoT compatible device or a simple appliance) through the voice by using the very popular technology Internet of Things. The aim is to make personal assistance to do anything by speech. Other main purpose is to save the power. Sometime human forgot to switch of the devices and man outside the house using this kind of IoT system to control device from anywhere in the word so that power can be saved from anywhere.

People with disabilities can benefit from speech recognition programs. For individuals that are Deaf or Hard of Hearing, speech recognition software is used to automatically generate a closed-captioning of conversations such as discussions in conference rooms, classroom lectures, and/or religious services.

Speech recognition is also very useful for people who have difficulty using their hands, ranging from mild repetitive stress injuries to involved disabilities that preclude using conventional computer input devices. In fact, people who used the keyboard a lot and developed RSI became an urgent early market for speech recognition.[6] Speech recognition is used in deaf telephony, such as voicemail to text, relay services, and captioned telephone. Individuals with learning disabilities who have problems with thought-to-paper communication (essentially they think of an idea but it is processed incorrectly causing it to end up differently on paper) can possibly benefit from the software but the technology is not bug proof.

SCOPE

Technology is constantly advancing and changing, and the voice assistant market will progress along with it. In April 2015, the research firm Gartner predicted that by the end of 2018, 30 percent of interactions with technology would be through conversations with smart machines, many of them by voice. Tractica is a market intelligence firm that focuses on human interaction with technology. Their reports say unique consumer users for virtual digital assistants (which they define as automated software applications or platforms that assist the human user through understanding natural language in written or spoken form) will grow from more than 390 million worldwide users in 2015 to 1.8 billion by the end of 2021. The growth in the business world is expected to increase from 155 million users in 2015 to 843 million by 2021. With that kind of projected growth, revenue is forecasted to grow from 1.6 billion in 2015 to 15.8 billion in 2021. According to Global Market Insights, Inc., between 2016 and 2024, the market share for the technology will grow at an annual rate of almost 35 percent. More and more sectors of the economy, like healthcare and the automotive industry, are finding uses for the speech recognition technology in addition to those found in devices like smart speakers and phones.

SYSTEM ARCHITECTURE

Existing Systems:

The existing systems suffer from the drawback that only predefined voices are possible and it can store only limited voices. Hence, the user can't get the full information coherently.

Proposed System:

The proposed system is such that it can overcome the drawback of the existing system. The project design involves text to speech. Here whatever the system receives as input after the command the output will get in the form of voice means speech. The proposed system will provide following features: It always keeps listening for its name and wakes up to respond upon calling with the assigned functionality. It keeps learning the sequence of questions asked to it related to its context which it remembers for the future. So when the same context is mentioned, it starts a conversation with you asking relevant questions. Performing Arithmetic calculations based on voice commands and giving back the computed solution through a voice. Searching Internet based on user's voice input and giving back the reply through a voice with further interactive questions by machine. Auto synchronization will keep itself updated by the data on its cloud server. Firebase cloud server to update the data on cloud. IoT architecture will help user to connect smart devices with the personal assistant and performing tasks such as switching ON and OFF lights, connect Smartphone, notify user by using push notifications such as email, etc. Other features such as playing music, setting an alarm, checking weather conditions of devices location. Setting reminders, spell-correct, etc can be performed by an input from user's voice.

LITERATURE REVIEW

Alexa, Echos engine, can work on various tablets and devices, encouraging new developers to design apps that work together with it. On the other hand, Siri works only with iOS devices. Echo will continue to be integrated with top companies around the world, while Siri is losing its interest among consumers who do not own an iPhone.

When Microsoft launched Cortana, it was promoted as taking the top pros from Now and Siri, and that is partially true. Cortana falls behind in its integration with the most important third-party apps available on the market. Until Microsoft Cortana will be available on Android and iOS devices, it remains the only good option for systems with Microsoft Windows 10 installed.

Voice recognition system can be translation of user-spoken words into the text. Voice recognition support as ASR model, this technique offers to recognize all speech automatically. Speech recognition system different types, some of the system speaker independent and other system utilize to training method. Training method uses this type of system, which is referred as speaker-dependent systems

.Now a day Speech recognition can be used in different areas. Its most important applications are aircrafts, speech-to-text processing, simple data entry, call routing, smart search, etc. Speech recognition mostly depends on the statistical models. This models transfer speech into text form and vice versa. Different type of statistical model available and used in this type of system are acoustic model, language model, lexicon model, hidden markov models. Voice controlled personal assistant is capturing photos and recognizing faces in the captured photo, checking similarity between two faces. It is also performing arithmetic calculations based on voice commands and giving back the computed solution through a robotic voice.

