

Smart Voice Control Framework for Home Appliances using IBM Cloud Services

¹Mrs. M. Kavitha *, ²Kalyan Jonnalagadda, ³P Naga Koteswara Rao, ⁴V Navya Sree
^{1,2,3,4}Dept. of Computer Science and Engineering, Koneru Lakshmaiah Education Foundation, Guntur,
Andhra Pradesh 522502, India

*Corresponding authors E-mail: kalyanjnd7@gmail.com, modepalli.kavitha@kluniversity.in

Article Info

Volume 83

Page Number: 2613 - 2620

Publication Issue:

May - June 2020

Abstract:

With the advancements of technology, the need for comfort, safety and security has been increased. Internet of things is one such technology that connects all things or end devices with the internet. Smart home comes under one of the illustrative fields of IoT. From the past, many models have been proposed for smart home automation i.e., to control the home appliances using a smart device over internet. Remote controls with IR features are proposed to control the end devices by pointing at them. But there occurred few drawbacks regarding the state dependencies in controlling the appliance and also in the interface of the remote. Other models are also implemented through an internet enables mobile phone. Voice recognition modules are implemented with the home automation cloud via Bluetooth SPP which detects the patterns and sends appropriate commands to the end devices like lights, fan, bulb etc. and perform necessary actions. These actions include turn on and off the devices. The sign of intuitiveness is missing in these models. So, to overthrow these drawbacks, a system that uses voice control through Home Automation cloud using IBM Watson and Pub-Nub is proposed in this project. IBM Watson is a speech-to-text engine that converts the speech signals into commands or text and sends it to data streaming network called Pub-Nub which process the command and trigger the action on devices connected in the smart home. This paper aims at interactions between the voice recognition device, the cloud and architectures involved in it.

Keywords: Cloud Services, Home Automation, IBM Watson, Speech-to-Text, Voice Recognition

Article History

Article Received: 11 August 2019

Revised: 18 November 2019

Accepted: 23 January 2020

Publication: 10 May 2020

I. INTRODUCTION

Internet of things is derived by the combination of three things they are, sensors, connectivity, people and processes. Many smart applications are developed by involving sensors with the users and certain services are also provided to look into the working of those devices. Internet of Things represents a perception for the ability of devices that can be connected to a network to sense data and collects it from the outside world. And also shared across the Internet where it can be processed and used for various interesting purposes. Though internet of things seems to be virtual, there are many

practical and realistic technologies that are involved in it. Some of those technologies may include self-parking, smoke detectors, automobiles like automatic ordering of home supplies, and day-to-day tracking of exercise habits which include the fitness trackers. One of the representative fields is the smart home automation.

But the technology developed from concept of Internet of things has many issues related to it. Internet of Things right away triggers queries round the privacy of non-public knowledge [4]. Whether data regarding our current location or information about our height and weight which will be

manageable by our health care suppliers, having more knowledge about ourselves running over wireless networking devices and probably everywhere around the world is a major concern. Providing power to the present new production of smart devices and their connections to the network will be overpriced and practically tough. Handy devices need batteries that sometime should get replaced.

Several firms and many projects have barred onto the Internet of Things idea wanting to require benefit of no matter business opportunities square measure out there. IoT adopts that the essential network instrumentation and connected technology will activate infrequently in a mechanical way. Apart from making them smarter it gets difficult just simply by keeping mobiles connected to Internet. Present generation people have various requirements that need associate degree IoT system to adjust for several completely different things and preferences [6]. At last after considering all those challenges and measures to overcome them, if individuals get too much dependent on the automation and if the technology is not strong enough, any minor problem in the system will cause a huge damage, both physically and financially [5].

a. Home Automation

Internet of Things has been broadly connected to various fields, for example, smart homes. The requirement for wellbeing, comfort and an advantageous life are particularly vital in smart homes. Along these lines, home automation is one among the preminent fundamental and requesting parts for the IoT-based smart home technology. Home mechanization frameworks are utilized to pick up command over home gadgets or machines in smart homes and give programmed remote control to both inside or outside homes. Home mechanization will be portrayed as presentation of innovation among the house setting to supply accommodation, solace, security and vitality intensity to its tenants. Adding knowledge to home setting will offer

increased quality of life for the older and disabled folks that would possibly otherwise need caregivers or on the other hand institutional consideration. There has been increment in home mechanization lately on account of higher reasonableness and headway in technology that licenses immense property. With the presentation of the net of Things, the analysis and implementation of home automation have gotten a lot of standard [3].

