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Review on Voice Controlled Home Automation System

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Abstract— A voice-controlled home automation system is a technological solution that allows users to interact with their home devices using voice commands. The system integrates various smart devices, such as thermostats, lights, security systems, and home entertainment systems (like music devices, TV's, etc..) and enables users to control them using voice commands via voice assistant. This system uses speech recognition and natural language processing to interpret voice commands and control the smart devices accordingly. In this paper, we have been reading several research papers and had written an extract of that research papers.

Keywords-Voice-Controlled , Home Automation System , Speech recognition and Natural Language Processing

I. INTRODUCTION

Home automation systems, which aim to enhance and simplify the operation of numerous appliances and devices in a home, have seen a considerable rise in popularity in recent years. Voice control has become a standout among the different technologies used to build home automation systems because it is both appealing and practical.[1] By allowing users to control their homes with simple voice commands, voice-controlled home automation systems eliminate the need for users to physically interact with the equipment they use to control the environment. Voice-controlled home automation systems have advanced and gained more features with the development of IOT (Internet of Things) technology, giving homeowners more freedom and control over their homes. Although using voice-controlled home automation systems has many benefits, there are also numerous issues that need to be resolved. Assuring the precision and dependability of voice recognition technology, the cornerstone of a voice-controlled system is one of the main problems. Additionally, user-friendly interfaces must be created, and platforms and devices must be compatible with them. We examine the state of research on voice-controlled home automation systems in this review paper, highlighting technological developments and outlining the key issues that still need to be resolved. We investigate the various hardware and software elements used to create voice-controlled home automation systems, analyze the literature on voice recognition technology, and weigh the advantages and drawbacks of these systems. We conclude with suggestions for future research directions to enhance the functionality and usability of voice-controlled home automation systems.

II. BACKGROUND

Voice-controlled home automation systems using IOT have been a popular area of research and development for many years. While these systems have the potential to improve the convenience and efficiency of home automation, they also present a number of challenges, including technical limitations and security concerns. A voice-controlled home automation systems can be traced back to the early **2010s,** as discussed below:-

2011: The first voice-controlled home automation system was developed by companies such as Google and Amazon in 2011. These systems depend on a simple voice commands to control basic home automation functions such as lighting and temperature.

2014: Security researchers began to raise concerns regarding the security of voice-controlled home automation systems. They found that many of these systems lacked basic security features such as encryption and authentication, leaving them vulnerable to hacking and unauthorized access.

2015: A number of high-profile security violation occurred in voice-controlled home automation systems, including one in which a hacker was able to take control of a home's heating and lighting systems.

2016: Researchers demonstrated that it was possible to use voice-controlled home automation systems to carry out so-called "voice squatting" attacks, in which an attacker registers a domain name similar to a valid voice command and attempts to spoof the system.

2017: Google and Amazon released updated versions of their voice-controlled home automation systems, which included improved security features such as encryption and two-factor authentication.

2018: Researchers found that many voice-controlled home automation systems were susceptible to so-called "ultrasonic attacks," in which an attacker uses ultrasonic frequencies to issue commands that are inaudible to humans but recognized by the system.

2019: Several privacy concerns were raised regarding voice-controlled home automation systems, particularly the collection and storage of voice data. Some users reported that their devices were recording their conversations even without issuing voice commands.

2020: The COVID-19 pandemic led to a significant increase in the use of voice-controlled home automation systems, as people spent more time at home and looked for ways to reduce physical contact with surfaces. However, this also led to an increase in security and privacy concerns, as more people began to rely on these systems for essential tasks such as locking and unlocking doors.

2021: Researchers demonstrated that it was possible to use

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voice-controlled home automation systems to carry out "voice injection" attacks, in which an attacker injects malicious code into a voice command that is then executed by the system. This type of attack could be used to carry out a wide range of malicious actions, such as unlocking doors or turning off security systems.

In conclusion, while voice-controlled home automation systems using IOT offer many benefits, they also present significant security and privacy challenges. The reported problems related to these systems shows that researchers and developers are actively working to address these issues, but that there is still much work to be done to ensure the safety and security of these systems.