The application has been developed based on the android system [2]. An interface card has been developed to assure communication between the remote user, server, raspberry pi card and the home Appliances. The application has been installed on an android Smartphone, a web server, and a raspberry pi card to control the shutter of windows. Android application on a smartphone issue command to raspberry pi card. An interface card has been realized to update signals between the actuator sensors and the raspberry pi card.

Cloud-based home appliance monitoring and controlling System. Design and implement a home gateway to collect metadata from home appliances and send to the cloud-based data server to store on HDFS (Hadoop Distributed File System), process them using MapReduce and use to provide a monitoring function to Remote user.

It has been implemented with Raspberry Pi through reading the subject of E-mail and the algorithm. Raspberry Pi proves to be a powerful, economic and efficient platform for implementing the smart home automation [4]. Raspberry pi based home automation is better than other home automation methods is several ways. For example, in home automation through DTMF (dual tone multi-frequency) [11], the call tariff is a huge disadvantage, which is not the case in their proposed method. Also, in Web server based home automation, the design of web server and the memory space required is ejected by this method, because it simply uses the already existing web server service provided by G-mail. LEDs were used to indicate the switching action. System is interactive, efficient and flexible.

Application developed using the Android platform controlled and monitored from a remote location using the smart home app and an Arduino Ethernet based micro web-server [8]. The sensors and actuators/relays are directly interfaced to the main controller. Proposed design offers are the control of energy management systems such as lightings, heating, air conditioning, security, fire detection and intrusion detection with siren and email notifications.

Embedded system Raspberry Pi to serve as a communication gateway between mobile devices and Konnex-Bus (KNX) home automation systems [9]. Store the information of all actors and sensors within a Smart Home, instead of using separate profiles. Ensures energy-consumption could be reduced, compared to a standard desktop computer.

Dual tone multi frequency (DTMF) used in telephone lines [13]. There are three components in the system DTMF receiver and ring detector, IO interface unit, PC. The PC detects the ringing of the line and then authenticates the user and use the keypad tones to control the devices as required. An example of stepper motor control is taken up. This system has the advantage of being secure and allowing international standardization. This is because the DTMF tones are the same all over the world. But it suffers from the drawback that the number of appliances is limited by the number of keys in the keypad.

TECHNICAL DETAILS

IoT is created by enabling machine-to-machine interactions; another important factor of IoT is the human-machine interaction. By creating a connected life, people can interact with their devices, appliances, vehicles, etc. As one of the most natural ways of communication, using speech to interact with things adds value by enriching the user experience.

As a subset of Internet of Things, smart/connected home is a fast growing industry that includes automation of household activities (e.g., centralized control of lighting, heating, air conditioning, etc.) for more convenience, as well as for added security (e.g., control of alarm system, doors, windows, etc.). This work focuses on a combination of speech recognition and natural language understanding for smart home applications with customizable devices. Dynamic hierarchical language models are discussed and shown to be effective in creating personalized speech recognition, and evaluated in terms of both word accuracy and semantic accuracy. Internet of Thing is developed with many technologies as cloud computing, big data, robotics and different communication technologies. In voice recognition, systems use many methods and strategies. Mostly voice recognition system use Hidden Markov Models, this is easy and simple to trained and use. House manufactured devices can be communicated using ZigBee. In the industry, some company uses Wi-Fi as its base wireless system network. Bluetooth networks are also used in IoT based wireless network. Apples home kit, Samsungs Smart Things platform, and ATTs home automation solutions are the example of smart home system. Comcast also has its own home automation system. Each has its own devices talking to each other. Thus, standardization is very fragmented in current times, which include Bluetooth, Wi-Fi, ZigBee, Infrared or more remote methods to frame a dedicated little system of Internet of Things.

Now days, Wi-Fi is the innovation to associate heterogeneous type of computer devices. It is the most widely recognized innovation to interface an adequate size

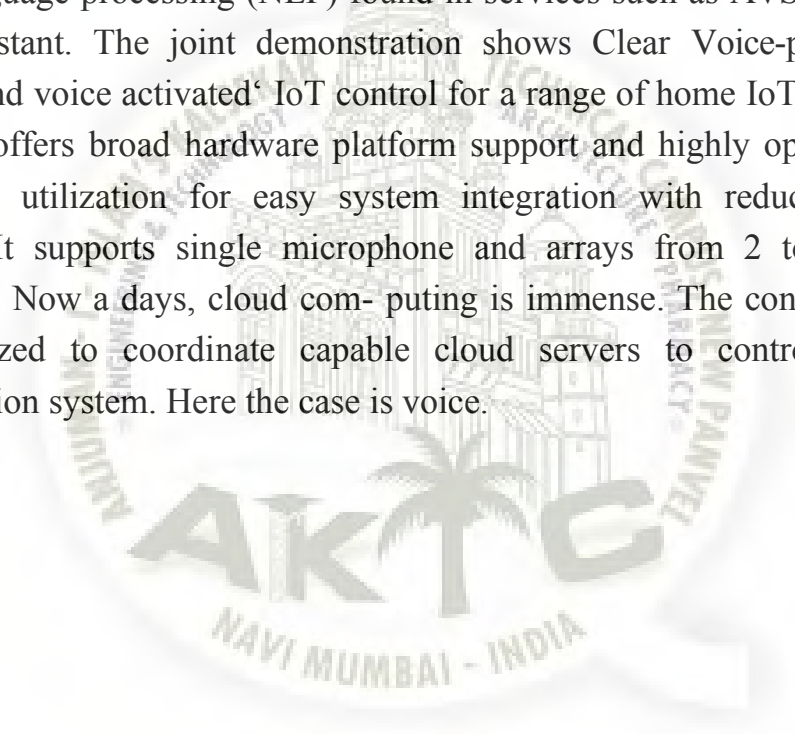
system in LAN, other computer, it desktop, portable PC, advanced mobile phone, tablet with Wi-Fi capability and also a latest technology ZigBee and X10 is devoted network which required extraordinary devices to create a network, ZigBee wants ZigBee Router, ZigBee controller, and ZigBee enabled devices.

X10 requires different type of transmitter and receiver for the sending an information to the devices in Analog mode.

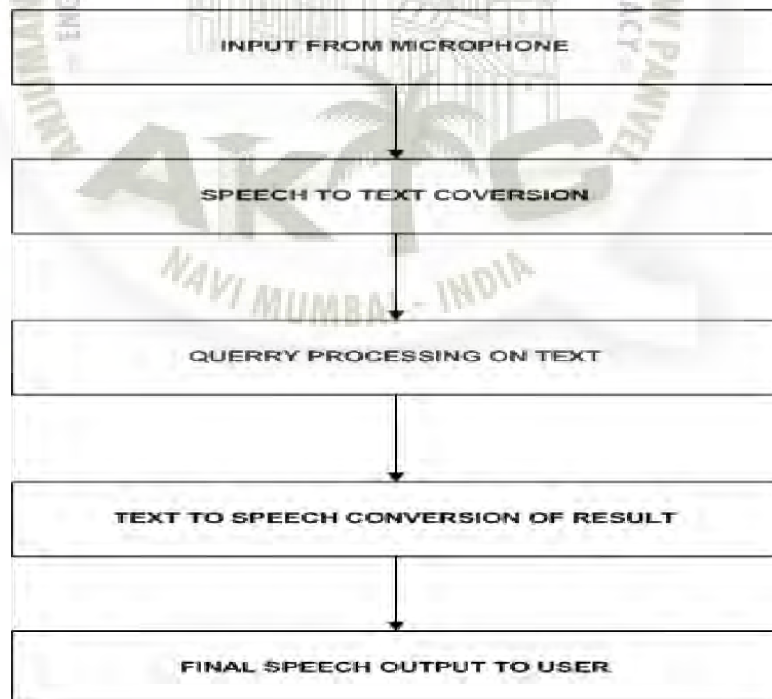
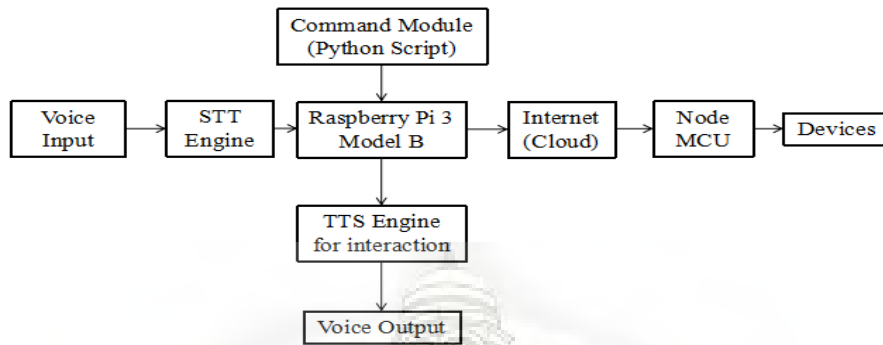
The cheapest wireless technology is a Wi-Fi. In the Wi-Fi device, dedicated router is not needed to make a virtual Wi-Fi router as its own secured Network, filling in as a Hotspot. So that Wi-Fi is most probably use in other type of home automation.

