

Exploring the Future of Smart Homes: Voice Control Technologies and Applications

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Abstract

With the use of voice commands, smartphones, and the Internet of Things, homeowners may utilise an intelligent house automation system, a technology-driven solution, to control and automate a variety of home systems and gadgets from a central hub. The system typically includes equipment such as smart thermostats, smart lighting, smart locks, security systems, and entertainment systems. With the increasing prevalence of IoT, smart homes have become increasingly popular, and automation systems have emerged as a key technology for controlling and managing various home appliances and systems. The system work with the multiple language like {English, Hindi} This note explores an exhaustive detail of the present state of automation systems for smart homes and aims to identify areas for future research and development along with comfort, energy efficiency, privacy, and accessibility that a smart home automation system offers users can enhance their life as a whole. The current paper also highlights the components of smart home automation system but also put a spotlight on application and challenges associated with it.

Keywords: Energy conservation, Raspberry Pi, portability, physically challenged, electrical and electronic devices, home automation.

INTRODUCTION

With the use of voice commands, smartphones, and the Internet of Things, homeowners may utilise an intelligent house automation system, a technology-driven solution, to control and automate a variety of home systems and gadgets from a central hub. The system typically includes equipment such as smart thermostats, smart lighting, smart locks, security systems, and entertainment systems. With the increasing prevalence of IoT, smart homes have become increasingly popular, and automation systems have emerged as a key technology for controlling and managing various home appliances and systems.

This note explores an exhaustive detail of the present state of automation systems for smart homes and aims to identify areas for future research and development along with comfort, energy efficiency, privacy, and accessibility that a smart home automation system offers users can enhance their life as a whole. The current paper also highlights the components of smart home automation system but also put a spotlight on application and challenges associated with it.

The rapidly developing sector of home automation, which lies at the nexus of lifestyle and technology, is revolutionising the way we use our living areas. It's a paradigm change towards a more connected, effective, and safe home environment rather than just being about gadgets.

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Throughout the day, mundane tasks like watering the plants or adjusting the blinds become automated rituals, leaving you with more time to focus on what truly matters. You can manage every element of your home environment, from creating the ideal mood for a dinner party to lowering the lights for movie night, with just a few taps on your smartphone or a short voice command.

And as night falls, your home seamlessly transitions into sleep mode, locking doors, dimming lights, and adjusting temperatures to ensure a restful night's sleep. The goal of home automation is to create a customised haven that adjusts to your wants and tastes, improving your quality of life in both significant and little ways [1]. It's not just about convenience.

Home appliances and other products can now be remotely controlled and automated because of the Internet of Things' ability to connect systems and gadgets. IoT home automation, which uses IoT technology to manage and control many home appliances from a single platform, is one of the most promising applications. Voice-controlled home automation devices have been created to increase public accessibility to home automation. These technologies provide a more natural user experience by enabling users to instruct a gadget in their own tongue.

Internet of Things (IoT)-based home automation system that manages many household appliances with a multilingual voice controller. The simplicity and user-friendliness of voice-activated home automation systems have contributed to their increasing popularity in recent years. These systems' primary benefit is that it eliminates the need for users to learn a set of commands and lets them operate gadgets in their local tongue. Additionally, a variety of devices, including lighting, thermostats, and security systems, can be managed via voice-activated home automation systems. In order to offer more functionality, these systems are frequently combined with other Internet of Things' gadgets, like sensors and cameras [2].

Any environment that includes gadgets like fans, TVs, air conditioners, motors, heaters, lighting systems, etc. is considered an electronic and electrical environment in this context. When an environment's appliances can all be accessed and controlled remotely by software, such as an Android or Web application, it's said to be remotely accessible. Although these remotely accessible devices are already on the market, they also have a lot of disadvantages. The purpose of this article is to survey all currently in use such systems and compare the features that are offered. Additionally, all the systems will be compared, and their distinct pros and weaknesses will be examined. For home automation systems, there are numerous possibilities. We'll look closely at each of these [3,4].

SURVEY OF LITERATURE

A review of the literature on home automation using multilingual voice controllers has identified several well-liked goods and services that are offered for sale. The most popular systems are Google Home, Amazon Echo, Apple HomeKit, Samsung SmartThings, Wink Hub, IFTTT, Logitech Harmony, HomeSeer, and Vivint Smart Home. Numerous studies have been done about multilingual voice controller efficacy. A central hub connects a collection of devices that make up the system. The hub oversees receiving voice commands, deciphering them, and adjusting the devices as necessary. Users can offer commands in their own language thanks to the voice controller's multilingual recognition capabilities.