Table 1: Comparison Table

year	Authors	Components used	Problem faced	Conclusion
2013	Dhawan S. Thakur and el.[1]	HM 2007 speech recognition chip, microphone, LCD display and sound alarm, Zig bee	Zigbee operates in the 2.4GHz frequency band, which can be crowded and prone to interference from other wireless devices such as Wi-Fi routers, Bluetooth devices, and microwaves.	In conclusion, while a voice recognition wireless home automation system based on Zigbee can offer many benefits, it is important to consider the potential problems that may arise
2016	K. A. S. V. Rathnayake et al.[2]	Microsoft Kinect sensor	The problem faced was that the accuracy on the sensor decreases when the distance of the transmitter increases more than 3 meter it drops by 55% and it was only able to detect British accent with more accuracy.	With further modifications Kinect would be able to clear its flaws and would be becoming the perfect home automation system.
2018	Manish Prakash Gupta [3]	Raspberry Pi, Google Assistant API, Bluetooth module, Relay module, LED module	There may be a research void that needs to be filled. The paper suggests an efficient smart home system that can be operated by voice commands through Google Assistant, although it mostly concentrates on the technical implementation of the system and its performance assessment.	The suggested system has the ability to increase user convenience and boost energy efficiency, and the evaluation's findings show how well it does so. Future research studies might fill the research deficit in this area by examining how well such a system is received and adopted by users.
2015	Sonali Sen & Shamik Chakrabarty [4]	Bluetooth module (HC-05), Arduino uno, Relay boards	The processing power of the Arduino Uno microcontroller is limited in comparison to other microcontrollers, which may become an issue when executing complex tasks such as voice recognition, especially if numerous sensors or other components are involved and require significant processing power. Additionally, the memory capacity of the Arduino Uno is also limited, which may lead to memory shortages if the codebase is large	In conclusion, the proposed project presents a microcontroller-based voice-controlled home automation system that enables users to operate appliances in their homes through natural language processing and a user-friendly Android application. The system's central control circuit is an Arduino Uno microcontroller.
2017	Mrs. Paul Jasmin Rani, et al.[5]	Arduino MK1000 (Genuino MK1000), Atmel ATSAMW25 SoC (System on Chip), Arduino Software (IDE),	Developing a voice-controlled system poses a significant challenge in achieving accurate speech recognition, especially in accommodating variations in accents, dialects, and speech patterns. Advanced machine learning techniques and algorithms are necessary to improve speech recognition accuracy.	The goal of this project is to develop a smart home system that can connect all household appliances through a central control panel, allowing wireless voice commands and reducing the need for manual interaction with the devices. The implementation will be carried out using Arduino boards, specifically the Arduino MKR1000

III. LITERATURE REVIEW

Author is trying to explain the importance and modifications in home automation system. Also, previously we were using this automation system but it was limited to TV or fridge or AC but nowadays our complete electrical home appliances can be controlled by our voice fan, light, water geyser can be controlled with IOT. Before jumping to the final project various prototypes were being made, the author has made use of Microsoft Kinect sensor V2, its working and functionality by conducting an experiment on Windows 10 64- bit operating system using this V2 sensor. Two parameters were considered one was the distance from Kinect and the ability of sensor to operate in noisy background. The problem faced was that the accuracy on the sensor decreases when the distance of the transmitter increases more than 3 meter it drops by 55% and it was only able to detect British accent with more accuracy. With further modifications Kinect would be able to clear its flaws and would be becoming the perfect home automation system but in present there are many other systems which are far better than this sensor. [2]

Voice assistants, such as Siri, Alexa, Cortana, and Google Assistant, which are software agents that can understand human speech and respond through synthesized voices. Users can ask voice assistants questions, control home automation devices, manage basic tasks, and perform media playback through voice commands. The research paper suggests that voice assistants have implications for privacy and security and highlights potential future uses, such as delivering library services and materials.

Voice assistants represent an expression of a long-standing science fiction idea of communicating with computers through spoken language. Companies such as Apple, Microsoft, Amazon, and Google have created software agents such as Siri, Cortana, Alexa, and the Assistant that operate on specialized speakers or mobile devices. These agents are designed to recognize and respond to human voice

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commands, making it easier for users to interact with their devices and complete various tasks. As each of the currently available voice assistants has its own unique features, they all have some similarities and are capable of performing basic tasks such as sending and reading text messages, making phone calls. They can also provide answers to general informational questions such as the current time, weather forecast, or conversion rates. In addition, they can set timers, alarms, and make calendar entries, create lists, and perform basic mathematical calculations.[6] Voice-activated devices, such as voice assistants, have useful features but also pose security risks. Anyone with access to a device can gather personal information, access accounts, and perform tasks. A reported case showed that Siri would unlock the front door for anyone who asked. Google's Assistant software now includes voice printing to uniquely identify each user by voice. [7]

Minimization of requirement for direct physical contact with technology. IOT can be used to test the viability of creating a voice-controlled home automation system, and it provides a practical, affordable, and effective way to operate home appliances.[8]
Mobile application, thing speak cloud, Web App with Web Server, Home Automation, Voice Recognition, IOT. The investigation was carried out utilizing a combination of testing, hardware and software design, and literature review. To determine the properties of the existing systems, a review of the literature was done. The hardware design process involved choosing the necessary elements, such as microcontrollers, sensors, and actuators.[9] The microcontroller was programmed as part of the software design, and the voice-controlled system's user interface was created. To verify the system's effectiveness and functionality, testing was done.

Parameters used: -

1) Raspberry Pi 3B+ microcontroller
2) Sensors: a variety of sensors that measure environmental factors like temperature, humidity, and movement
3) Devices that operate home appliances including lights, fans, air conditioners, and security systems are known as actuators.
4) Google Assistant voice recognition API less than one second for a response
5) Testing system effectiveness and usefulness through experimentation
6) Evaluation of cost-effectiveness based on the price of system components
7) User interface: created to allow interaction between the user and the voice-controlled system. [10]

The study demonstrates the viability of developing a voice-controlled home automation system using IOT. The system developed in this study offers a cost-effective and efficient solution for controlling home appliances through voice commands. The system is scalable and can be extended to control more devices and integrate with other IOT systems.[11]

Author's study introduces a micro controller-based voice-controlled home automation system employing cellphones by fusing all of them. An Arduino Uno microcontroller serves as the central component of the control circuit, processing user commands and managing device switching. Natural language processing is a new technology that will allow us to control objects with our voice. An Android smartphone, which is in nearly everyone's hand these days, and a control circuit are all that the user requires.[12]
Any automated system's key selling point is its reduction of labour, effort, time, and mistakes brought on by human error. Users of such a system will be able to voice-control every appliance in their home. The proposed project aims to automate homes by providing a centralized control system that allows users to operate appliances from a single point without physically switching them on or off. This is achieved through the use of a Bluetooth module, which enables users to control appliances from various locations within their homes. The system is also voice-controlled, allowing users to operate appliances simply by saying the appliance name and its corresponding number. This eliminates the need for users to have extensive knowledge of English language. Overall, the project offers a simplified and convenient way to control home appliances.[13]
The use of Android applications in this system provides a simple and user-friendly interface, making it easy for users to understand and use the functionalities. The system is flexible and scalable, allowing for the addition of any number of appliances as needed. It can be used in homes or offices, enabling remote control of appliances on multiple floors, thereby saving manual labor and human effort. This results in saving time and providing a convenient way to control electronic appliances. [14]

Beginning with a discussion of the advantages of adopting voice-controlled systems and the necessity for home automation. The design of the suggested system is then described, and it is built on the Raspberry Pi platform and uses the Google Assistant API to receive voice instructions from the user and transmit control signals to connected devices. The software implementation, as well as the code needed to operate the system, is thoroughly explained in the paper. The author illustrates how the system interacts with various home appliances, including smart switches, lighting, and thermostats, using several protocols, including Wi-Fi and Bluetooth.
The system is assessed using several scenarios to see how well it works to use voice commands to operate different home appliances. The evaluation's findings are included in the report, along with a discussion of the system's shortcomings.[15]
In general, the methodology utilized in the paper takes a hands-on approach to creating a smart home system that can be operated by voice commands through the usage of Google Assistant. The author system gives a thorough explanation of how the program is implemented, and numerous scenarios are used in the system evaluation to strengthen the dependability of the results.
The technical implementation of the system is described in detail, along with the components that were used, and its

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performance is assessed using a number of criteria, including user satisfaction, reaction speed, device compatibility, and voice recognition accuracy.

The suggested system has the ability to increase user convenience and boost energy efficiency, and the evaluation's findings show how well it does so. Future research studies might fill the research deficit in this area by examining how well such a system is received and adopted by users.[16]

The research makes a significant addition to the subject of smart home automation overall and emphasizes the possibilities of voice commands and natural language processing for controlling house appliances. Further developments in this field could have a big impact on how users live their lives and how much energy they use. [17]

Table :2 ***Source: Online rating of mentioned assistants.***

S no.	Attribute	Alexa	Google assistant	Cortana	Siri
1	Year of invention	2014	2016	2009	2010
2	Performance according to users	Good	Great	Good	Average
3	Availability	Smart speakers of amazon only	Easily available on any platform	Only in window OS	Only in apple products
4	Accuracy	good	good	Poor (only British accent)	good
5	Activating command	Alexa!	Ok Google!	Hey Cortana!	Hey Siri!

In Table:1 Source: Online rating of mentioned assistants. Different home assistants are compared on the basis of performance, availability, accuracy, year of invention and activating command. Real time performance was seen while making this comparison table and availability was considered as major factor as Amazon Alexa, Cortana and Siri are only limited to their respective products like Siri is only available in Apple devices (IOS system) , Alexa is only available in Amazon echo dot and Cortana in Windows OS. But Google assistant is widely available in all devices. Performance Rating is given on the basis of user experience

Great: - 4.5-5.0, Good: - 4.0-4.5, Average: - 3.5-4.0.

IV. RESULT AND DISCUSSION

The integration of the Internet of Things (IOT) and voice control technology has made it possible to control various aspects of a smart home, from lighting to temperature, with simple voice commands.

Enhance User Experience: The primary goal of a voice-controlled home automation system is to enhance user experience. The system eliminates the need for physical buttons or remote controls, making it easier and more convenient to use.

Enhance Home Security: A voice-controlled home automation system can enhance home security by allowing users to monitor and control their home's security system using simple voice commands. Users can arm or disarm their security system, lock or unlock doors, and even receive notifications of any unusual activities in their home.

Increase Energy Efficiency: The system can automatically turn off lights and appliances when they are not in use or adjust the temperature based on occupancy, saving energy and reducing the user's utility bills.

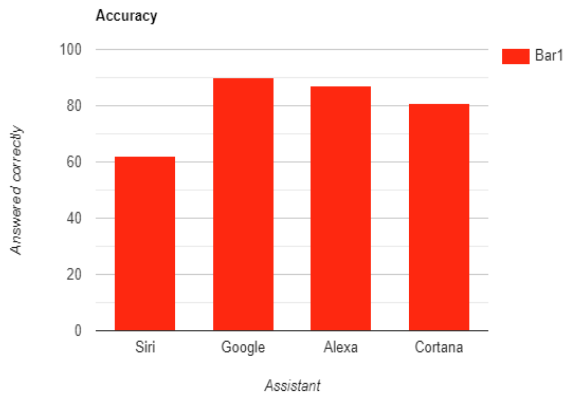

Fig:1 Accuracy based on user experiences

The above bar graph is made by collecting the data from users and from various online platforms. This graph shows the data that has been answered and understand correctly by the respective assistant after that it convert into percentage, According to Business Insider and Search Engine Journal. 62% Accuracy is shown by Siri, 80% by Cortana, 87% by Alexa and 90% by Google.

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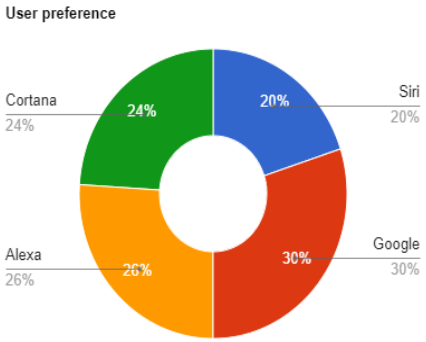

Fig :2 Pie chart based on overall user experience

This pie-chart is showing the overall preference of the users considering all features, drawbacks and Accuracy of assistants. Out of 100, 24% prefer Cortana, 26% Alexa, 20% Siri and 30% Google.

V. CONCLUSION

After analyzing the literature on voice recognition technology, it can be concluded that this technology has a lot of potential for home automation systems due to its convenience and ease of use. Fig 1 shows The Accuracy of understand correctly by the respective assistant google assistant give better response as compared with other. Fig. 2 shows the overall preference of different assistant out of with google assistant got max percentage. The benefits of using voice-controlled home automation systems include hands-free operation, increased accessibility, and the possibility of saving energy. However, there are also some drawbacks to using these systems such as speech recognition errors, concerns over privacy, and limited language support. In order to improve the functionality and usability of these systems, future research could focus on enhancing speech recognition accuracy, addressing privacy concerns, and expanding language support.[13] Overall, voice recognition technology has great potential for improving home automation systems, but further research is needed to overcome the current limitations.

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