The controller gadget can be utilized to coordinate capable cloud servers to control the home mechanization. Access Point or a Repeater are used to increase the range of the network. So, that we can increase the range of Wi-Fi network.

Clear Voice vastly improves automatic speech recognition (ASR) for voice command and control user interfaces (UI) and artificial intelligence (AI) driven natural language processing (NLP) found in services such as AVS, Cortana and Google Assistant. The joint demonstration shows Clear Voice-powered AVS integration and voice activated IoT control for a range of home IoT applications. Clear Voice offers broad hardware platform support and highly optimized CPU and memory utilization for easy system integration with reduced cost and complexity. It supports single microphone and arrays from 2 to 8 or more microphones. Now a days, cloud computing is immense. The controller gadget can be utilized to coordinate capable cloud servers to control the home computerization system. Here the case is voice.



METHODOLOGY



Software Requirements Specification

The Jasper system, even though it works offline, compromises accuracy and speed. This would be useful for systems that have no access to the internet, though. A small caveat: The system takes up almost a whole 4GB memory card, so use at least an 8GB card with it. Some of its services are cumbersome and take a lot of effort from the user to pronounce repeatedly until the system picks it up. The softwares presented by Oscar and Steven use Google voice APIs, they are very accurate and precise. Both of them also use Google speech, so the system can be manipulated to talk back and respond to your commands and queries. But I prefer the third software because it has a simple and straightforward interface. Here, you will be able to de-fine each of your voice commands and link them to particular tasks in the form of bash commands. These are defined inside a configuration file.





Raspberry Pi:

Raspberry Pi is a Linux single board computer. It was developed by the British Raspberry Foundation which aimed to promote basic computer science with low-cost hardware and free software. The 700-bit BCM2835 processor, 256MB of memory (B-type has been upgraded to 256 MB of memory). Raspberry Pi use the SD card as a storage medium and has an Ethernet, two USB interfaces, a USB interface, HDMI (support sound output) and RCA terminal output support. The operating system is open-source of Linux. In the studies of the Internet of things, the raspberry faction has many applications. Its operating system can not only operate itself but also has access to wireless networks and Bluetooth chips. With the development of things networking conditions, raspberry itself has variety of hardware connections with USB interface. You can connect the camera and keyboard or mouse to facilitate the development. Vladimir Vujovic[5] proposed the use of raspberry as a Web sensor application in the wisdom of residential. The raspberry faction as a small server which connected to the raspberry through the router and sensor is network node. Raspberry pi can tell the indoor temperature and humidity.

Special-purpose features:

The Pi Zero can be used as a USB device or "USB gadget", plugged into another computer via a USB port on another machine. It can be configured in multiple ways, for example to show up as a serial device or an ethernet device. Although originally requiring software patches, this was added into the mainline Raspbian distribution in May 2016.

The Pi 3 can boot from USB, such as from a flash drive. Because of firmware limitations in other models, the Pi 3 is the only board that can do this.

