

Literature Review of IoT based Home Automation System

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Abstract—Home automation system is gainif a significant research attention in recent years. It helps us in leading a comfortable life and quality of lifestyle is gradually uplifted. The different methodologies used in this system have been discussed. In modern days, a smartphone having an android application is used to supervise and control the appliances present in the home automation system. In this paper different types of communication methodologies such as GSM, IoT, Wi-Fi, and bluetooth are reviewed. The pros and cons of these techniques along with their features have been presented. Based on this paper the user can choose the best suitable methodology depending upon their personal needs and specifications for implementing an efficient automation system.

Index Terms—Android application, Bluetooth, IoT, Wi-Fi, GSM, Home automation.

I. INTRODUCTION

Home automation is evolving the quality of human life at an unprecedented rate. This eliminates the need of labour and also helps in the consumption of electricity thereby saving energy. The motive of this paper is to supervise and operate the appliances through different methodologies from anywhere in the world just by us- ing an android application. In this paper the various techniques of automation methodologies used in homes are compared with their speed, cost and other functions. It highlights the drawbacks and advantages of each method [1]. Over the years there have been many definitions for home automation [2]. These definitions endure the phenomenon of the components of technology highlighting its functions and need to meet the aim of smart home. There are numerous definitions given by a variety of people which may be overlapping each other but the common points of everyone can be narrowed to services, technology and the desire to meet the user's demand. Home automation system also helps the elderly or the handicapped people. It is easier for them to operate or control all the house appliances with an android application. In addition to this home automation system also helps in reducing the energy consumption within an area. There are a lot of threats to environment which are emerging nowadays such as global warming, change of climate and volatility in the prices of energy which has helped in developing the home automation system. As shown in Fig. 1, the use of automation system through different mediums has made it possible to reduce the consumption of energy [2]. Home automation also provides opportunities to create new fields in architecture, computing and engineering. The

wireless technology introduced various connections namely bluetooth, IoT, Wi-Fi and GSM each of

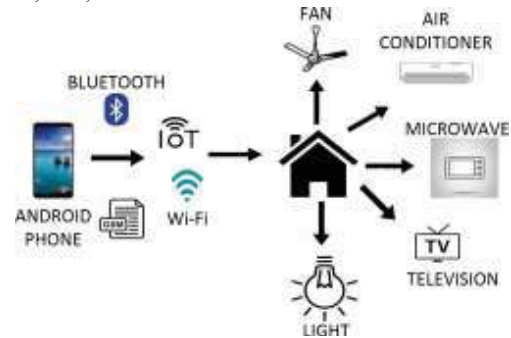


Fig. 1. Home Automation System.

which have their own advantages, disadvantages, applications and the specifications [3]. Home automation system is a rapidly developing field but it has not evolved much due to high expenditure [4]. This paper presents the control of appliances through an android application which helps to overcome the drawbacks of traditional smart home control. The traditional home automation control system that has been used widely includes bottom push buttons, PCs and infrared remote controls. The usage of these will consume more power and energy. They are the least efficient and require more expenditure. The advantage of using android as a platform is that it is easy to understand. Also, it can use any medium such as bluetooth, IoT, Wi-Fi and GSM to execute the commands given by the user [5].

Home automation system is a developing technology in the modern world that helps in transforming the user's home to an extent that it will be able to perform multiple tasks automatically and independently. The technology is gradually upgrading by incorporating new features in order to meet the requirement. The goal of this system is to reduce the usage of electricity. This system helps the people to live a comfortable life and also manage the energy for future requirements [6]. The system is designed and developed for monitoring the various interconnected home appliances such as lights, temperature, locks, emergency system, power plugs and it can also control them [6]–[12]. Home automation will be one of the most popular fields in the near future. Also, the future market of home automation system will be very versatile [10].

II. SMART HOME METHODOLOGIES

A. Bluetooth Based Home Automation

This technology is developing nowadays to make life easier. This is secure and the cost is also less [2]. Home automation system built on bluetooth proposed by R.Piyare consists of the electronics hardware component which has an android phone and the Arduino Bluetooth(BT) as shown in fig. 2. This arduino BT board and mobile phone are communicated using bluetooth. The electrical relays are used to connect home appliances with arduino BT board [3], [13]. Another method proposed uses HC-05 module of bluetooth as it is a serial port module which is easy to use [6]. This module requires normal (5V) supply. With just a tap on the mobile application, the data is transmitted serially to arduino which is interfaced using bluetooth. Arduino receives and decodes the data and takes the necessary actions needed. It also returns the current status of the device to the android phone. One more method presented in [12] gives us an idea for a low cost, robust, user friendly automation system. This system is integrated with the bluetooth module, arduino board, an android application and sensors. It is easy to operate and helps in supervising and operating of the home appliances. The disadvantage of this method is that the appliances can be controlled only from a range. This particular method proposed below uses HC-06 module of bluetooth which is interfaced with arduino board and appliances of home are connected with board of arduino via relay. The serial communication between the bluetooth module and android phone is done using serial communication and then further connected to the board of arduino. This particular method satisfies the need of the user to operate and supervise the appliances within a range which is very much user friendly. It is useful for the handicapped people, elderly people and also helps in time management. The paper proposed [14] gives a solution for smart home automation using google firebase cloud messaging (FCM) and bluetooth. It does not require any technical knowledge of the user. It gives a simple interface to control and operate all the home appliances. With the developing technology of Bluetooth, there is a network formed due to digital devices where the appliances and electrical equipment's are able to transfer the data among them. Now, the major application of bluetooth technology is smart home [15]–[17].

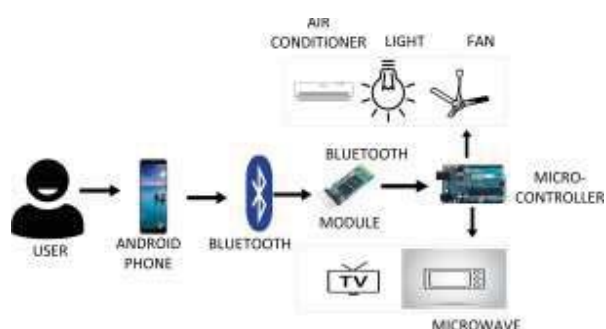


Fig. 2. HAS using Bluetooth.

B. IoT Based Home Automation System

Home automation system built on IoT is designed and implemented on an android phone, a software application, controlling appliances and embedded micro web server. It basically consists of three sections namely home gateway along with home environment and remote environment. The users can control and monitor the appliances through an android application in a smartphone supporting 3G or 4G, Wi-Fi. The hardware module of interface and home gateway is present in the home environment. The exchange of data between the internet, arduino ethernet server and router is provided by the home gateway. This scheme has the ability to decrease the consumption of energy by managing the system such as lightings, security system, door and gate locks, ventilation. The fig. 3, shows the control of appliances through IoT using an android application. The proposed method helps in creating a smart environment which helps the user to switch on/off the devices using an android application. It makes the job easier for handicapped and elderly people and also helps in saving the electricity thereby reducing the usage of energy. Another major advantage of this method is that it can operate 8 appliances at a time and the cost is also less when compared to other mediums [18]–[26]. A similar method of dual-mode IoT built home automation system is presented in the paper [19] which uses NLP and a touchscreen interface node. An android application helps in controlling the appliances. One major advantage of this method is that it can add or remove new rooms depending on the demand [20], [21]. This paper also mentions about a similar system which uses World Wide Web to control and monitor the home appliances. For the controlling of different appliances Wi-Fi and raspberry known as the server system is used. This method has an additional feature of alerting the user if there is a case of fire accident thereby protecting the complete system [1], [25]. Another method proposed in [27] controls the home equipment with the help of node MCU as the interfacing component where home automation using IoT is done with the help of a blink app. The controlling of the appliances using IoT is possible from anywhere in the world that is it does not have a limited range which makes it highly scalable [17]–[27]. The exchange of data transmission is faster as compared to other mediums.

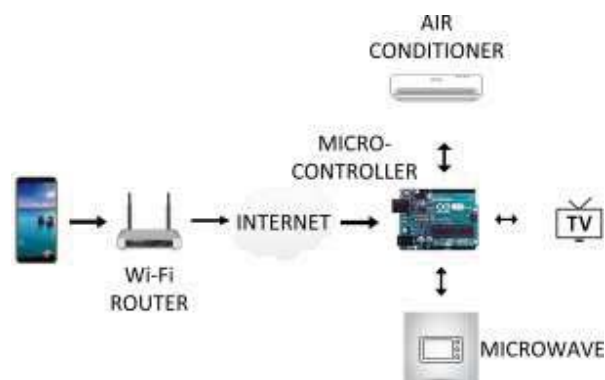


Fig. 3. HAS using IoT.

C. Wi-Fi Based Home Automation System

In order to communicate and facilitate connection between the android application and the appliance, a module of Wi-Fi is used. A home automation system in which an android mobile application with integrated Wi-Fi can be used as shown in fig. 4. In working, this system of home automation uses an application installed in a smart phone to transfer the data using a long range Wi-Fi technology. A preconfigured Wi-Fi device can be used to update status collected from sensors continuously on the firebase database. Using Wi-Fi technology SSCS switches and devices can be remotely controlled using android application. There is a development in the smart home system field that it can offer a longer range and can control multiple devices at the same time from anywhere in the world. ESP 8266 12 E is used as central controller and as Wi-Fi chip in this, it is an advance version of ESP 8266 [1], [28].

The most useful feature of this is that a USB can be used to power this device rather than using batteries. It is very useful for beginners due to its durable nature and easier operation. In smart homes, low cost, multi-purpose and flexible remotely monitoring and controlling of devices through a Wi-Fi medium which is a sophisticated wireless device system using mobile application which can be easily operated by the people from their mobile phones is done. Delivery of control instructions can be done through Wi-Fi medium by utilizing text messaging technology. [28]. IPCam used in smart homes for security can send good quality images to the android for a long range. In this way smart home technologies can be installed using Wi-Fi modules.



Fig. 4. HAS using Wi-Fi.

Another method of home automation built on Wi-Fi is discussed in [29] where the system has been divided into three major categories namely firebase database, components of hardware and a smart phone application. This needs an active internet connection with good speed throughout. The operations on the system can be performed without actually being in contact with the direct line. It offers a higher range when compared to that of bluetooth. The interface was developed with the help of android studio and is also currently in use. A similar method is presented in [30], where a cost effective and an efficient home automation system which helps in operating the home appliances using a smart phone application. This ensures more safety and reduces the power consumption and also reduces the consumption of water by using a soil humidity sensor during the home garden irrigation.

D. GSM Based Home Automation System

The complete set up consists of three major components namely GSM modem, microcontroller PIC16F887, relays and an android phone as shown in fig. 5. A SMS request is given through GSM modem to control the electric appliances. A GSM is interfaced with microcontroller PIC16F887 and as soon as it receives the data, it starts decoding the data to execute the required command. Microcontroller PIC16F887 is connected with smart home appliances through relays [1], [31]. RS232 helps in serial communication. This method helps in faster execution that is less than 500 microseconds. The complete process is finished just within two seconds.

The main positive point of this method is that the users receives the status via SMS on their android smart phone. This method was developed in hardware and has got an accuracy of 98percent. As there is a broad coverage of GSM, consumer can control their appliances from anywhere in the globe. This method also gives a conclusion that GSM built home automation system is the most secure and most reliable [32]–[34].

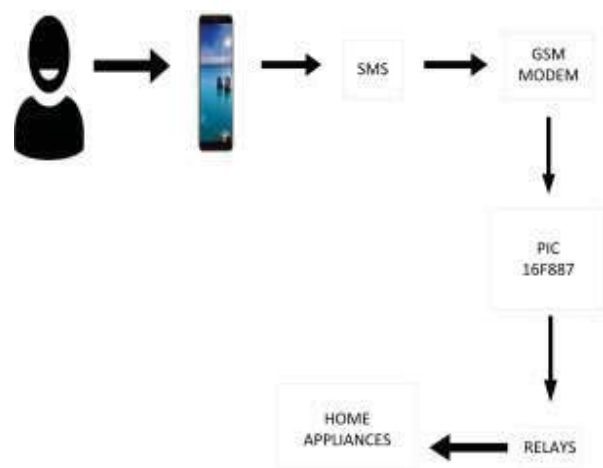


Fig. 5. HAS using GSM.

III. DISCUSSION

The comparisons of the proposed methodologies for home automation system has been done highlighting the advantages and disadvantages along with their common features. The above system consists of a main module which is connected with home appliances. The commands are interfaced from the user to the main controller board using transmit commands. The comparison of the above mentioned modules based on their speed, time and cost is as shown below [1]–[3].

TABLE I
COMPARISON OF DIFFERENT HAS

	<i>BT</i>	<i>IoT</i>	<i>Wi - Fi</i>	<i>GSM</i>
<i>Price</i>	<i>Low</i>	<i>High</i>	<i>Moderate</i>	<i>High</i>
<i>References</i>	[1],[12],[17]	[1],[18],[24]	[1],[28]	[1],[32]
<i>Latency</i>	<i>No</i>	<i>No</i>	<i>No</i>	<i>Present</i>
<i>References</i>	[1],[13],[17]	[1],[18],[22]	[28],[31]	[32],[34]
<i>Data Speed</i>	<i>High</i>	<i>Slow</i>	<i>Slow</i>	<i>Slow</i>
<i>References</i>	[1],[12],[17]	[1],[19],[21]	[29] – [31]	[33],[34]
<i>Range</i>	<i>10m</i>	<i>Wide</i>	<i>40m</i>	<i>Wide</i>
<i>References</i>	[13],[17]	[19] – [24]	[28] – [31]	[32],[34]

According to the table, bluetooth based home automation system is a cost effective and high speed method with a short range. Home automation system built on IoT has a widerange in comparison with the other methodologies. Wi-Fi built home automation system is a cost effective moderate range system. GSM based home automation system is a system with wide range and time delay is present. In Bluetooth based home automation system A smart phone or in specific android phone can be used as a receiver device in the bluetooth system which has excellent security , low cost and high communication rate due to which it can be realized as a real time automation system. The only disadvantage of this system is that the range is limited to few meters which means that the user cannot control the appliances if the smart phone is out of this range.

IoT is the most reliable and flexible system. The consumer is able to communicate with the home appliances through internet. An internet or a Wi-Fi supporting smart phone can be used by the user for communicating the commands that is connected to the home appliance. The main positive point of this technique is that the people can operate the home appliances from anywhere in the world using 3G or 4G even in the absence of Wi-Fi [10]–[25]. Wi-Fi is the communication channel used here. Internet is used as the platform for the exchange of information and for the working of the system an active internet connection is always necessary. One of the prominent advantages of Wi-Fi is that for performing operations there is no need to be in direct line of contact and also the range is larger unlike GSM and Bluetooth connection [26]–[30].

In the home automation systems built on GSM, text messages are used as a medium of communication channel between the main module and the appliances which controls and monitors around the world. The implementation cost of this technique varies depending on the distance between the home appliances and the user. The GSM based home automation system is considered as a non-reliable system as there might not be a guarantee that the text messages are delivered to the system every time which is one of its main disadvantage because of which the technique is not preferred to implement in a real time environment [31]–[34].

CONCLUSION

In this proposed paper, the positive and negative points of the different methodologies implemented in home automation system are discussed. Home automation built on bluetooth is affordable in cost and flexible in implementation but it can work only in the narrow range of Bluetooth wireless network. Home automation system built on IoT brings greater advantages with a few limitations such as it can work only in the presence of the internet. Home automation systems built on Wi-Fi are flexible in terms of number of devices that could be operated at the same time from anywhere. The system designed has a user friendly interface on android. Home automation system built on GSM has been discussed and in accordance to which controlling and monitoring of home appliances is done by the people through text messages from the normal GSM phone. The future home automation system will be smarter, faster and scaling them would be much easier. In this field a lot of research and work is being done in order to incorporate Artificial intelligence which will bring a drastic effect in this field which might yield to the achievement of a fully capable smart home system.

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REFERENCES

- [1] Asadullah, Muhammad, and Ahsan Raza. "An overview of home automation systems." *In 2016 2nd International Conference on Robotics and Artificial Intelligence (ICRAI)*, pp. 27-31. IEEE, 2016.
- [2] Marikeyan, Davit, Savvas Papagiannidis, and Eleftherios Alamanos. "A systematic review of the smart home literature: A user perspective." *Technological Forecasting and Social Change* 138 (2019): 139-154.
- [3] Ramlee, Ridza A., Mohd A. Othman, M. H. Leong, Mohd M. Ismail, and S. S. S. Ranjit. "Smart home system using android application." *In 2013 International Conference of Information and Communication Technology (ICOICT)*, pp. 277-280. IEEE, 2013.
- [4] Khunchai, Seree, and Chaiyapon Thongchaisuratkul. "Development of Smart Home System Controlled by Android Application." *In 2019 6th International Conference on Technical Education (ICTechEd6)*, pp. 1-4. IEEE, 2019.
- [5] Sawidin, Sukandar, Deitje Sofie Pongoh, and Ali Akbar Sreven Ram-schie. "Design of Smart Home Control System Based on Android." *In 2018 International Conference on Applied Science and Technology (iCAST)*, pp. 165-170. IEEE, 2018.
- [6] Shinde, Anuja, Shobha Kanade, Namrata Jugale, Abhijeet Gurav, Ram-babu A. Vatti, and M. M. Patwardhan. "Smart home automation system using IR, bluetooth, GSM and android." *In 2017 Fourth International Conference on Image Information Processing (ICIIP)*, pp. 1-6. IEEE, 2017.
- [7] Abdulrahman, T. A., O. H. Isiwepeni, N. T. Surajudeen-Bakinde, and A. O. Otuoz. "Design, specification and implementation of a distributed home automation system." *Procedia Computer Science* 94 (2016): 473-478.
- [8] Wang, Xinyan, and Jing Li. "Design of Intelligent Home Security Monitoring System Based on Android." *In 2018 2nd IEEE Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC)*, pp. 2621-2624. IEEE, 2018.
- [9] Raj, Jennifer S., and J. Vijitha Ananthi. "AUTOMATION USING IOT IN GREENHOUSE ENVIRONMENT." *Journal of Information Technology* 1, no. 01 (2019): 38-47.
- [10] Tanaka, Hisayoshi, Hidekazu Suzuki, Akira Watanabe, and Katsuhiro Naito. "Implementation of Secure End-to-End Remote Control System for Smart Home Appliances on Android." *In 2019 IEEE International Conference on Consumer Electronics (ICCE)*, pp. 1-6. IEEE, 2019.
- [11] Xiaodong, Zhang, and Zhang Jie. "Design and implementation of smart home control system based on STM32." *In 2018 Chinese Control And Decision Conference (CCDC)*, pp. 3023-3027. IEEE, 2018.
- [12] Nafea, Marwan, Nurul Ashikin Abdul-Kadir, and Fauzan Khairi Che Harun. "Brainwave-Controlled System for Smart Home Applications." *In 2018 2nd International Conference on BioSignal Analysis, Processing and Systems (ICBAPS)*, pp. 75-80. IEEE, 2018.
- [13] Asadullah, Muhammad, and Khalil Ullah. "Smart home automation system using Bluetooth technology." *In 2017 International Conference on Innovations in Electrical Engineering and Computational Technologies (ICIEECT)*, pp. 1-6. IEEE, 2017.
- [14] Debnath, Banashree, Rajesh Dey, and Sandip Roy. "Smart Switching System Using Bluetooth Technology." *In 2019 Amity International Conference on Artificial Intelligence (AICAI)*, pp. 760-763. IEEE, 2019.
- [15] Porjazoski, Marko, Pero Latkoski, and Borislav Popovski. "Bluetooth Low Energy-based Smart Home Android Solution." *In IEEE EUROCON 2019-18th International Conference on Smart Technologies*, pp. 1-5. IEEE, 2019.
- [16] Adiono, Trio, Sinantya Feranti Anindya, Syifaul Fuada, Khilda Afifah, and Irfan Gani Purwanda. "Efficient Android Software Development using MIT App Inventor2 for Bluetooth-based Smart Home." *Wireless Personal Communications* 105, no. 1 (2019): 233-256.
- [17] Hasan, Mehedi, Maruf Hossain Anik, and Sharnali Islam. "Microcon-troller Based Smart Home System with Enhanced Appliance Switching Capacity." *In 2018 Fifth HCT Information Technology Trends (ITT)*, pp. 364-367. IEEE, 2018.
- [18] Piyare, Rajeev, and M. Tazil. "Bluetooth based home automation system using cell phone." *In 2011 IEEE 15th International Symposium on Consumer Electronics (ISCE)*, pp. 192-195. IEEE, 2011.
- [19] