IOT Driven Home Automation System: A Comprehensive Review

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Abstract— **The Internet of Things (IoT) evolution produced major changes to living areas by building spaces that understand more like a human being while responding interactively. Smart home automation systems underwent a fundamental transformation because of this technological advancement which allows them to oversee devices linked to the internet throughout households. Modern systems that combine monitoring capabilities with security functions and lighting controls have improved both security measures and energy efficiency as well as delivered better user benefits. The usage of modern wireless communication systems and AI together with cloud computing also makes it possible for sophisticated sensors combined with actuators along with devices to function seamlessly between devices and human operators through interconnection via these technologies. The user experience has been enhanced by home automation because it eliminates manual work and automates common activities and maximizes energy efficiency through scheduled resources management. The optimization problems within home automation get solved effectively with two algorithms: Tabu Search (TS) and Evolutionary Algorithms (EAs). Tabu Search relies on adaptive memory functions to optimize solution exploration that utilizes state visitation memories for avoiding local optima thus improving its solution search capabilities. The operational method of Evolutionary Algorithms duplicates biological evolution mechanisms by putting selection and crossover and mutation methods on various candidate solutions to develop better results in their search for optimal answers. This research examines both Tabu Search and Evolutionary Algorithms regarding their performance in optimizing actual home automation situations through an evaluation of their processing efficiency as well as solution quality achievement. The analysis results will yield definitive recommendations about optimized methods based on particular requirements along with system constraints of home automation. Today's intelligent technology focuses on developing central management systems which combine various home services on integrated home servers that control household communication platforms and broadcast media and operate smart devices. The combination of stable computer hardware components like Raspberry Pi and Home Assistant or OpenHAB open-source platforms enables users to create unified home server solutions that deliver efficient control of all domestic services through one coherent management platform. Research results demonstrate the practical design of integrated home servers and their implementation methods and related advantages for both users and business operations with emphasis on improvement of convenience and energy savings alongside higher user experiences and lower total operational expenses when compared against using independent standalone systems.**

Keywords— **Advanced Smart Home Technologies, Internet of Things (IoT), Home Automation Systems, IoT-Based Control, Smart Home Security, Connected Devices.**

I. INTRODUCTION

The goal of home automation is to provide customers with precise control over common electrical equipment in the home, resulting in more affordable lighting options, improved energy efficiency, and lower power consumption [1]. Smart homes are becoming more and more popular as the Internet of Things expands, and automation systems are becoming crucial for controlling many home systems and devices [2]. In addition to solving lighting issues, the idea enables the development of a centralized home entertainment system and the control of entire house security systems, among other uses [1]. The system functions with communication technologies that include Bluetooth and ZigBee together with GSM (Good System for Mobile Communications) and Wi-Fi. A wireless network formation becomes possible through combining multiple devices at home workplaces which then operate together as a single unified system [3].

The different configurations among contemporary communication devices as well as their complexity levels create obstacles for management. The development of bidirectional communication in Home Automation Networks (HAN) allows monitoring and controlling household appliances in addition to demand response (DR) system requirements [4]. The growing consumer market attracts an increasing number of users to Home Automation Systems (HASs). HASs face unique limitations because their benefits for disabled users as well as senior citizens do not overcome user resistance due to perceived cost and complexity issues. A wide range of smart devices links up with internet to form the core components of Internet of Things [5] [6].

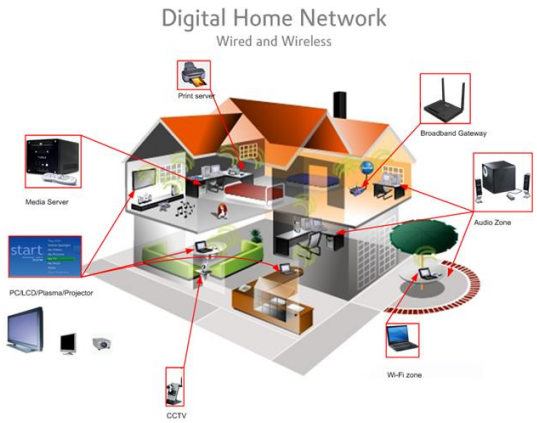

Fig 1: IoT-based Smart Home Automation Architecture.

In this paper we analyze the different parts, features, and impediments in the construction and refinement of smart home infrastructure utilizing IoT technology. We elaborate on the interconnectedness of communication protocols, sensors, cloud computing, and artificial intelligence capable of turning a plain architectural construct into a sophisticated home automation device. The paper will also discuss the application of optimization methods such as Tabu Search and Evolutionary Algorithms in boosting the energy efficiency, safety, and user interactions of smart houses. A comparative study of these techniques was also prepared, aiming at their effectiveness in exploitation of home automation systems. This way, it is aimed at covering the existing gaps in this fast-evolving technology, mapping out future research pathways, and dissemination highlights in the zone of IoT-based smart home solutions.

II. LITERATURE REVIEW

Research capabilities regarding the vast Internet of Things (IoT) field are limited because home automation serves as a priority domain because it directly affects human comfort. The operation of home electronic devices by linking them to smartphones plus tablets or computers which possess internet capability constitutes home automation. Users are adopting home automation systems because they can monitor and manipulate their appliances remotely worldwide and this necessity will evolve into a standard requirement in the upcoming future [7]. Appliances gain their "smart" capabilities through internet connection which provides users remote setting management and detailed procedural information about performances while improving their usability [8].

The Home Automation System (HAS) includes a unified system of management devices and home appliances that operate autonomously to manage shared family sources like water energy water power and gas. Research analyzes single-objective genetic algorithms (GAs) together with multi-objective GAs for optimizing control strategy parameters then evaluates their success against Tabu Search (TS). Researchworks aim to understand distinct optimization approaches' behavior when handling home automation issues so existing studies can incorporate practical evaluations of diverse algorithmic strategies [9]. The concept of IoT involves expanding internet connectivity by adding capabilities for embedded devices to monitor and control things from a distance. The research centers on low-cost Wi-Fi-based home automation systems as one of the diverse methods that enable physical objects to communicate globally for delivering automated and intelligent services to users [10].

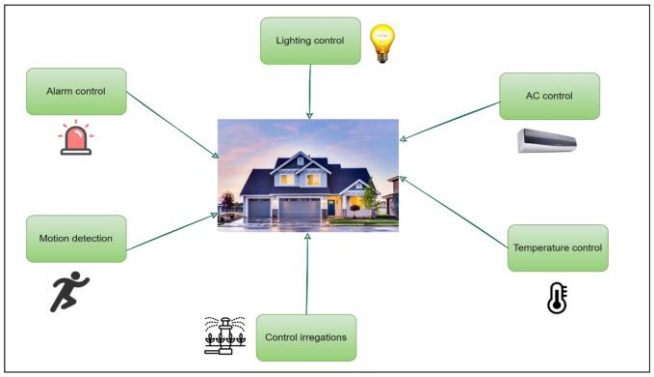

Fig 2: Integrated IoT Smart Home Network.

The development of home network technology has led to aggressive competition between HGs, PCs, STBs, gaming consoles, and home automation systems in the market. The new technological development of Home Gateway systems connects internal home networking infrastructure with external access networks and organizes diverse devices as well as services spread across residential environments. Cost-effective customization through peripheral component interconnect (PCI) slots is possible due to PCs having a modular design structure. The combination of advanced technical capabilities along with multitasking features in PCs result in suited architectures for media centers within home networks because of graphic cards and digital video disks (DVDs) and hard disk drives (HDDs) [20].

Fig 3: Modular PC Setup for Home Media Center

The automation system programming incorporates microcontroller instructions for performing self-executing tasks by reading sensor information thus enabling temperature-based fan regulation and luminescence changes from motion detection. Through the combination of microcontrollers that use Arduino boards connected to Wi-Fi modules users gain internet connectivity to monitor energy consumption and operate multiple household devices located inside and outside the home which significantly improves convenience and control capabilities [21].

III. METHODOLOGY

A smart home automation system facilitates a safer lifestyle, more comfort, and greater control over household energy and consumption, all of which contribute to load control and energy conservation [6]. The initial automation systems mostly operated one or two machines and could only be employed for certain tasks, which made them extremely inefficient [4].
The evaluation of review papers about Home Automation has yielded essential techniques for discussion given below:-

1. Android-based home automation

The main focus of Android technology is touchscreen mobile devices including smartphones and tablet computers but it also supports customized platforms for televisions (Android TV), wrist watches (Android Wear) and automobiles (Android Auto). The system implements direct manipulation as its base user interface method. The main function of this technology is touchscreen control yet it has successfully adapted to power digital cameras and other game systems. Operating on-screen items through the OS requires the virtual keyboard combined with touch inputs which correspond to gestures like swiping, tapping, pinching, and reverse pinching [11].
Results confirmed the satisfactory functioning of home automation controls based on the attachment of sample appliances and their successful operation through GSM mobile smartphone interfaces. Through this project users can operate items at a distant range. The implementation bases its operations on secure GSM networks together with DTMF-based protocols. Every person possesses a mobile phone which could serve our project as equipment controller [19].

2. RTOS-Based Home Automation

The scmRTOS is a well-known and open source RTOS (Real Time Operating System) that has a very small footprint on the microcontroller and has been integrated to improve the system's responsiveness and dynamic nature. Other well-known smartphone operating systems, such as Apple's iOS, Microsoft's Windows 7/8, and BlackBerry OS, can readily support the controlling program that was created for Android smartphones. To ensure that only authorized users may operate the appliances, pattern-based password protection is used [12].

3. Bluetooth-Based Automation

Bluetooth wireless technology shows promise in revolutionizing how people approach digital home and office appliances. Various equipment now operate beyond their individual functions because Bluetooth connectivity enables these devices to develop communication pathways between themselves. The wireless technology serves as an essential connection method when there is no existing framework for smart equipment communication in residential areas. The application of this technology presents both reasonable costs as well as suitable deployment for home automation systems. Bluetooth enables multiple digital devices to communicate through an unlicensed 2.4 GHz frequency with 1 Mbps speed reaching up to 10 meters (or 100 meters based on power transmission capabilities). We introduce a Bluetooth-based home automation system according to our proposed idea [13].

4. Voice-Controlled Automation

Regardless of the technology used, users would rather have constant access to their home devices than be uncomfortable having to physically visit the closest control locations. In this sense, voice control automation technologies—which are currently in vogue—offer a greater edge over other technologies in terms of security, ease of use, and adaptability.

A voice-activated home appliance control system model has been given in this study. This has easily resolved the issue of mobility for all groups of individuals, including the elderly, the disabled, and even those who are able to use household equipment. Additional work can accommodate home appliances with voltages higher than five volts (5V+), even if this work is restricted to appliances with a maximum of five volts (5V) [14].

5. DTMF-Based Control

Through telephone lines Dual-tone multi-frequency (DTMF) signaling connects to telephone equipment as well as communications devices while talking to switching centers through the voice frequency band. DTMF signaling functions as a standard process for voice mail systems while serving as a communication link for data entry applications and analog telephone usage and consumer good remote functions including auto answering machines and home automation systems and bank information services. The controlling operation of this system occurs from a distant location. The wireless communication system makes use of mobile phones as the wireless components replace traditional transmitter and receiver equipment. The frequency diversity of calls allows cell phone-operated systems to provide extended control capabilities and many applications supported by various service providers with reduced chance of signal disruption. Cell phone-operated systems use the process of interpreting Dual-Tone Multi-Frequency (DTMF) tones for their operation. Dual Tone Multi Frequency stands as an abbreviation which represents the term Dual Tone Multi Frequency (DTMF). This remote lighting operation project includes three central components which are Arduino UNO and relay module and

DTMF Decoder. We connected these system components to operate a cell phone as a distant control device which allowed us to monitor various household appliances [15].

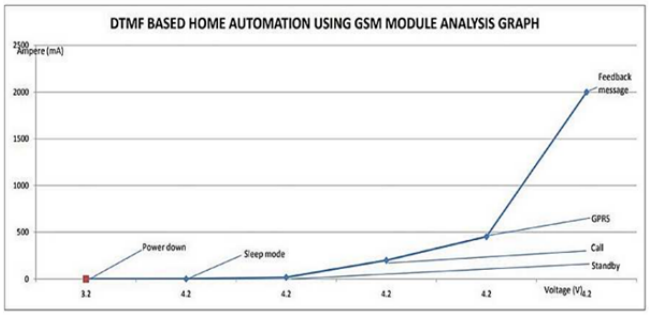

Fig 4: Graphical analysis of the designed project.

6. Radio Frequency (RF) Technology

An RF-based home automation system may determine if the electrical appliances are in the on or off state from any location in the house that does not have a direct line of sight. Together with a Peripheral Interface Control (PIC) 16f877A microcontroller and a few passive parts, the controlling circuit is constructed around RF transmitter and RF receiver modules that operate at 433 MHz. Using the PIC16F877a microcontroller, the system are developed. This is both the mind and the heart of it. They are affordable, offer a wide range of applications, a sizable customer base, a comprehensive collection of application notes, free or inexpensive development tools, and the ability to serially program and re-program with flash memory. A program that emulates a COM port terminal is used to communicate between a computer and a PIC microcontroller, resulting in input and four channels at the receiver. A relay connects the microcontroller output to the appliances [18].

7. Cloud Computing Integration

The method integrates cloud computing with all of the new and developing ideas of the Internet of Things (IoT). The Internet of Things (IoT) offers a suitable method for measuring, tracking, and managing all household appliances and conditions.

For the creation, upkeep, and operation of home services, cloud computing offers quick computing that is dependable, power-efficient, and reasonably priced. Additionally, cloud computing enables the user to monitor and/or operate their home equipment from any location at any time. A group of services-oriented structures known as cloud computing architectures enable users to access a variety of resources in an elastic, economical, and on-demand manner [23].

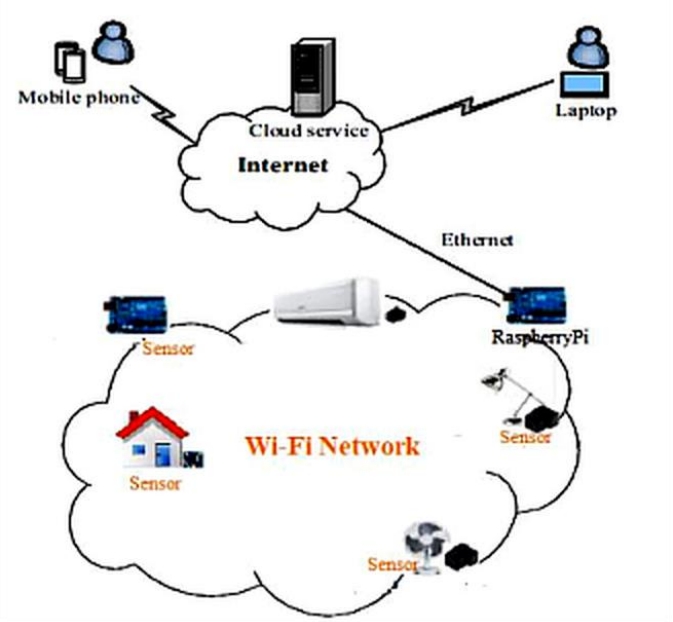

Fig 5: Cloud computing integration.

8. Arduino-Based Home Automation

Since we live in a time when everything is connected, the Internet of Things (IoT) is the primary tool that makes it possible to remotely operate and monitor things. Connecting everything in our environment to the Internet and controlling how they interact is known as the Internet of Things (IoT) (Khan et al., 2012). A microcontroller with appropriate sensors and actuators is the basis of every home automation system. Typically, sensors like temperature sensors are used for monitoring, and actuators like relays are used for controlling (Banerjee and Singhal 2010). Any home automation system needs a communication channel to communicate with its hardware components [22].

Arduino is an open-source platform for electronics prototyping built on top of adaptable, user-friendly hardware and software. The microcontroller on the Arduino I board has 54 digital input/output pins. Alarms, lighting, room temperature, and other home appliances can all be monitored and managed by the system. The system's testing results demonstrate that it can be properly controlled and that control monitoring functions can be carried out from a device connected to an HTML-capable network [27].

The main piece of hardware that transmits and receives instructions and status updates via the internet is an Arduino Mega microcontroller that is coupled to an Ethernet shield [26].

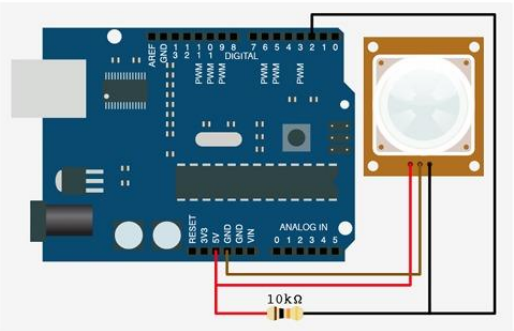

Fig 6: Connection Circuit of PIR Sensor

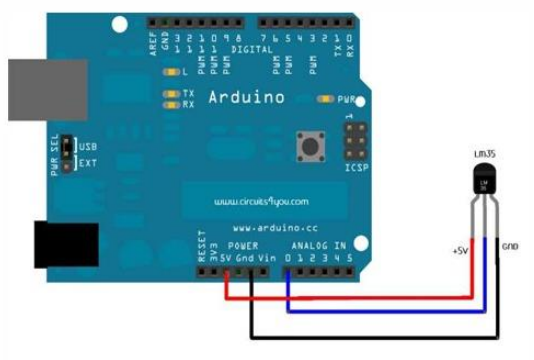

Fig 7: Connection Circuit of LM35 Sensor

9. FPGA-Based Control

FPGA (Field Programmable Gate Array) is used as controller to control the devices connected to it. We use Bluetooth to wirelessly monitor the gadgets. The Android smartphone is what we're using for speech recognition. Since the FPGA may be used as a controller or a processor and we can connect numerous devices that can be monitored, we are utilizing it instead of a microcontroller. Through a serial link, the Bluetooth module and the central FPGA controller exchange data. This calls for an FPGA-based Universal Asynchronous Receiver/Transmitter (UART). Due to its availability in the majority of mobile phones, low implementation costs, low power consumption, and the ability to pair and operate at short distances, this technology was chosen above alternative options [29].

10. Artificial Intelligence and XMPP Protocol

The study of the nature of intelligence through the construction of computer systems and the application of these ideas to the resolution of real-world issues is known as artificial intelligence (AI). An artificial intelligence (AI) system that has a substantial quantity of knowledge in an explicit, declarative format is called a knowledge-based system (KBS). Over the last 20 years, the field of KBS development has grown in maturity. First-generation expert systems, usually developed through fast prototyping, had a general reasoning engine and a single flat knowledge base [30].

An open communication protocol called the Extensible Messaging and Presence Protocol (XMPP) was created for contact list management, presence data, and instant messaging. It facilitates the near-real-time transmission of structured data between two or more network entities and is based on XML (Extensible Markup Language).

11. Motion Sensors in Home Automation

A home automation system can trigger certain activities automatically by using motion detectors as sensors. Motion detectors can set off an alert, start a video recording, or turn on a light automatically. Your home automation system's eyes may be motion detectors. PIR (Passive Infrared) sensors, the most advanced motion detector available, are used in its operation. This indicates that the detector senses infrared light (heat) or variations in heat level rather than motion. PIR detectors measure a room's ambient temperature and detect rapid changes in that temperature, which they interpret as motion. The sensitivity of the detector, which is the rate at which the light must vary, is adjustable [31].

12. Network Administration in Smart Homes

A number of problems would need to be discovered before attempting to administer such a system. Finding the network topology inside a home is the first task. Every device is either: i) linked to a wireless router; ii) connected to a hub that is either Ethernet or Wi-Fi connected using other wireless communication technologies; or iii) directly connected to Ethernet. It is obvious that having an Internet connection is necessary. Many Home Automation systems are outfitted with the necessary hardware and software to securely communicate with external servers because they link to external web servers to provide users with Internet access. Despite these limitations, some goods employ protocols like Z-Wave and ZigBee to connect with one another. [34].

13. Home E-Health Systems

Almost every government is becoming more concerned about the cost of health care. E-health improves the user experience by developing healthcare more efficiently and making the most of the resources already available. For governments and businesses looking to create viable business plans and practical e-health solutions to deal with the scarcity of health care resources, this is a well-known fact.

Numerous businesses (from various sectors: ICT, telecare, etc.) have created their own home e-health solutions that novice users can use at home. Microsoft and Google, for example, have created Personal Health Record (PHR) databases, which are distributed databases that provide communication between patients and medical professionals via third-party software. Both Tunstall and Intel have created comprehensive telehealth solutions that enable telemonitoring using particular hardware (Tunstall RTX337X and Intel Health Guide PHS6000). Medical personnel can use the server side of these technologies, while the client side is made to help individuals engage with their homes [16].

IV. Result and discussion

Numerous difficulties at the following general levels are addressed by the actual usage of this system in a person's daily life: (a) moral, ethical, and medico legal; (b) socio-medical and organizational; (c) economical; (d) technological, and of quality assurance. It is impossible to fully isolate the technological and computational parts of such a system from the other aspects of the issue, though. Human-computer interaction modeling, which assumes the presence of an effective multidisciplinary human resource organization and collaboration, is the primary illustration of this issue [17].

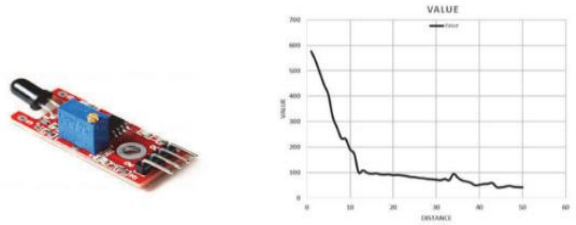

Fig 8: Flame sensor with output voltage vs distance graph [24].

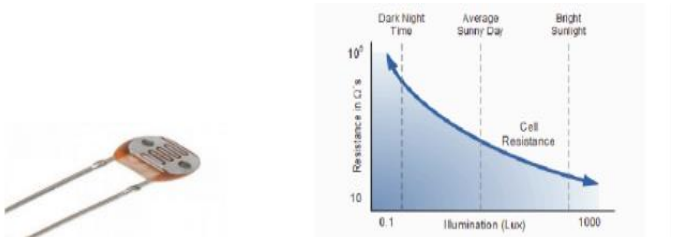

Fig 9: Light Dependent Resistor with graph [24].

Table 1. Comparison between RFID types

Passive tag	Active tag
Doesn't need to power supply source.	Need power supply source.
Modulation activated when the tag receives the electromagnetic waves from the reader.	Modulation activated directly from the tag because it has a powered already.
A reading range is about 10 cm to 10 m.	A reading ranges up to 100 m.
Having 100,000 times for read/write.	Effected by the tag battery life.