Performance:

While operating at 700 MHz by default, the first generation Raspberry Pi provided a real-world performance roughly equivalent to 0.041 GFLOPS. On the CPU level the performance is similar to a 300 MHz Pentium II of 1997/99. The GPU provides 1 Gpixel/s or 1.5 Gtexel/s of graphics processing or 24 GFLOPS of general purpose computing performance. The graphical capabilities of the Raspberry Pi are roughly equivalent to the performance of the Xbox of 2001.

Raspberry Pi 2 V1.1 included a quad-core Cortex-A7 CPU running at 900 MHz and 1 GB RAM. It was described as 46 times more powerful than its predecessor. The GPU was identical to the original. In parallelised benchmarks, the Raspberry Pi 2 V1.1 could be up to 14 times faster than a Raspberry Pi 1 Model B+.

The Raspberry Pi 3, with a quad-core ARM Cortex-A53 processor, is described as having ten times the performance of a Raspberry Pi 1.

Supply:

The raspberry pi is low power controller which uses a micro USB connection to power itself. The recommended amount of current is between 700mA for a Raspberry Pi Model A, and up to 2.5A for a Raspberry Pi 3 Model B+.

Microphone:

Microphone is used to take the audio input of the sound. This audio input when further passed through the system would be searched for keywords. These keywords are essential for the functioning of the voice command system as our modules work on the essence of searching for keywords and giving output by matching keyword.

Keyboard:

Keyboard acts as an input interface mainly for the developers, providing access to make edits to the program code.

Mouse:

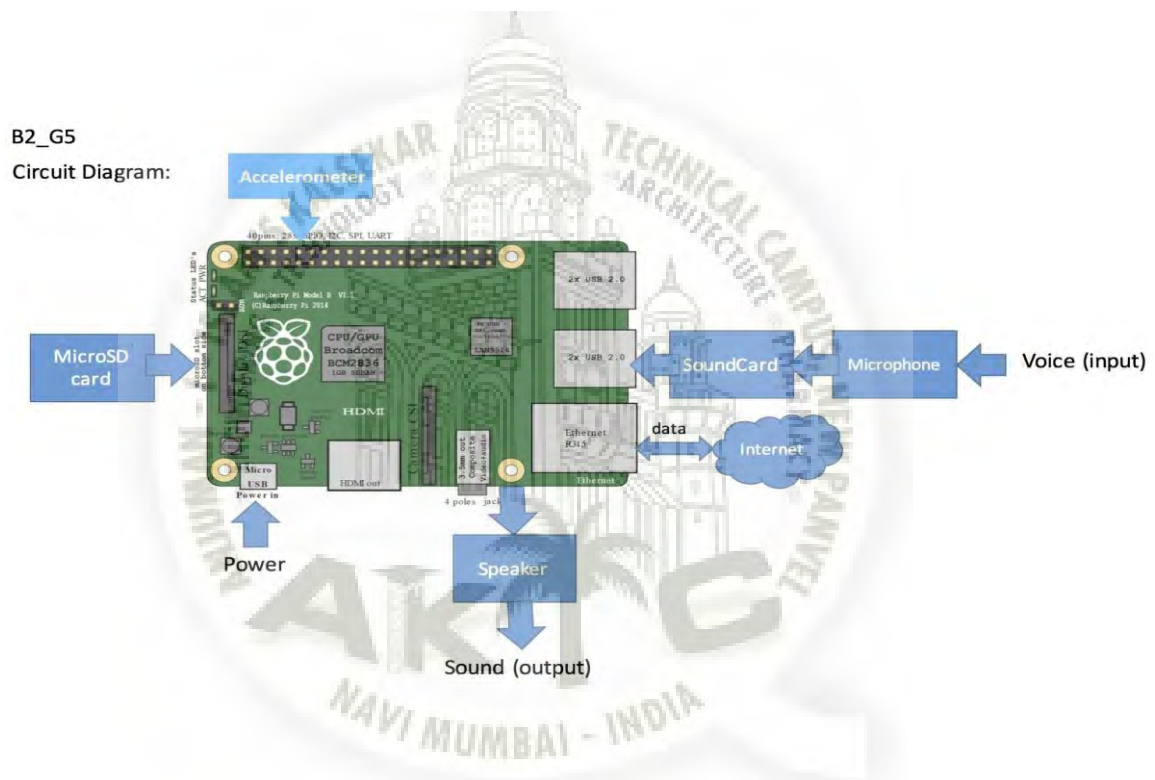
Mouse also acts an interface between the system and the developer and does not have a direct interaction with the end user.

