# A Comprehensive Review of Technologies, Services, and Intelligent Approaches for Smart Home Automation

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***Abstract*—Automation is the process of managing a system's functions with the least amount of human involvement. The development of technology has improved our quality of life. A system for home automation is one example of this kind of technology. Because of its greater openness and nominality, the home automation market is expanding quickly, and smart home automation has become more widely available very quickly. The salvation arrangement heavily relies on the automation of the smart home. The bulk of home automation systems that have been created to date have prioritized functionality above overcoming more obstacles. Intelligent decision making, secure device identification and authentication, constant connectivity, data security, and privacy concerns are the main obstacles in a smart home. The solutions only address one or two of these problems; however, it is time for a smart home automation system that is not only safe but also capable of making wise decisions and doing analysis. This paper aims to investigate the technologies utilized in home automation. This paper aims to provide a detailed analysis of the technical components of home automation technology.**

***Index Terms*—Home Automation, Artificial Intelligence, Sys- tem on Chip, IoT Devices, Sensors**

## I. Introduction

With the benefit of humanity as its primary goal, smart technology has emerged as the primary force behind ground-breaking concepts like home automation. Globally, smart home technology is developing at a quick pace because to the surge in device inter-connectivity and information distribution that has been brought about by the evolution of smart products and services [1].

The smart home has emerged as one of the most promising areas of home automation and control is shown in Fig.1. The phrase "home automation" does not only refer to houses occupied by humans. Instead, it has a broader variety of technological ramifications, such as intelligent or smart living [2]. In order to achieve energy, security, and healthcare, com-fort and convenience, and entertainment conservation, smart technology integration into homes is referred to as home automation, which is a branch of ecumenical computing [3]. At first, home automation was seen as a convenience product, but as technology advanced, it became clear that it also offered efficiency, preference, and security. According to studies, smart houses can lower their overall electricity cost, which has a significant impact on efficiency [4]. Although a single home automation system using this technology saves very little, when used as a whole, the impact is bigger than it was previously. The security system in the house is another area with a lot of potential that home automation may greatly influence. A smart home's security system can make use of a variety of sensors to create a safer atmosphere [5]. The ambient elegance of a home can also be significantly influenced by
home automation.

Based on the aforementioned topics, a summary of recent works on technological advancement in smart homes is pro-vided in this review. This report additionally examines data gathered from other researchers' works in order to accurately describe the particular fields and approaches those academics in HAs use. This review's primary goal is to compile the most recent developments in the field of HAs research. This thorough analysis will provide a systematic and thorough examination of HAs as well as a broad understanding of current developments, which will be helpful to researchers, engineers, designers, and other individual's implication in the development of HAs.

Section 1 contains an introduction to this study. Section

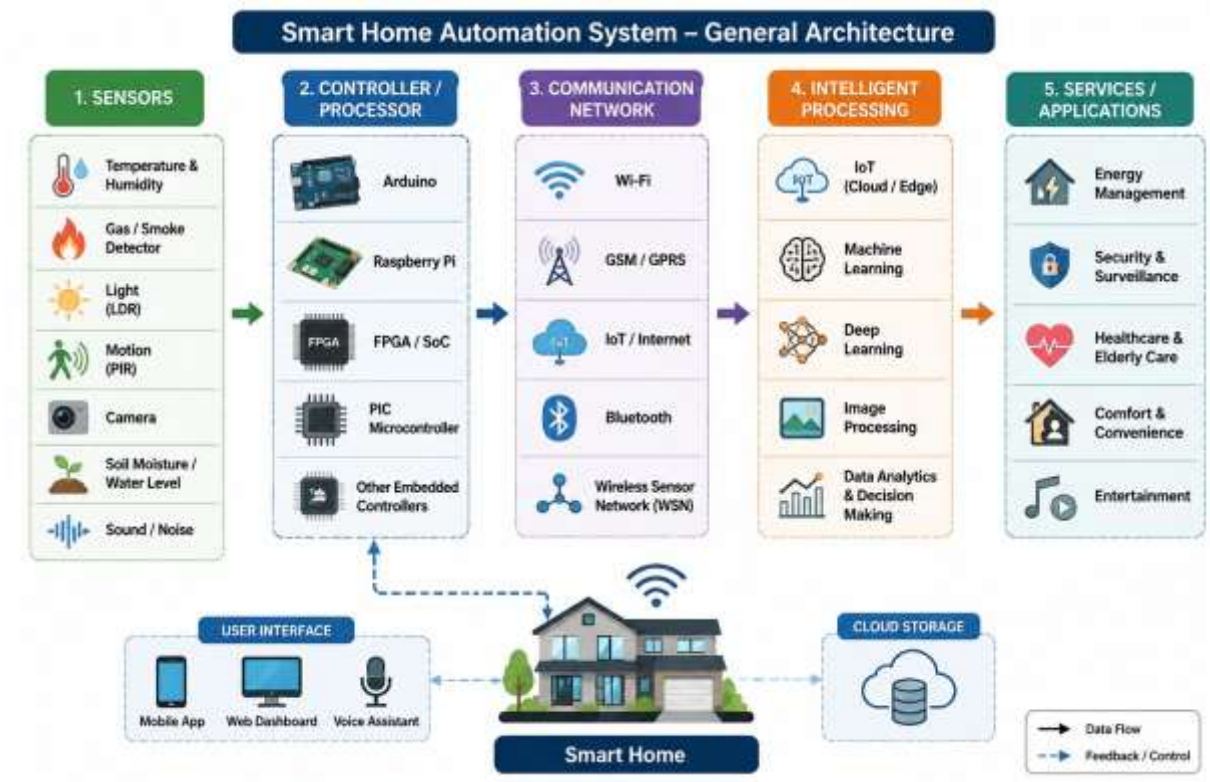



Fig. 1. The General Structure of Home Automation System

2 outlines the procedure used to choose the study mate-rials. Section 3 outlines the technical approaches to home automation as developed by different researchers. Section 4 lists the services offered by home automation analysis. The technological methods to home automation offered by HAs are examined in Section 5. In the Section 6, there are last thoughts and reflections. Section 7 contains the future work of home automation system.

## II. Methodology

Presenting an unbiased assessment of a research topic with the aid of a trustworthy, exacting, and verifiable technique is the goal of a review [6]. Future researchers can benefit from the systematic review's concise and enlightening overview of earlier studies conducted by different researchers on a given domain or title. This section outlines the research methods used to examine previously published papers and develop a comprehensive study of the HAs idea. This review assessed and summarized the body of work on HAs that has already been done, taking into account a number of factors like comfort, energy management, sensors, and communication channels. These ideas served as the foundation for the following four main research questions:

- What strategies or techniques go into building a home automation system?
- What kinds of sensors were used in the home automation system's development?
- What kind of networking equipment and communication protocols were used?
- For home automation systems, what kinds of security precautions were taken into account?

This study's primary goal is to examine previous research on home automation systems and identify the methodologies used, the hardware, sensors, and networking technologies employed, as well as the security measures taken into consideration.

## III. Technical Methods on Home Automation

The development of software and hardware innovation has combined to significantly alter the trajectory of home automa-tion. There is an abundance of goods on the market that facil-itate home automation. However, most of them were built by integrating sensors, user interfaces, networking technologies, processors/controllers, and computational techniques.

### *A. HAs Use Central Micro Processors/Controllers*

A microcontroller's typical components include one or more CPUs, memory or storage units, and input/output peripherals. Microcontrollers are utilized in the construction of HAs for a range of tasks, together with command execution, data computation, sensor control, and information storage. The evaluation and list of all the microcontrollers utilized in the creation of HAs are provided below.

- Arduino
- Raspberry Pi
- FPGA
- PIC Microcontroller.

### B. The Use of Sensors

The formation of HAs is significantly influenced by sensors. During the literature study phase, it was determined that several sensor types were being used. The list of sensors used in the design, development, and implementation of HAs is presented in detail in the list below. The Controllers in Has.

- Temperature / Humidity sensor
- Gas / Smoke / Flame sensor
- Light / Accelerometer / Gyroscope sensor

### C. HAs Utilize Networking Technologies

Networking between the sensors, processing unit, and user-end device is necessary in order to process the data that is provided by sensors and other devices, or to communicate the results of the analysis of the data to end users. Sensors, processors, and users are connected continuously through a network system [7]. In general, sensor-processor networks and processor-user networks are the two distinct networks that make up the network system.

### D. Interfaces for Users in HAs

A user-end communication interface is built up in HAs so that the user can send commands and receive vital system messages. An application for a smartphone could serve as this interface [8] or an internet page.

## IV. SERVICE PROVIDED BY HOME AUTOMATION

A few of the services offered by home automation systems are mentioned in this section. Many services have been intro-duced recently for HAs; nevertheless, the most common ones are included in this section.

### A. Systems for Energy Management in HA

An intelligent network control system built on the principles of smart homes is the home energy management system (HEMS) [9]. It combines energy storage devices, electricity consumption, and power generation into a single management and control system [10]. Customers' power bills can be reduced and household renewable energy efficiency can be increased with HEMS.

HEMS is a new generation of information technologies that use the home as a carrier to create a low-carbon, intelligent, safe, comfortable, and healthy family lifestyle. These technologies include cloud computing, big data, mobile Internet, and Internet of Things [11].

### B. HA's Security systems

The security system that can be implemented in a residential setting is predicated on motion detection and monitoring. In addition to standard home control, a smart home automation system is expected to provide safety and home security services. Intelligence is integrated into the smart home environment to minimize the amount of work that needs to be done by humans to monitor and control the home and its appliances. The residents can live in a comfortable atmosphere free from constant alerts and notifications thanks to ambient intelligent home control and security systems.

Because home automation allows us to operate our equipment from a smartphone or tablet, it has given us peace of mind about security even while we are not at home. It's somewhat peculiar that a worldwide technology exists without outlining the limitations and difficulties encountered throughout IoT development and providing users with privacy and security. IoT distribution necessitates intensive work to implement and address security and privacy threats [12]. An effective home automation system design improves life quality by lowering stress and wasting money on necessities.

### C. HA's entertainment systems

In the entertainment sector, home automation technology has completely changed the game. Thanks to the development of smart gadgets and integrated systems, you can now cus-tomize and control your own home entertainment like never before. Home automation technology is here to revolutionize your entertainment options, whether you're a tech aficionado or just love the concept of turning your living area into a cutting-edge entertainment hub.

IoT-based HAs systems, which enable users to manage a variety of household gadgets, including audio, video, home theatres, and other entertainment systems, in addition to keep-ing an eye on their living space [13]. A number of techniques are available for controlling the entertainment applications, in-cluding voice command and wireless control via a smartphone app [14].

### D. Convenient and comfort in HA

It belongs to the home automation subset. Most devices in HAs communicate and control through a single window point. Gesture control is the term used to describe how less human interaction—such as hand gestures or facial expressions—is required when domestic appliances and items are scheduled automatically. In [15], body motions were recorded using a Kinect v2 sensor. These gestures are then utilized to identify a set of hand state combinations that can be used to control household appliances. In [16], gesture recognition is achieved by the employment of a wearable wrist-mounted motion-sensing device. The gadget is made up of an RF wireless transceiver for communication and data transmission to the main processor, an Arduino board for data processing, and an inertial sensor for hand motion detection.

### E. Health Care systems in HA

As home automation technology develops, it will become increasingly capable of offering residents health care and health surveillance services, particularly for the elderly and those with physical disabilities [17]. a reasonably priced intelligent support system for the elderly that can remind users to take their medications and notify specific individuals of important occasions like incursions or free eruptions. In addition, it offers a wireless speech and text-based system for controlling home appliances, which allows users to turn on and off different appliances with voice commands or text messages. Those who are physically challenged or old can use this way to control their appliances remotely, which is quite helpful.

## V. TECHNOLOGICAL APPROACHES OF HOME AUTOMATION

Many technical methods to HAs have been identified after carefully study and evaluating the research articles chosen for this review. This section contains a comprehensive examina-tion and assessment of the technological strategies used by the HAs.

### A. HAs based on Wireless Sensor Network (WSN)

A wireless sensor network (WSN) is a network of dispersed, wirelessly connected sensors that are used to monitor several environmental parameters like force, pressure, sound, temper-ature, and humidity. In addition to ambient factors, additional sensors pick up on gas, smoke, movement, stardom, and a host of other things. Each of these sensors is a component of a wireless sensor network (WSN), which wirelessly gathers data from each sensor and transmits it to processing. The flexibility, affordability, and scalable architecture of the WSN have made it extremely well-liked by HA developers.

### B. HAs based on Image Processing (IP)

Image processing in home automation systems (HAs) in-volves the examination of information gathered from many cameras to provide a range of services, including object-detection-based smart home security systems and gesture control [18].

Image processing-based home automation systems typically have a high data communication rate among the camera and the data processing sector since these systems rely on real-time videos and images from the home automation. However, the image processing system occasionally falls short of pro-ducing the desired outcome because cameras are impacted by shadows, distortions, inadequate light, and other variables.

### C. HAs based on Internet of Tings (IoT)

Smart homes have been designed and implemented using IoT .In [19], an IoT-based home automation energy manage-ment field has been investigated in conjunction with the use of sensors to keep an eye on the residents. IoT is utilized to employ machine learning to identify dementia in its early stages. One of the most important technologies for the creation of HAs is now IoT. The primary controller, sensors, and computing devices are all internally associated via the Internet in an IoT-based HA.

### D. HAs Based on Machine Learning (ML)

The data gathered from the smart house is examined and used in a machine learning-based home automation system (HAS) to forecast the condition and manage the home ap-pliances. In [20], machine learning is employed to identify early dementia symptoms in the elderly. Smart home security systems can also be monitored by machine learning-based systems [21].

### E. HAs Based on Deep Learning (DL)

Deep learning can assist with energy conservation and smart home automation, as suggested in [22]. In [23], an object recognition system for HAs using image processing was created. IoT and deep learning have both been applied in the healthcare industry.

### F. HAs Using the Global System for Mobile (GSM)

Using this SMS capability, GSM-based HAs alert users to a variety of threats, such as fire, smoke, and theft, directly to their phone. Additionally, users may send an SMS from their phone to monitor and operate smart home appliances, as detailed in [24].

## VI. CONCLUSION

Home automation has been developing for many years, and researchers have made significant progress in this area. Smart homes offer a safe, comfortable, and effective way of life. In this study, We've compiled a detailed comparison of the six main technological approaches, four of the most widely used microcontrollers, and eight distinct types of sensors that researchers employ in their work, along with information on their popularity and research trends.

In addition to these, this study has included a thorough examination and analysis of the networking technologies used, as well as a number of services like energy management, secu-rity systems, health management, comfortable and convenient systems, and entertainment systems. In addition, a thorough analysis of the data gathered from the different articles is presented in the discussion section, demonstrating how the increased functionality resulting from the use of multiple approaches is driving the popularity of multiple approach based home automation.

## VII. FUTURE WORK

While some of the smart house challenges are addressed by the current systems, it is imperative that we move towards a home automation system that not only provides energy control and security, but also possesses analytical and intelligent decision-making capabilities. In upcoming work, we present a novel concept for home automation that leverages blockchain technology to guarantee the identity and authentication of the Internet of Things (IoT) devices, artificial intelligence for intelligent decision making, and system on chip technology

for implementing hardware integrated with GSM network accessibility to support 2n devices. A dependable, secure, and decentralized method for identifying and authenticating the Internet of Things devices utilized in the suggested home automation system is provided by emerging blockchain technology, which is crucial. Furthermore, the suggested home automation system uses the combination of Machine Learning, Deep Learning, and Natural Language Processing to categorize the status of its components. The Android platform will be used to construct a mobile application. The application and System on Chip hardware communicate with each other through the web interface and cloud server.

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