To offer greater functionality, the voice controller is also integrated with other IoT gadgets, like cameras and sensors. Over the past few years, there has been a growing interest in the application of Internet of Things (IoT) for home automation. IoT home automation is a system that uses an internet connection to securely control lighting, temperature, appliances, and other aspects in a home. To make home automation systems more effective and user-friendly, a lot of research has been done. An Internet of Things home automation system with a multilingual voice controller was suggested by Mohan and Singh [1].

Using Google Speech-to-Text and Text-to-Speech APIs, the Raspberry Pi-based system allowed multilingual voice control of household appliances.

After testing, the system proved to be dependable and effective. Lalitha Vanathi et al. (2019) created a home automation system that can control different home amenities with a clap switch circuit and Google Assistant. The precision and dependability of the system were verified, and it was intended to be energy efficient. demonstrated a smart, IoT-based, energy-efficient home automation system that utilised an Android app in 2019 [2]. It was discovered that the system, which allowed for the remote control of household appliances, was dependable and effective. Nobrega et al. (2019) created an intelligent agricultural solution that measures soil moisture, temperature, and humidity using sensors [3]. After testing, the system proved to be dependable and effective.

A multilingual speech interaction system for Internet of Things-based home automation was proposed by Gao et al. [4]. The system, which enabled multi-language voice control of household appliances, was built around a Raspberry Pi and made use of Google Speech Recognition and Text-to-Speech APIs. After testing, the system proved to be dependable and effective. IoT applications and associated issues were covered by Kamal and Sayed (2017) [5]. Additionally, they demonstrated a speech-based natural user interface, which includes Google Assistant, Siri, Cortana, and Alexa. (2017) Lopez et al. [6]. They talked about their benefits, drawbacks, and features. Jasmin (2017) used IoT and natural language processing to create a voice-activated home automation system [7].

The system, which employed a speech recognition algorithm to enable voice control of household appliances, was built on a Raspberry Pi. After testing, the system proved to be dependable and effective. A Bluetooth-enabled Android smartphone smart dwelling system was proposed by Yan and Shi (2013). After testing, the system proved to be dependable and effective. Mowad used an Android application and a microcontroller to create an automated control system for smart homes. After testing, the system proved to be dependable and effective [8]. Ganesh et al. (2015) created a web application and Raspberry Pi-based home automation system. After testing, the system proved to be dependable and effective [9].

A scheduler and a voice recognition system were two features of the home automation system that Firmanda et al. (2015) suggested. After testing, the system proved to be dependable and effective. A Raspberry Pi- and email-based home automation system was proposed by Narender and Vijaylakshmi (2014). After testing, the system proved to be dependable and effective. In conclusion, a great deal of research has been done to enhance the usability and functionality of IoT-based home automation systems. Reliability and efficiency tests have been conducted on the creation of energy-efficient systems, multilingual voice controllers, and smart living systems. To create home automation systems that are more dependable and effective, additional study is required [9]. Schematic Diagram of system presented in Figure 1.

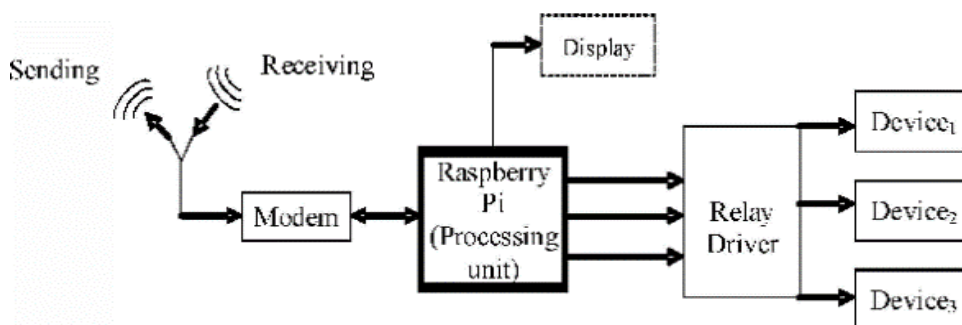


Figure 1. Block Diagram of Home Automation system.

COMPONENTS

This project Security System (Motion Capture) has three main components.