Many models had been proposed to achieve control over home appliances. A remote controller is used to control the devices present in the home [5]. This remote controller can be a smart mobile phone equipped with internet facility. Using the mobile phone, the appliances the home can be monitored. The devices are physically interconnected and collectively to a sub-controller that is then retrieved and controlled over the shrewd phone.

b. Voice Recognition

Voice recognition can also be termed as speech recognition or Speech-to-text conversion. Speech acknowledgment is the capacity of an electronic gadget to record, get it and process spoken words. The device like microphone is used to record a user's voice and the related hardware present in it converts the signal from analog sound waves to digital audio signals. For conversion of analog sound waves to digital sound waves a technique called sampling is implemented. The analog-to-digital converter samples the sound by taking precise measurements of the wave at frequent intervals.

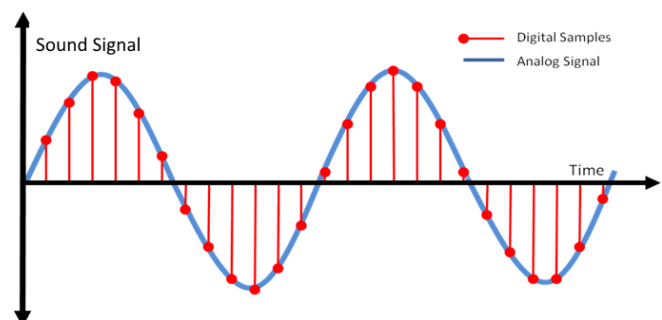


Fig 1. Sampling of audio signal

The system performs filtration on the digital sound waves to remove unwanted noise, and also to divide

it into different bands of frequency. This audio is then processed by software and it depicts the waves of sound as distinct words.

The program within the software package examines phonemes within the context of the opposite phonemes around them. It runs the discourse speech sound plot through an applied mathematics model and associates them to an outsized library of notable words, phrases and sentences. The program then defines what the user was in all probability spoken language and either outputs it as text or problems a command.

So, the complete Speech-to-text happens in three steps.

- Software classifies the audio segments in the received audio signals.
- It recognizes the particular language spoken by the user.
- Speech is converted to text.

This result has all transcription, punctuations and other phonemes. It is fully in annotated XML document. This annotated document can be straightforwardly recorded by a search engine and can be changed over to plain content or commands. This voice recognition is implemented in home automation for gaining access of control over various appliances the home [3]. This can be achieved by combination of speech recognition cloud and home automation cloud. Generally, cloud is the combination of various network devices like servers, computer systems which are connected together over internet to achieve a particular task or to provide a necessary service to any existing architecture. There are primarily three services provided by the cloud, they are

- Software as a service

A cloud service provider gives the facility to use software and applications that are hosted in the datacenter through the internet. Users can avail their subscription to the software and use it through the web.

- Platform as a service

A cloud service provider gives the facility to access a cloud-based environment i.e. both platform and environment to allow developers to build applications.

- Infrastructure as a service

A cloud service provider allows accessing more resource utilization by the clients through pay-as-you-go access to storage, virtualization and networking resources from the cloud.

The voice command control over smart devices has become very widespread and is available to every door step. There are already many existing devices present in the global market, which can be accessed by available online based voice recognition services. The existing solutions for smart home automation have given mobile and web applications as user interface. But there are many other voice acknowledgment based skills that are as of now accessible which are incorporated with highly advanced embedded systems. They include Google home, Amazon Alexa. These makers also furnish the customers with APIs that can be utilized to operate the home appliances with voice recognition services. Several architectures of voice control home automation cloud are discussed in below sections of this paper.

II. Literature Survey

Home Automation Cloud

Voice control module is actualized with the home computerization cloud. Speech-to-text conversion is already made clear along with the working in the prior section of the project. Vox-sigma is one of the speech-to-text engines that process analog voice signal into digital signal and convert it into necessary voice command or text that is fully annotated in XML format. The Vox-Sigma software collection is offered as an online administration by means of a REST API over HTTPS. It enables its customers or clients to get to the advantages of enhancements and to take advantage of many features that are additionally given by the online service [8]. Vox sigma supports many languages.

They include Arabic, Dutch, English, French, Finnish, German, Greek, Italian, Mandarin, Polish, Portuguese, Romanian, Russian, Spanish and Turkish [8]. Its fundamental functionalities incorporate Speech-to-content interpretation and dialect recognizable Evidences.

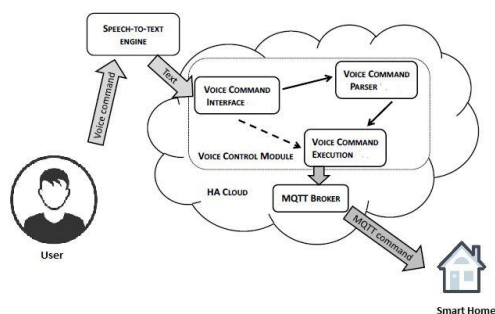


Fig 2.Architecture of voice-controlled home automation cloud

This output command processed by the engine is taken as input by the home automation cloud for further enhancements. [7] This architecture has a home automation cloud which is equipped with three modules.

- Voice Command Interface Module.
- Voice Command Parser Module.
- Voice Command Execution Module.

Generally, the current voice acknowledgment engines execute both speech-to-text changes alongside semantic investigation. In any case, the disconnected based voice acknowledgment engines can't perform semantic examination [7]. So, a special feature called parser is enabled for this purpose.

In this architecture the voice direction interface in the home automation cloud gets the consequence of speech-to-text engine as input. If the input is already has information about semantics the command is directly sent to voice command execution service or it is sent to voice command parser to add the semantics. In the voice command parser, semantic analysis is performed on the text. ANTLR parser generator is used for this purpose as its fast and supports languages that are used in majority of the cloud services. Voice command execution process the data along with semantics and sends a command to the devices through a messaging protocol like

MQTT. MQTT is message queuing telemetry transport protocol that reaches directly to the mentioned device in the command and performs the applied action.

MQTT allows resource inhibited IoT devices to send, or publish data. That information works as associate MQTT message specialist. The intermediary at that point drives the information unflinching those buyers that have previously marked to the client's subject. The MQTT protocol appears to be a better choice for connection of wireless networking devices that have varied levels of potential problems like latency because of occasional information measure limitations or defective connections[9]. If the connection from a consumer who had subscription and the specialist gets broken, at that point the broker can support messages and push them unflinching the endorser once it's back on-line. On the off chance that the association from the distributing customer to the representative gets disengaged without earlier cautioning then the agent can close the association and send supporters a reserved message with commands from the publisher [9]. Other architectures of voice controlled home automation systems are mentioned below. These architectures include both online and offline mode of transmission.

Architectures Of Voice Enabled Home Automation Online Voice Enabled Home Automation System:

Voice enabled home automation system based on home automation and voice recognition cloud is depicted in the below figure. The user should be online to avail this mode of transaction [2]. The voice recording gadget records the voice flag and conveys it to the voice acknowledgment benefit. Depends upon the handled content, the cloud benefit speaks with the home automation cloud to perform the required activity.

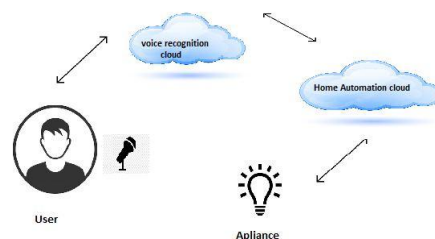


Fig 3. Voice enabled home automation system architecture based on home automation and voice recognition cloud

Online Voice Enabled Home Automation System with Gateway:

Voice enabled home automation framework dependent on voice acknowledgment cloud and passage with voice recorder is another depiction of architecture using cloud. In this architecture the home automation gateway itself records the user's voice and sends it to voice recognition cloud service through a required API [2]. Here the gateway processes all the commands and messages.

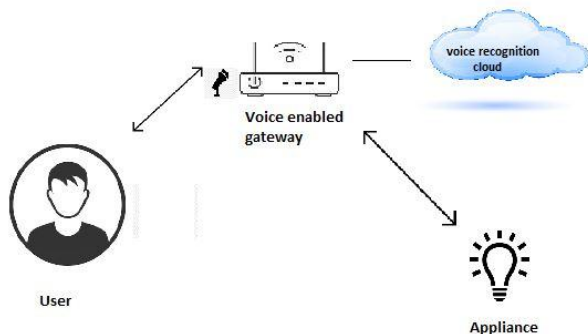


Fig 4. Voice enabled home automation system architecture based on voice recognition cloud and gateway with voice recorder

Offline Voice Enabled Gateway:

Voice empowered home automation framework with complete speech enabled gateway is an offline architecture for voice recognition. Here the home automation gateway is fully equipped with embedded systems that can process the voice commands [2]. It need not be connected to the internet. So it requires high processing power compared to previous modules.

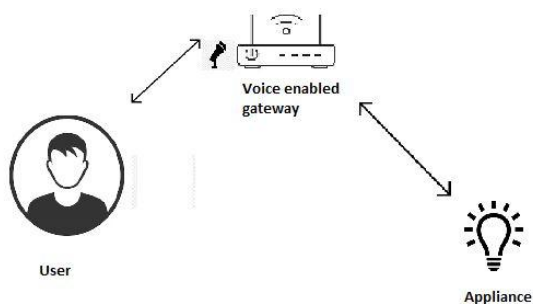


Fig 5. Voice enabled home automationsystem architecture with complete speech enabled gateway.

These architectures are already implemented within the Home automaton cloud and the results seem a bit slow and it also relies on many components for execution of commands. So, to enhance this system the commands can be directly generated in the cloud from the user through IBM WATSON speech-to-text service.

III. Proposed Work

Since our architecture for voice control through home automation cloud is in a need for respective APIs to perform the desired actions. IBM Blue-mix solves this problem. IBM Blue-mix is a platform as a service that allows you to easily extend the functionalities of your applications with services and API's from both IBM and third parties that are based on the most powerful open-source technologies to pair with developed applications. [1]IBM Watson is one of the infrastructures of Blue-mix.

1. IBM Watson

Watson speech-to-text provides advantage over previously existing architectures as it provides machine intelligence and knowledge of language structure and semantics of grammar. This service can be used to convert streaming audio to text in real time.

Other features of IBM Watson are

- a) It learns with less data that means the quality of data is emphasized compared to the quantity.
- b) It protects insights and you can maintain ownership of your data.
- c) Watson provides intelligence to the systems and is useful for large data sets.

2. Pub-Nub

Pub-Nub could be an international information Stream Networkand period infrastructure-as-a-service (IaaS). Pub-Nub employs a Publish and Subscribe model for period information streaming and device communication and supports all of the capabilities of net Sockets, Socket.IO, WebRTC information Channel and alternative streaming

protocols. Pub-Nub provides SDKs for over seventy totally different programming languages and environments together with JavaScript, iOS, and automaton, also as JavaScript frameworks like Angular JS. Pub-Nub conjointly provides consumer libraries for board platforms together with Raspberry-Pi, Arduino, Texas-Instruments, and chip. Generally, in a home automation system the connected devices are controlled through any application on internet enabled mobile phone. But as the technology increased rapidly, the smart home automation devices also increased. So, to control all the devices, a mobile application may not be intuitive enough as one has to navigate to application and select appropriate device to control it. So, a system that is voice assisted is much more intuitive. It acts like an assistant that process the commands and control devices in your home. This gave scope for Watson and Pub nub.

Home Automation System with Watson and Pub-Nub:

HTTP REST API is used by WATSON Speech-to-text service [1]. Watson service converts speech commands to text. A local server is made available in the home. It generates authentication tokens using service credentials for accessing the service. A microphone is connected to the computer and a client web page served by the local server listens to the microphone and directs the speech signal to Watson speech-to-text provision [1]. The speech signals are converted to text and are parsed to generate control commands. Pub-Nub data stream network looks after this. Some of the commands that can be supported by home automation application are “turn on light”, “turn off light”, “turn on fan” etc.

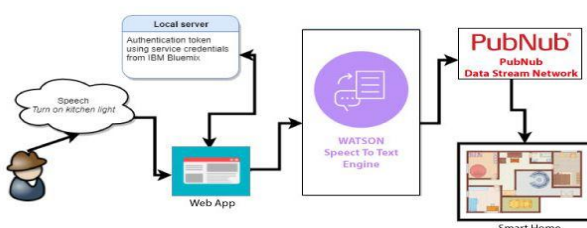


Fig 6.Home automation system using Watson and pub nub

IV. Result Analysis

The proposed system has a web application hosted on the local server. The Watson Speech-to-Text service credentials are taken from IBM cloud by creating a user account and mentioning the related plans for the usage of service. The credentials given by Watson service are used to generate authentication tokens by the local server. Web application that is hosted on the server looks as shown in Fig. 7. The local server is accessed using Node JS.

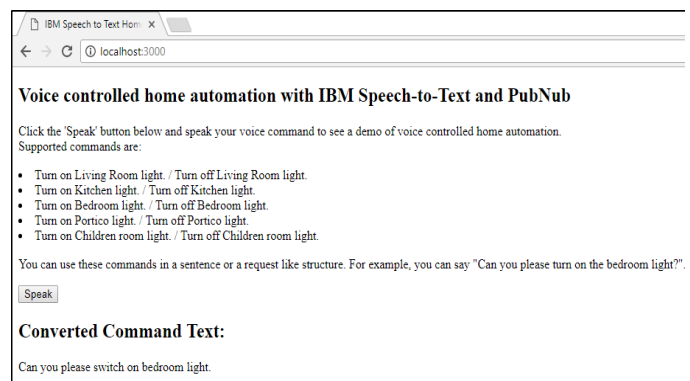


Fig 7. Web Application hosted on local server.

The server uses the Speech to Text service via REST APIs and allows the converted text to be displayed on the Web page for information to the user. A local script involved in the Web page parses the converted text to extract reinforced home automation commands and devices. This script then publishes a JSON message containing the command and the device to a channel on Pub-Nub network. The JSON payload contains the command i.e. on or off and the device to be controlled.

When the user gives a command like “Can you turn on bedroom light?”. The Watson service process the text into a convenient command. The command might look like “TURN ON bedroom LIGHT”. Pub-nub network then starts the task of publishing the messages to devices associated with the particular

channels. Then the actions are triggered by the devices in the home.

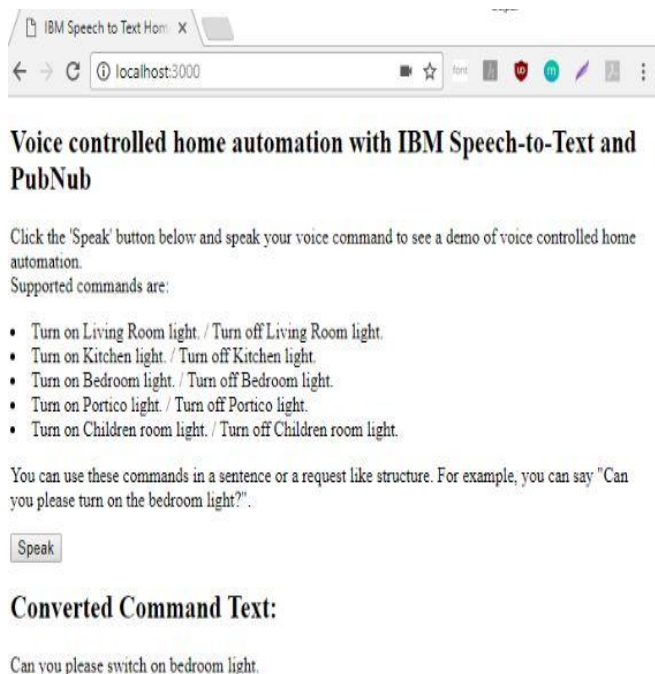


Fig8. Speech given to Watson Service

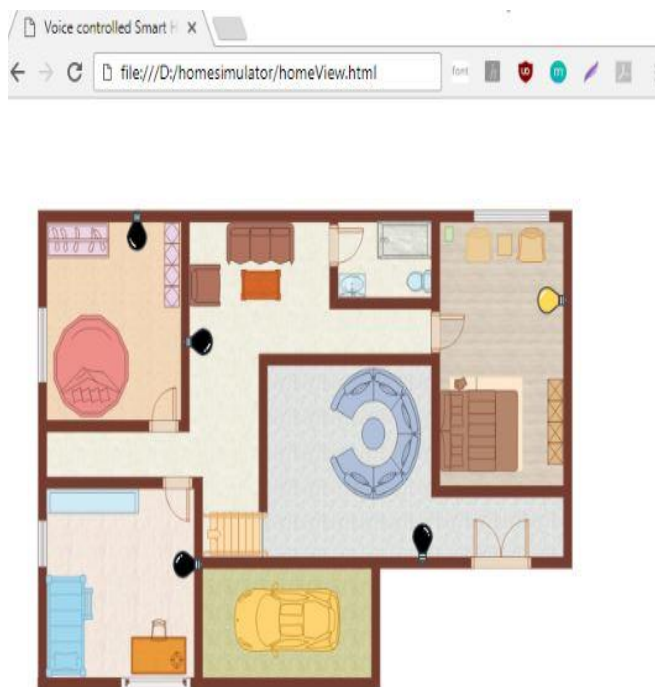


Fig 9. Actions triggered in Smart home

V. Conclusion

The need for smart home automation is discussed and various architectures that can be used to gain control of home appliances are also been presented. Gaining intuitiveness over the smart device control has been the major reason to choose voice control medium. All the respective architectures that involve voice recognition to process the voice commands and perform the required action are furnished in this paper. IBM Watson and Pub-Nub that are provided by IBM Blue mix, a platform as a service that is provided by IBM cloud is implemented to control the smart home appliances by voice commands from computer that is connected to a local server. Watson Speech to Text service from IBM provides a powerful API to add speech recognition capabilities to the web application. Future scope for this model is in be developing applications for physically disabled people who can use voice for various tasks which otherwise may be difficult for them to meet their needs.

References

- [1] Home Automation using Watson an Pub-Nub[Online]Available :<https://www.ibm.com/blogs/bluemix>
- [2] Erić, Tatjana, et al. "Voice control for smart home automation: Evaluation of approaches and possible architectures." Consumer Electronics-Berlin (ICCE-Berlin), 2017 IEEE 7th International Conference on. IEEE, 2017.
- [3] AlShu'eili, Humaid, GourabSen Gupta, and Subhas Mukhopadhyay. "Voice recognition based wireless home automation system." Mechatronics (ICOM), 2011 4th International Conference On. IEEE, 2011.
- [4] Sen, Sonali, et al. "Design of an intelligent voice controlled home automation system." International Journal of Computer Applications 121.15 (2015).
- [5] Lee, Kuen-Min, Wei-GuangTeng, and Ting-Wei Hou. "Point-n-Press: An Intelligent Universal Remote Control System for Home

- Appliances." IEEE Trans. Automation Science and Engineering 13.3 (2016): 1308-1317.
- [6] Yerrapragada, Chaya, and Paul S. Fisher. "Voice controlled smart house." Consumer Electronics, 1993. Digest of Technical Papers. ICCE., IEEE 1993 International Conference on. IEEE, 1993.
- [7] Nan, Eleonora, et al. "Architecture of voice control module for smart home automation cloud." Consumer Electronics-Berlin (ICCE-Berlin), 2017 IEEE 7th International Conference on. IEEE, 2017.
- [8] <http://www.voxsigma.com/speech-to-text-services.html>
- [9] Hunkeler, Urs, Hong Linh Truong, and Andy Stanford-Clark. "MQTT-S—A publish/subscribe protocol for Wireless Sensor Networks." Communication systems software and middleware and workshops, 2008. comsware 2008. 3rd international conference on. IEEE, 2008.