Speaker:

Speakers, once the query put forward by the user has transmitted via the speakers which are connected to the audio been processed, the text output of that query is converted to jack of the raspberry pi as shown in Figure 2. speech using the online text to speech converter. Now this speech which is the audio output is sent to the user using the speakers which are running on audio out.

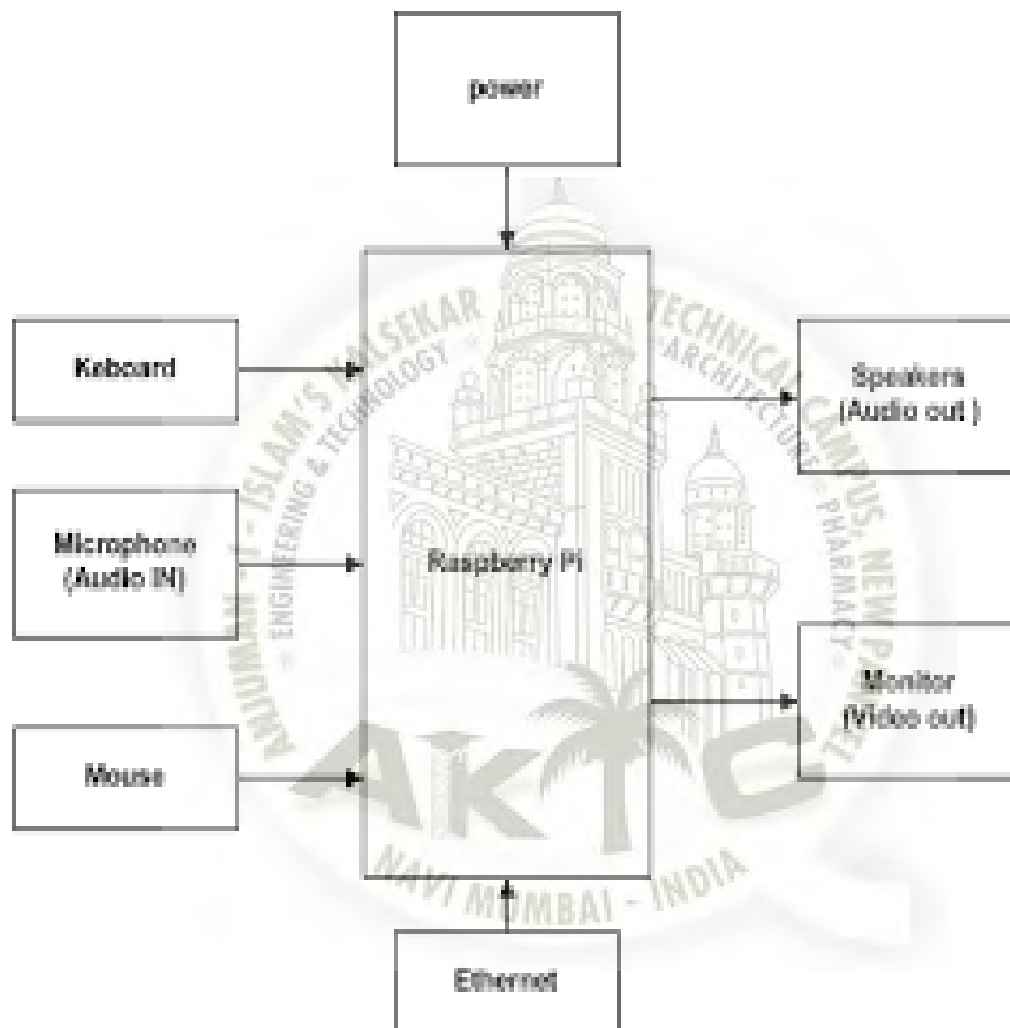
SYSTEM DESIGN

Hardware Connection:



Voice recognition devices: Here smart personal assistant is a software agent. IPA (intelligent personal assistant) can perform errands and administrations for an individual its related tasks. These task and services are rely on upon client input, location of clients, and the capacity to get to data from an assortment of online sources. Cases of such an operator are Amazon Alexa, Siri from Apple's, Samsung's voice Google Now, Microsoft's Cortana, and this system can be classified into modules and they are use different type of voice services and devices.