1. *Raspberry Pi Pico*: The Raspberry Pi Pico is a microcontroller board that has revolutionized the world of embedded systems and IoT development. This tiny, affordable, and highly capable board is designed by the Raspberry Pi Foundation, a non-profit organization dedicated to promoting coding and computer science education. The Pico is built around the powerful RP2040 microcontroller, which features dual-core Cortex-M0+ processors running at 133 MHz, 264 KB of RAM, and 2 MB of flash storage as shown in Figure 2. This impressive combination of processing power and memory allows the Pico to handle complex tasks such as machine learning, audio processing, and high-speed data transfer. Additionally, the Pico is equipped with a range of peripherals, including USB, SPI, I2C, I2S, and UART interfaces, making it an ideal choice for projects that require connectivity and data exchange. The Pico is also highly versatile, supporting a wide range of programming languages including C, C++, MicroPython, and Circuit Python, making it accessible to developers of all skill levels. With its compact size, low power consumption, and ease of use, the Raspberry Pi Pico is an excellent choice for a wide range of applications, from robotics and automation to home automation and IoT projects [10].

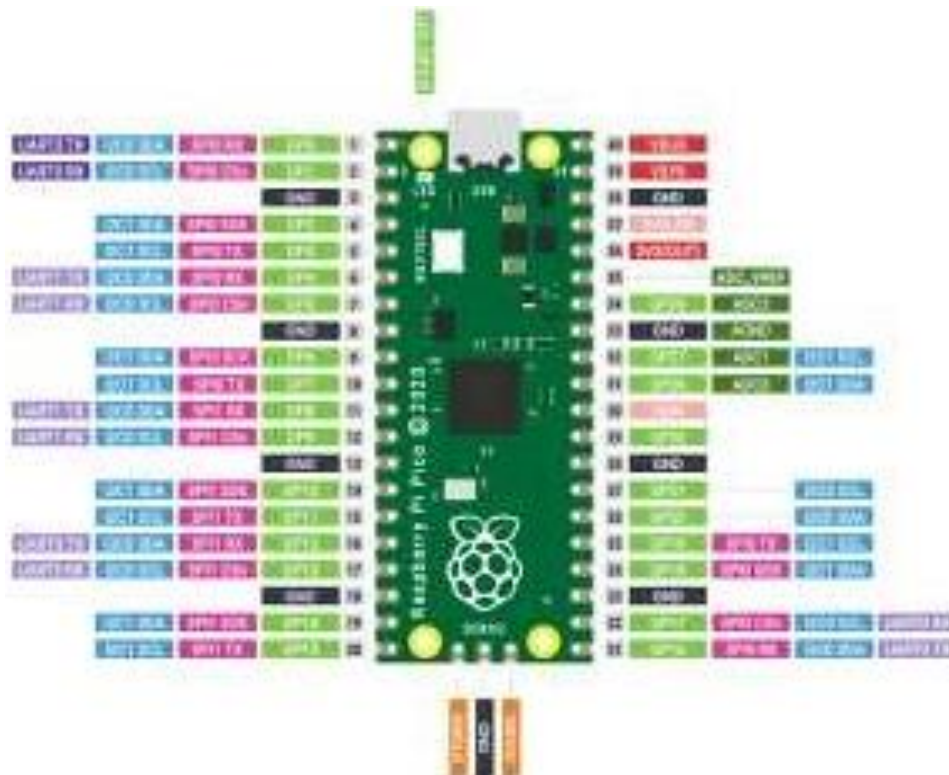


Figure 2. Raspberry Pi Pico.

2. *ESP32 Camera Module*: The ESP32 camera module is a powerful and versatile add-on to the ESP32 microcontroller board as shown in Figure 3, designed specifically for applications that require high-quality image capture and processing. This module is equipped with a high-resolution CMOS image sensor, capable of capturing images at resolutions up to 5 megapixels, and features a range of advanced camera functions including autofocus, auto-white balance, and exposure control. The ESP32 camera module is also equipped with a dedicated image processing unit, allowing for real-time image processing and analysis, making it an ideal choice for applications such as object detection, facial recognition, and motion tracking. Furthermore, the module supports a range of popular image processing libraries, including OpenCV, allowing developers to leverage the full potential of computer vision and machine learning in their projects. The ESP32 camera module is also highly integrated with the ESP32 microcontroller, allowing for seamless communication and data transfer between the camera and the microcontroller, making it an excellent choice for IoT projects that require high-quality image

capture and processing, such as smart home security systems, surveillance cameras, and autonomous vehicles [11].



Figure 3. ESP 32.

3. *Relay*: An electromagnet powers an electrical switch used in a power relay module. A separate low-power signal from a micro controller activates the magnets. The electromagnet pulls to open or close an electrical circuit when it is turned on.

An iron yoke that provides a low reluctance path for magnetic flux, a moveable iron armature, a wire coil wound around a soft iron core, or solenoid, and one or more sets of contacts make up a basic relay as shown in Figure 4. The moveable armature is connected to one or more sets of moving contacts and attached to the yoke. When the relay is de-energized, the armature, which is held in place by a spring, creates a gap in the magnetic circuit.



Figure 4. Relay Module.

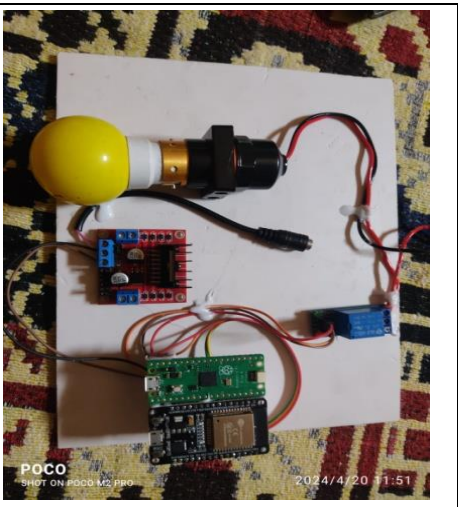


Figure 5. Hardware implementation

In this configuration, one of the two contact sets is closed and the other is open as shown in Figure 5 [11]. An armature is activated by a magnetic field created when an electrical current flows through a coil. A connection with the fixed contact is established or broken by the movement of the moveable contacts. The contacts that were closed open and break the connection when the relay is de-energized, and vice versa if the contacts were open. When the coil's current is cut off, the armature is forcibly brought back to its relaxed state. In most cases, a spring provides this force, although in some situations, gravity can also be employed. The majority of power relays are designed to run quickly [12, 13].

RESULT

The rapidly developing sector of home automation, which lies at the nexus of lifestyle and technology, is revolutionising the way we use our living areas. It's a paradigm change towards a more connected, effective, and safe home environment rather than just being about gadgets. Imagine waking up to your bedroom lights softly coming up in time with the dawn, all the while your smart thermostat adjusting the temperature to your preferred setting. Your programmable coffee maker welcomes you with the aroma of freshly brewed coffee as soon as you step downstairs. You can feel secure knowing that your home security system is keeping an eye out for any strange activity while you're away or at home. During the day, routine chores like adjusting the curtains or watering the plants become automatic routines, freeing up more time for you to concentrate on the important things in life. You can manage every element of your home environment, from creating the ideal mood for a dinner party to lowering the lights for movie night, with just a few taps on your smartphone or a short voice command. Furthermore, your house automatically enters sleep mode as dusk approaches, locking doors, lowering lights, and regulating air conditioning to guarantee a good night's sleep. Convenience isn't the only benefit of home automation; it's also about designing a customised haven that fits your tastes and requirements, improving your life in both significant and little ways.

CONCLUSION

To sum up, this article outlines the characteristics of the perfect system for home automation with remote access, based on an analysis of all the systems assessed and their benefits and downsides. A user should be able to access an ideal system in real time and from anywhere in the world. A GSM network has been suggested as a possibility for this. To access the internet, nevertheless, one must use the GSM data channel. The only thing that can guarantee access is always available is the Internet. This will lead to the development of a common Internet protocol-based access method for household equipment. A web application with a corresponding mobile application should serve as the user interface. in order for users of all backgrounds to access the system. Another aspect that such a system ought to have is ease of installation. Then and only then can automated homes turn a profit. The user interface design of these apps ought to be carefully considered. The system's ability to plug and play will be an extra plus. The technologies' ability to be added to an automated home with ease will be crucial to their commercial success. The potential for home automation systems in the future includes even more intelligent dwellings. Sensors such as temperature, light, and motion sensors can be interfaced with homes to enable automated gadget toggling based on conditions.

Ensuring that the house is occupied before turning on electronics, checking for brightness, and turning off lights when not in use can all help save more energy. To give homeowners more control and security, the system can be tightly connected with home security systems. The next stage would be to expand this system's functionality to automate expansive spaces like factories and offices.

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