

Smart Home Automation System Using IoT, AI and Communication Protocols

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Abstract: The Internet of Things (IoT) is a very broad term, but we can define it as a network of intelligent devices that are equipped with networks, sensors, and processing systems which communicate with each other without human interventions and sometimes or in some case with human interventions. Artificial Intelligence (AI) is nothing but replication of human intelligence with help of machines or computer. AI and IoT based applications nowadays encompass a wide range such as industrial sector, agriculture, the health sector, smart cities, security, home automation, office automation and emergency services, among many others. IoT enables us to make and use intelligent devices to address problems and difficulties in the real world and get empowered with new technologies such as AI. The present internet is being expanded through the "Internet of Things" to allow for connectivity and communication between various living and non-living objects. This review paper offers an analysis of IoT-based home appliances that can simplify people's lives. IoT-based devices are employed in a variety of contexts. The present paper emphasis on the smart home automation system using IoT and various communication protocols. Current paper also focus on the beginning to present era of home automation system.

Keywords: Internet of Things, home automation, security, sensors, communication protocols.

INTRODUCTION:

The digital world of today enables machines, products, and devices of various sizes to automatically send data across a network, essentially "talking" to one another in real time. Nearly every aspect of daily life will be affected by Internet of Things (IoT) technology, which will also improve and safeguard our standard of living. Smart IoT with AI support sensors are aware of our preferences, including the music we enjoy, the temperature and lighting we prefer, as well as the times we wake up, eat, and go to bed. Smart lighting, outlets, and security systems are just examples of gadgets that make our daily lives easier. We don't need to worry about our security of home when we are away because they are simply regulated using a smartphone app and IoT based devices. Artificial Intelligence (AI) is nothing but replication of human intelligence with help of machines or computer. With the help of AI and IoT technology, we can automate our daily tasks, improve our lives, and making our houses safer. Comprehensive IoT adoption can enhance every element of human life, including home security, recreation, and healthcare [1, 2]. Due to many benefits of AI and IoT including ease operation, simplicity, centralised control of appliances, less expensive, energy savings, reliability, and security, automation systems are becoming increasingly necessary in daily life. A home automation system enhances users' quality of life, particularly for the elderly and people with disabilities [3].

Many different products that cater to the majority of users' wants are available on the market. Users may easily connect with their embedded systems and gadgets thanks to companies like Apple (HomeKit), Samsung (SmartThings), and Google (Alexa). Additionally, there are platforms like BACnet, KNX (Konnex), and Dupline that have been around for a while and use the home's structured wires to provide home automation. As a result, alternative technologies such as Zigbee, Z-Wave, Bluetooth, and Wi-Fi offer wireless communications. Additionally, some companies are providing cutting-edge technologies like Insteon and EnOcean as well as those originating from the Internet of Things: LowPAN and Thread [2-5].

EVOLUTION OF HOME AUTOMATION SYSTEM:

Beginning in the 1990s, a variety of electronic and electrical devices or appliances were being used in the average home. There were standard electric appliances like the refrigerator, as well as digital appliances like the television, telephone, and communication gadgets. A typical domestic setting would have power wiring, telephone wire, and cable TV wiring because each of these equipment needs a specific wiring system to function [5, 6]. Figure 1 reveals evolution of technologies in home automation system. For house security, PC local area networks, and other purposes, some homes also included additional wiring. All of these systems operated independently of one another and carried various types of signals using various communication media. Dedicated microprocessors became a widespread component of household appliances as a result of significant advances in IC technology, which also caused a steep decrease in processing costs and accelerated the downsizing process, increasing the level of intelligence of these products [6, 7]. The IC technology evolution the new concepts in the market in the field of automation. The 8085 and 8086 series based microprocessors used in the field of automation. After that, some wire and wireless with microcontroller based system was employed [8].

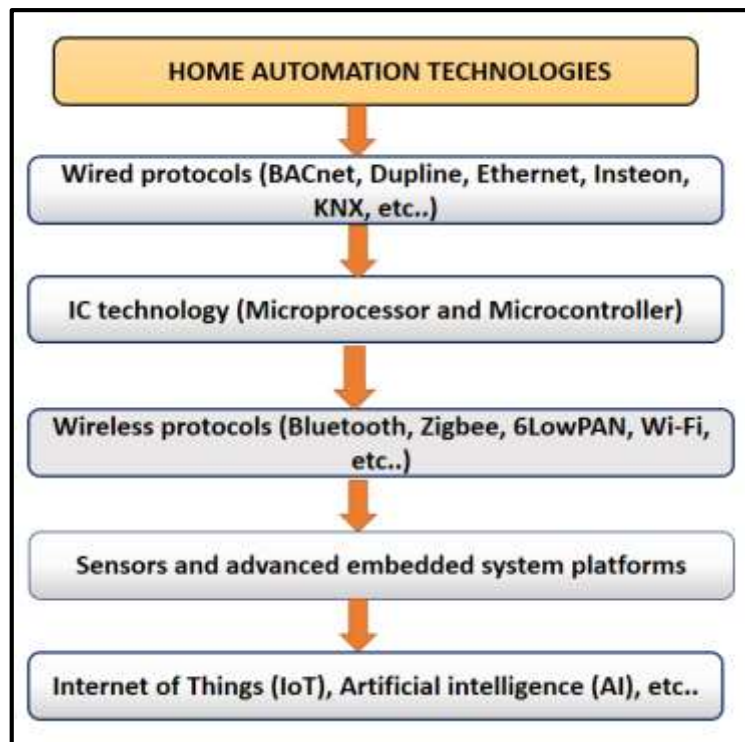


Figure 1: Evolution of technologies in home automation system

LITERATURE SURVEY ON IMPLEMENTATION OF TECHNOLOGY IN HOME AUTOMATION SYSTEM:

Hiroshi Kanma [9] stated in 2003 that although the fast uptake of the Internet at home may offer a practical method of setting up a home network and its control, there were some obstacles that needed to be overcome to develop home automation.

Hayong Oh [10] emphasised the significance of an energy-efficient routing architecture for the sensors installed in homes in 2005. The authors say that sensors must be installed all throughout the house in the developing automated home in order to gather physical data like temperature, humidity, and light for use by various appliances. According to the authors, each sensor node in the traditional sensor routing scheme detects an event and broadcasts it to all other sensor nodes within a one-hop radius, from which point all nodes broadcast the message to subsequent nodes. Up until the event approaches the base station, this process is repeated. An energy-efficient sensor routing system is essential for the effective deployment of the home network because this scheme causes an undue drain on the battery power of the sensor nodes, which have limited battery life. Evidence of the suggested plan's energy efficiency was presented.

Bhagat, K. [11] developed a Dual-Tone Multi-frequency (DTMF) remote control system for residential appliances. The system consists of two mobile phones, a DTMF decoder, and an ATmega8 microcontroller. One mobile phone is used as the receiver and may be placed distant from the home. The control information is transmitted to the mobile phone as a DTMF tone, which is subsequently received by the mobile phone at home and processed by the DTMF decoder MT8870 IC. The ATmega8 microcontroller receives input via the decoder's output logic signal. The DTMF decoder's output is used to programme the ATmega8 microcontroller to operate home appliances. This system has one disadvantage, we required two mobile phones continuously. Among two mobile phones one mobile is always connected to the main circuit. Hence it's bulky and expensive as well as required more maintenance.

A low-cost, adaptable, and safe home automation system based on a cell phone was designed and implemented by Muthukumaran, M. [12]. The home appliances are wired through relays to the input/output ports of a standalone Arduino BT board, which serves as the design's foundation. Cell phones and Arduino BT boards can communicate wirelessly. With just minor changes to its fundamental structure, this system's low cost and scalability enable the control of a wide range of devices. Only authorised individuals are permitted access to the home appliances thanks to password protection. A smartphone, an Arduino board, and a Bluetooth module are the three physical components of the described home automation system. An app for the smartphone and Bluetooth technologies are utilised to communicate with the Arduino board. For the hardware implementation in this research project, Bluetooth module HC 05 and Arduino Uno are used. Bluetooth based home automation system working at very low distance i.e. home appliances can be controlled in very short range, this is the one of the disadvantage of proposed system.

Sood, E. [13] built and presented an advanced home automation system using a standard web server and Wi-Fi technology. Through Wi-Fi, a Personal Computer (PC) may read sensors and turn on and off the devices. The Arduino microcontroller is employed in a unique architecture for a low-cost, adaptable home automation system. The coding for Arduino is simple to comprehend. We can guarantee that energy saving can be done by putting in place this kind of technology. We can improve the efficiency of the appliances with the aid of this technology. We can operate our household appliances in full control from a distance. The ability of humans to be comfortable will increase, and human effort will decrease.

Efendi, A. [14] introduced 6LoWPAN wireless embedded internet technology and a system that is specifically created for the task of home automation. This system is a low-power wireless home network that combines Contiki embedded RTOS with the CC2530 SoC for 802.15.4 applications. The home gateway offers a clever and effective framework for linking home automation to the

outside world using Ethernet or Wi-Fi. To protect our 6LoWPAN-based wireless home automation system. The authors also develop latent verification for secure remote home controllers and a 6LoWPAN anomaly-based intrusion detection system.

A wireless home automation system that has been developed and implemented into use has an overall design by Arul, S. [15]. The automation focuses on voice command recognition and makes use of low-power RF ZigBee wireless communication modules, which are reasonably priced. All of the lights and electrical devices in a house or business are supposed to be controlled by voice commands using the home automation system. The programme has been examined and validated. A speech recognition response test and an indoor ZigBee communication test were among the verification tests.

The development and use of the relatively new Z-Wave protocol in smart homes are discussed by Yassein and M. [16]. As it offers higher dependability, low radio rebirth, easy to use interface, and simple interoperability, this wireless protocol has numerous advantages over the well-known and commonly utilised ZigBee protocol. Z-Wave is a wireless protocol developed by Zensys and approved by the Z-Wave Alliance for automation devices for homes and business settings. It can control all major electrical appliances in the house, including on/off lights, air conditioning (HVAC), kitchen, monitors, and home security. A wireless protocol called Z-Wave is used in homes to connect automation equipment. It is focused on and attempts to provide a simple, reliable method of wirelessly controlling automation systems in homes. There are numerous Z-Wave products available under different brands. This protocol was created by Zensys, a Danish startup that Sigma Designs acquired. Through the Internet, a Z-Wave gateway, or a central control appliance, a Z-Wave network can be remotely controlled.

Using Google Assistant, Rishi, R. [17] designed home automation system. In the current research authors used Arduino board, Android OS, Smart phone, Remote control, GUI application, transmitter and Google Assistant for control home appliances. One can use voice commands to give the Google Assistant instructions in human-based language. All connections in this project are connected to the Internet of Things because it helps with IoT familiarisation. A home automation system that uses the Google Assistant, or an alternatively an android-based programme, enables users to control motorised appliances using voice commands and, in this case, a single toggle on a smartphone screen. A simple gadget like a light bulb is an example that is regularly triggered in motion by a motion detector signal or is a component of a networked home self-operating system.

An effective, low-cost supervisory system for smart home automation that can be controlled by IoT is suggested by Kamal, M. [18]. The suggested solution, which is based on the Apriority algorithm, will assist in efficiently and reliably monitoring and controlling all household appliances and electronic gadgets through a supervisory system. By keeping an eye on the amount of electricity being used, both customers and providers will have the chance to control how the power is distributed.

Milica, L. [19] developed home automation system using sensors, Raspberry Pi, IoT and other electronic components. This article describes the implementation of an Internet of Things (IoT) application that displays the usage of humidity and temperature sensors for sensing using DHT11 sensors on Raspberry Pi software with the extra transfer of data to the Cloud which is inside the software IDM Bluemix. The action is carried out using a Raspberry Pi running Raspbian Stretch Lite as the programming environment. The IBM Internet of Things (IoT) platform is built on the Node-RED programme installed on the Raspberry Pi and accesses data through the IBM Cloud.

"UJALA- Home Automation System Using Google Assistant" was designed by Agarwal, A. [19]. The ESP8266 Wi-Fi module will be used as a network provider in this project's design and prototype for a home automation system that will link with other appliances. Additionally, we will link the particular residence to our database so that it may be accessible from anywhere using a particular IP address or website. Additionally, a tool would be created that would enable users to operate their gadgets with the Google Assistant.

Modern usage of the phrase "smart home" refers to homes with electronic systems and gadgets that can be managed remotely by the owner, frequently using a smartphone app; nevertheless, the idea of managing all aspects of a home with a centralised control system dates back to at least the early 20th century [20]. IoT devices are more accessible than ever before, and smart home systems are becoming a more affordable choice for homeowners. However, due to proprietary software and systems, the home automation sector has had significant growing pains. Consumers frequently have to choose between getting the numerous devices they really want and having those devices function well during a smooth implementation [20, 21].

The Home Automation System is an expansion of current activities carried out inside the home, and it is now possible to create a Home Automation System quickly thanks to powerful computing devices and wireless sensor networks (WSNs). These technologies allow IoT-based smart banks to achieve home automation with gesture detection and control. As centralised control systems with remote-controlled switches become more common in modern homes, conventional switches are gradually being replaced by them [22, 23].

Imagine living in a world where you could simply use your voice to tell your household appliances to perform the tasks you need them to. In the upcoming days, we'll employ automated, activated homes. As a result of their ability to share their current state with other connected items, today's smart objects in the IoT can work together to make deft judgments on their own. People always look for alternatives around to do tasks successfully. Additionally, similar or alternative items that are in line with user expectations, the current situation, and prior information should be able to be provided automatically by service provisioning in the Internet of Things. The progress of automation technology has made life in every way simpler and easier. Manual systems are preferred to automatic ones. Automation technologies that can adapt to the modern environment have supplanted traditional household chore-completing techniques. Traditional methods need to be replaced since the people of the current generation no longer find manual procedures acceptable [23-25].

Each technology has distinct advantages and characteristics that make some of them better suitable for specific purposes while others may be used for all types of conventional home automation setups.

IoT ARCHITECTURE:

The Internet of Things (IoT), a recently developed technology, is expected to usher in the following revolution in computers and information technology. IoT systems have applications in a variety of industries owing to their exceptional flexibility and capacity to be used in any setting [26, 27]. The objects that will be managed make up the physical layer. This layer is also connected to the sensors that detect the ambient conditions around them. The IoT gateway router, device management, and numerous communication protocols compose up the data link layer. Through Wi-Fi connection, this layer connects the home appliances to the webserver or cloud. Web protocol is used in the application and presentation layers. This layer entails either establishing a website for PC or laptop users to access the devices connected to the perception layer, or establishing an iOS or Android mobile application if the devices are to be operated and monitored via smartphones [26-28]. Figure 2 shows that IoT ecosystem layers.

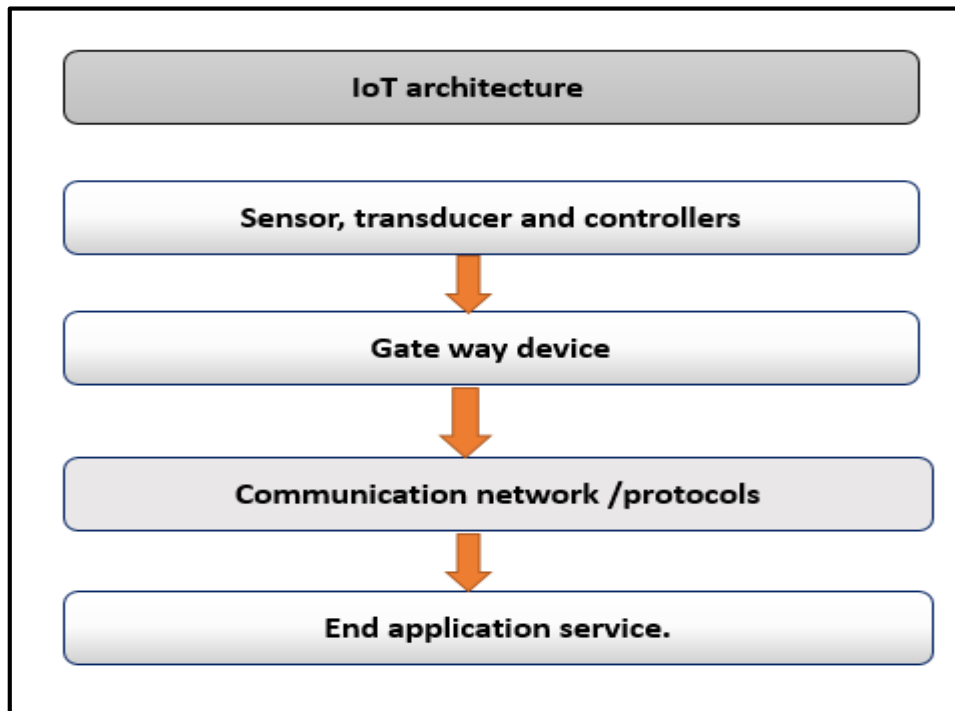


Figure 2: IoT ecosystem layers

CONCLUSION AND FUTURE SCOPE:

The term IoT has a larger use in all aspects of life. IoT is a collection of technologies. Unlocking useful, relevant data from the IoT requires collaboration between sensors, devices, networks, controllers and software. This review paper provides a high-level overview of a home automation system that makes use of IoT and a number of communication protocols. It also includes a review of numerous technologies that vehemently assist home automation systems in a trustworthy manner. IoT-based devices are employed in a variety of industries, including the medical field, business organisations, and government institutions. IoT devices are utilised for home automation in addition to their many other applications. IoT-based home appliances are simple to control remotely. Artificial Intelligence (AI) is nothing but replication of human intelligence with help of machines or computer. Artificial Intelligence and the Internet of Things work together and enhance the quality of overall human civilization.

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