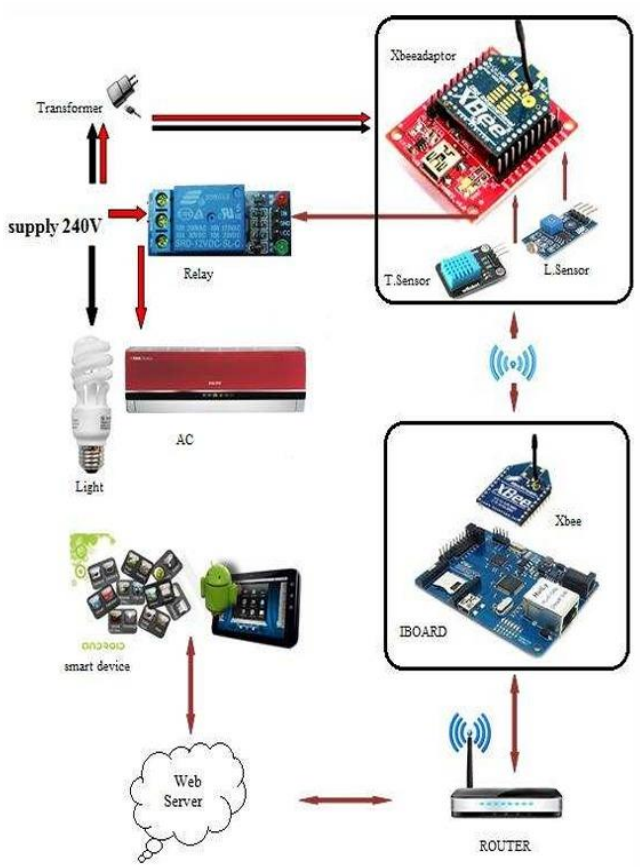

Fig 10: System architecture of Android Smart Switch system [25].

Every home automation system implementation depends on wireless technology. Users now have better access to controlling their home appliances through Arduino and GSM and Android-based automation solutions. The document provides design and implementation schemes and flowcharts for home automation solutions built with Arduino, GSM, and Android technologies and successfully measure their positive and negative points. A home automation system dedicates its core purpose to offer users an easy way to manage home appliances through Android applications while improving electrical energy utilization and saving user time and money. This system helps users protect their homes from burglary through two operations: it generates audible alarms during burglars' house entry attempts as well as sending mobile device alerts when unauthorized people attempt access to homeowners' residences. This technology shows the residence entry count on an LCD display [32].

All of the capabilities which Wi-Fi technology-based solutions possess today significantly surpass the functionalities available in older system designs while offering both remote functionality and security features and lower cost. The essential targets of the home automation system prove successful through its implementation. The system design process included architectural considerations which are displayed through the prototype detection functions along with basic appliance managerial features. The proposed solution tops existing commercial home automated systems regarding its capacity for growth and extensive application [33].

V. Suggested Application

This system may be modified to include a number of other features, such as home security features like taking pictures of people moving around the house and uploading them to the cloud, using it as a foundation. Compared to employing a CCTV camera, which continuously records and retains data, this will require less storage space. Weather stations and energy monitoring could be added to the system. With the appropriate modifications, this type of system can be used for environmental monitoring, in industries where human intrusion is hazardous or impossible, or in hospitals for the crippled [28].

Table compares the features of home automation systems that have been published in scientific journals during the past 10 years [6].

Communication	Controller	User Interface	Applications
Bluetooth	PIC	mobile app	control indoor appliances
Bluetooth	Arduino	mobile app	control appliances indoor and outdoor, within short range
Bluetooth, GSM	PIC	mobile app	control appliances indoor and outdoor
ZigBee, Ethernet	Arduino MEGA	mobile app	control appliances indoor
X10, Serial, EIB, ZigBee, Bluetooth,	32-bit ARM microcontroller	Control panel (touch pad), desktop based	indoor automation solution
Wi-Fi, ZigBee	Raspberry PI, NodeMCU		controlling humidity, temperature, luminosity, movement, and current
ZigBee	Laptop/PC server	mobile app	control of indoor appliances but not actually implemented
ZigBee, Wi-Fi	Linux board	GUI interface	control HVAC appliances
ZigBee, Wi-Fi, Ethernet	Raspberry PI	web-based, mobile app	remote control of appliances (IP cams, smart plugs)
Wi-Fi	TI-CC3200 MCU	mobile app	control indoor appliances, monitor the soil moisture
Wi-Fi	NodeMCU	web-based	control indoor appliances
Bluetooth, Wi-Fi	Raspberry PI	mobile app	control indoor appliances
Wi-Fi	Arduino mega	web-based, mobile app	control of indoor appliances
Wi-Fi	PC server	web-based, mobile app	security, energy management
Wi-Fi, IR	PC server	mobile app	control of indoor appliances
Wi-Fi	Arduino	mobile app	control indoor appliances, video surveillance
Bluetooth	Arduino	mobile app	control indoor appliances, energy management
Wi-Fi	Arduino, ESP8266	mobile app	control indoor appliances
Bluetooth, Wi-Fi	Arduino mega	web-based, mobile app	indoor and outdoor control, monitoring, energy management, safety, security
Ethernet	Arduino mega	web-based	control of indoor appliances
Ethernet	Raspberry PI	web-based	control home appliances, surveillance
ZigBee, Z-wave, Wi-Fi	Raspberry PI	unspecified	light automation and physical intrusion detection
Wi-Fi	NodeMCU	web-based, mobile app	control indoor appliances (luminosity sensor, LED, buzzer)
Wi-Fi	ESP8266	unspecified	testing modules in a smart home system, related to indoor appliances control, surveillance, energy management
Wi-Fi	Arduino, ESP8266	mobile app	control of switches
Wi-Fi	Node MCU	web-based, mobile app	control of appliances indoor and outdoor, safety, security, energy management, monitoring
Ethernet	Galileo board	web-based, mobile app	indoor and outdoor control, energy management, security
GSM, Wi-Fi	PC server	web-based	safety, monitoring (gas, temperature, fire sensors)
GSM	8051 MCU	web-based	indoor and outdoor control
GSM	Arduino	web-based	control of indoor appliances, safety, energy management
ZigBee, Wi-Fi, GSM/GPR	PC	LabVIEW PDA Module	remote monitoring and control system for intelligent buildings
ZigBee	PC	web app	power outlet control
Wi-Fi	**Raspberry PI, ESP 8266**	**web-based, mobile app**	**multiple home automationsindoor and outdoor, irrigations, security, monitoring, power and energy management (including solar energy), Google assistant compatible**

VI. Conclusion

This research paper reviews the evolution, diversity, and technologies behind smart home automation systems. Its papers range from the initial studies of IoT-based applications to high-end ways of implementing an intelligent home using AI, RTOS, and cloud computing, and the whole gives meaning to some important tendencies.

The concentration of all in-house functionality into an integrated home server is brought further towards design matrices of modularity, scalability, and user centrality with sensor-based systems such as Arduino-based controllers and IoT frameworks. Studies of optimization algorithms developed (such as Tabu Search and Evolutionary Algorithms) and studies arising in the field of AI-driven protocols are showing how intelligent systems may enhance energy efficiency, adaptability, and performance in home automation.

Arduino, Bluetooth, DTMF, and Android promise low-cost solutions for making smart homes accessible to the majority.
The promising technologies of cloud computing, AI, voice recognition, and motion sensors indicate toward the future development of systems with even more intelligence, contextual awareness, and security that may be able to address any household need.

The e-health integration through IoT-based surveillance systems is one of the other growing examples that reflect the increasing focus on creating such environments where health as well as security aspects could be worked out.

this kind of analysis reveals progress and prospects that can be opened through smart home automation technologies. In this period, the studies can also provide much-needed insights on how cost-effective, intelligent, and user-friendly systems could be developed to meet modern household needs and pave the way for innovation in the future.

REFERENCES

[1] "Home automation system"- Aaditya Gupta Shah*1, Aashish Gaurav, Abhishek Anand, Ganesh Kumar Shah, Student Department of Computer Science & Engineering, Sharda University, Greater Noida, India - 2021

[2] "A comprehensive review of smart home automation systems" - Simar Singh, Sourabh Anand, Guru Gobind Singh Indraprastha University - 2023

[3] "Home automation systems - a study" - Satish Palaniappan, Naveen Hariharan CSE, Naren T Kesh, Vidhyalakshimi S, Angel Deborah S Assistant Prof., CSE, SSN College of Engineering, Anna University, Chennai, India - April 2015

[4] "A review paper on smart home automation" - Pankaj Bhardwaj (Assistant Professor), Paras Manchanda, Prashant Chahal, Prashant Chaudhary, Robin Singh Department of ECE, Moradabad Institute of Technology (U.P), India- 2017

[5] "Smart home control" - Syeda Ayesha Unisa(Assistant Professor), D Sharath, Adithi Pateriya, Chinmay Chauhan, Sahithi Sri Garimella, Department of Computer Science and Engineering, MVJ College of Engineering, Bangalore, India

[6] "An IoT-Based smart home automation system" - Cristina Stolojescu-Crisan, Calin Crisan and Bogdan-Petru Butunoi - 2021

[7] "An intelligent, secure, and smart home" - Rizwan Majeed, Nurul Azma Abdullah, Imran Ashraf, Yousaf Bin Zikria, Muhammad Faheem Mushtaq and Muhammad Umer - 29 October 2020

[8] "Smart home automation system" - Fouad Zaro, Ali Tamimi, Anas Barakat, Palestine Polytechnic University, Electrical Engineering Department, Hebron, Palestine - 2021

[9] "Optimizing home automation systems: A comparative study on tabu search and evolutionary algorithms" - G. Morganti, A. M. Perdon, G. Conte and D. Scaradozzi, A. Brintrup- 2009

[10] "IoT-based smart home automation system" - Ms. K. S. Gulghane, Dr.Mrs. S. S. Sherekar, Dr.V.M.Thakare, PG Department of Computer Science & Engineering, SGBAU, Amravati, India - 2019

[11] "Smart home appliances through Android" - Azman Bin Talib, Norazlina Binti Ahmad, and Ismail Bin Asis - 2017

[12] "RTOS-based home automation system" - Syed Anwaarullah, S.V. Altaf, Lords Institute of Engineering and Technology, India - 2013

[13] "Bluetooth-based home automation system" - N. Sriskanthan, F. Tan, A. Karande School of Computer Engineering, Nanyang Technological University, Nanyang Avenue, Singapore, Singapore 639798 - 2002

[14] "Design of a voice-based intelligent prototype model for automatic control of multiple home appliances" - Akanbi C.O. and Oladeji D.O., Department of Information and Communication Technology Osun State University, Osogbo, Osun State Nigeria- 30th Mar, 2016

[15] "Applications and recent development of DTMF-based technology in home automation" - Ayodele S. Oluwole, O. P. Odekunle, and E. Olubakinde – June 2021

[16] "Home e-health system integration in the smart home through a common media server" - I. Pau, F. Seoane, K. Lindecrantz, M.A. Valero and J. Carracedo - 2009

[17] "An experimental health smart home and its distributed internet-based information and communication system" - Vincent Rialle, Norbert Noury, Thierry Hervé Laboratory TIMC-IMAG UMR CNRS 5525, μISFV team, Grenoble, France - 2001

[18] "Home automation using radio frequency" - Y Laxmana Rao ,P Hari Babu, V Prasad, T Srinivasa Rao, Department of Computer Science & Engineering, Raghu Institute of Technology, Visakhapatnam - 2016

[19] "Control of the home appliances using mobile telephony" - Akshay S., Arun K., Sunu P. B. Department of Computer Science, Amrita Vishwa Vidyapeetham, Mysuru Campus, Amrita University, India - 2016

[20] "An integrated home server for communication, broadcast reception, and home automation" - Intark Han, Hong-Shik Park, Youn-Kwae Jeong, and Kwang-Roh Park- 2006

[21] "Towards the development of an efficient and cost-effective intelligent home system based on the Internet of Things" - A. Imtar Chaudary, Muhammad Usman, Arshad Farhad, Wajid Ullah Khan, Dept. of Computing and Technology, Abasyn University Peshawar, Pakistan – June 2016

[22] "Arduino-based real-time home control system: Design and implementation" - QUSAY I. SARHAN * AND NECHIRVAN A. MOHAMMED** * Software Engineering and Embedded Systems (SEES) Research Group, Dept. of Computer Science, College of Science, University of Duhok, Duhok, Kurdistan Region, Iraq ** Dept. of Information Technology, Duhok Private Technical Institute, Duhok, Kurdistan Region, Iraq - May 24, 2016

[23] "Design and implementation of a cloud computing system for smart home automation" - Murad O. Abed Helo, Alaa Shaker, Laith A. Abdul-Rahaim Electrical Engineering Department, University of Babylon, Babylon, Iraq – October 2021

[24] "Designing and implementing applications of smart home appliances" - Hamzah M. Marhoon, Mohammed I. Mahdi, Ehab Dh. Hussein & Ahmed R. Ibrahim, Al-Esraa University college, Department of computer techniques engineering, Iraq, Baghdad, University of Wasit, College of science, Department of Chemistry, Iraq, Wasit, Altinbas University, School of Engineering and Natural Sciences, Istanbul, Turkey – November 9, 2018

[25] "Implementation of smart home control by using low-cost Arduino and Android design" - Zaid Abdulzahra Jabbar, R.S. Kawitkar, Department of E&TC, SCOE, Pune, India – February 2016

[26] "Arduino-based smart home automation system" - Nuri Almali, Kosar Salih Bahir, Özkan Atan, Electric and electronic engineering department, Yüzüncü Yıl University, Turkey – August 2016

[27] "Implementation of smart home automation and security system using Arduino and Wi-Fi through Android application" - Mr. J.Chandramohan, K.Satheeshkumar, P.A.Gopinath, N.Ajithkumar, S.Ranjithkumar, Department of Electrical and Electronics Engineering, Gnanamani College of Technology, Namakkal (DT), Tamilnadu (St), India - 2017

[28] "Home automation using Internet of Things" - Vinay sagar K N, Kusuma S M, MSRIT, Bangalore, India – Jan 2015

[29] "Advanced home automation using FPGA controller" - Sweatha K N, Poornima M, Vinutha M H, Dept of ECE MVJCE, Bangalore – July 2013

[30] "Smart home automation using AI and XMPP protocol" - Jacob Simon Areickal, S. Gopi, SRM Institute of Science and Technology, Chennai, Tamil Nadu - 2018

[31] "Home automation through motion sensors" - Aniechi Gideon Oluwatobi, Mr. Oyebola O., The Department of Computer Engineering, Gateway Ict Polytechnic, Saapade in Partial Fulfilment of The Requirement for The Award of National Diploma in Computer Engineering Technology

[32] "Home automation and security system" - Surinder Kaur, Rashmi Singh, Neha Khairwal and Pratyk Jain, Department of Information, Bharati Vidyapeeth's College of Engineering, A-4 Paschim Vihar, New Delhi-110063, India – July 2016

[33] "Design and implementation of a Wi-Fi-based home automation system"- Ahmed ElShafee, Karim Alaa Hamed, World Academy of Science, Engineering and Technology 68 - 2012

[34] "Network administration for home automation" - Nahush Kulkarni, Department of Computer Science, Florida State University, Tallahassee FL, USA – December 2, 2014