Flow Diagram:



MODULES IMPLEMENTATION

Speech To Text Engine:

(AVS) is a Speech-To-Text (STT) engine which is used to convert the commands given by the user in audio input to text form, so that these commands can be interpreted by the modules properly. To use (AVS) engine, an application has to be created in the Amazon developers console and the generated API key has to be used to access the speech engine. It requires continuous internet connection as data is sent over the Amazon servers.

Text To Speech Engine:

(AVS) is a Text-To-Speech (TTS) engine is used to create a spoken sound version of the text in a computer document, such as a help file or a Web page. TTS can enable the reading of computer display information for the visually challenged person, or may simply be used to augment the reading of a text message. To use (AVS) engine, an application has to be created in the Amazon developers console and the generated API key has to be used to access the speech engine. It requires continuous internet connection as data is sent over the Amazon servers.

Query Processor:

The Voice Command System has a module for query processing which works in general like many query processors do. That means, taking the input from the users, searching for relevant outputs and then presenting the user with the appropriate output. In this system we are using the site wolfram alpha as the source for implementing query processing in the system. The queries that can be passed to this module include retrieving information about famous personalities, simple mathematical calculations, description of any general object etc.

Wikipedia:

This module works on the keyword of wiki. The system asks for what you would like to learn about. Then the request is made to the Wikipedia API for the required query. It generates the summary of the information regarding the query and the data is output through the microphone to the listener in audio form. In case of failure, the error message is generated saying unable to reach dictionary of wiki.

Weather:

This module tells the user about the weather conditions of the location whose station identifier is specified in the profile of the user. This module can be executed by using the keyword weather. The weather information is taken from the weather underground service which includes the details of temperature, wind speed and direction etc. It generates an error message, if the information cannot be retrieved for the specified location.

Other Command Specific Modules:

The Voice Command System also has some command specific modules like fetching hacker news, email and current time. Each of these modules is related to the system using keywords like hacker news, email and time respectively. Whenever any of this keyword is said to the system, it fetches that module and launches the contents of that module thereby providing the appropriate response to the user.

IMPLEMENTATION

The whole idea of smart home assistance for controlling using IoT provides access to control and monitor vital parameters of the devices (AC, Heater ect) through Alexa voice service and MQTT Server, And Subscriber, of a multi-level IOT platform. The starting of the project to make voice recognizance or personal assistance. In the market so many voice recognize personal assistance available as like Siri, Cortana, Google Assistance, Wit.ai, Api.ai, IBM Watson, Amazon Alexa, but we implement our own ALEXA PI by using Amazon voice services (AVS). The Raspberry Pi can easily run the Alexa Voice Service, MQTT broker among other things. Here is the first step to implement personal voice based home assistance. For that, Raspberry pi 3 is used. It is portable, affordable and low power consumption with Raspberry Pi at the core.

We walked through downloading Raspbian Jessie and boot the SD card. This bootable SD card put in the Raspberry pi 3 and connecting the hardware setup to complete setup of raspberry pi 3. After completing raspberry pi 3 setup Install Alexa Voice services to make voice control personal assistance to further controlling the different devices. Affordable low cost ALEXA PI working as personal assistance, now go to next step, the main purpose of next step is to control appliance. First, we need MQTT broker. So many Broker Available but we have used Adafruit MQTT broker. It is quite simple Adafruit.IO MQTT Broker.

RESULT

The Voice Command System works on the idea and the logic it was designed with. Our personal assistant uses the button to take a command. Each of the commands given to it is matched with the names of the modules written in the program code. If the name of the command matches with any set of keywords, then those set of actions are performed by the Voice Command System. The modules of Find my iPhone, Wikipedia and Movies are based upon API calling. We have used open source text to speech and speech to text converters which provide us the features of customizability. If the system is unable to match any of the said commands with the provided keywords for each command, then the system apologizes for not able to perform the said task. All in all, the system works on the expected lines with all the features that were initially proposed. Additionally, the system also provides enough promise for the future as it is highly customizable and new modules can be added any time without disturbing the working of current modules.



APPLICATION

Usage in education and daily life:

For language learning, speech recognition can be useful for learning a second language. It can teach proper pronunciation, in addition to helping a person develop fluency with their speaking skills.

Students who are blind (see Blindness and education) or have very low vision can benefit from using the technology to convey words and then hear the computer recite them, as well as use a computer by commanding with their voice, instead of having to look at the screen and keyboard.

Telephony and other domains:

ASR in the field of telephony is now commonplace and in the field of computer gaming and simulation is becoming more widespread. Despite the high level of integration with word processing in general personal computing. However, ASR in the field of document production has not seen the expected.

In Car systems :

Typically a manual control input, for example by means of a finger control on the steering-wheel, enables the speech recognition system and this is signalled to the driver by an audio prompt. Following the audio prompt, the system has a "listening window" during which it may accept a speech input for recognition.

Simple voice commands may be used to initiate phone calls, select radio stations or play music from a compatible smartphone, MP3 player or music-loaded flash drive. Voice recognition capabilities vary between car make and model. Some of the most recent car models offer natural-language speech recognition in place of a fixed set of commands. allowing the driver to use full sentences and common phrases. With such systems there is, therefore, no need for the user to memorize a set of fixed command words.

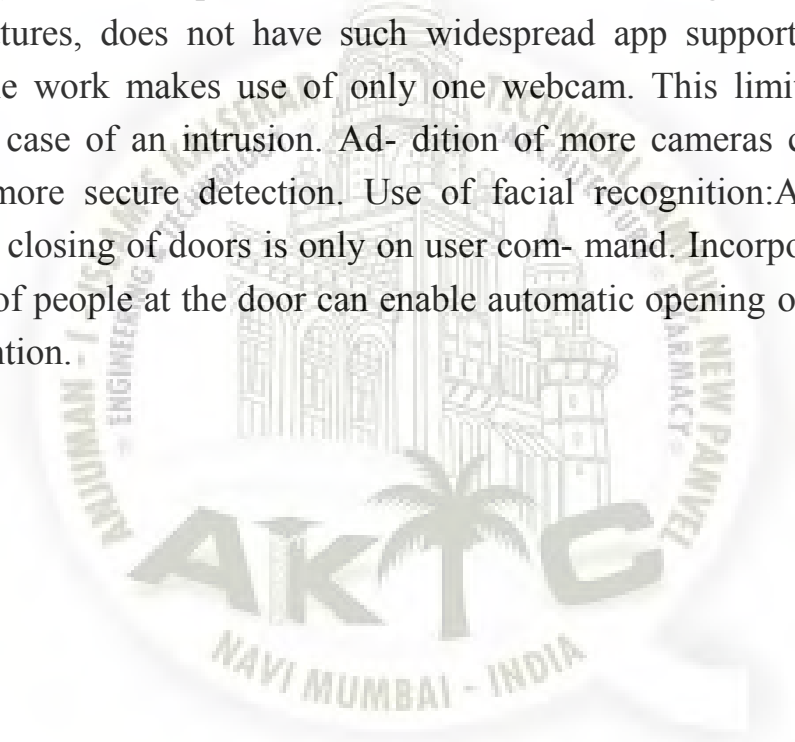
CONCLUSION

In conclusion, Amazon has invested considerable funds and time to develop the Echo, and have produced a state-of-the-art product with a large number of features not covered by the RasPi Personal Assistant. The RasPi personal assistant is simply an attempt to show possible areas of improvement. Alexa provides a better way of communication with the IoT devices and the users. The Internet of things will connect various hardware devices installed in homes, industries and other sophisticated places which the users can control. These devices can also control each other. This will be the future of technology.



FUTURE SCOPE

processing algorithm used in the project has its limitations. It can only pick up fingers when there is a definite backgroundforeground demarcation. Presence of a large number of objects and lighting variations can cause the algorithm to malfunction. Improving range of support and features :Amazon Echo has extensive app support in the form of Amazon Skills (a set of apps to extend functionality)The RasPi personal assistant however, though including a wide array of features, does not have such widespread app support. Use of more cameras: The work makes use of only one webcam. This limits the range of detection in case of an intrusion. Addition of more cameras can provide for better and more secure detection. Use of facial recognition:At the moment, opening and closing of doors is only on user command. Incorporation of facial recognition of people at the door can enable automatic opening of doors without user intervention.



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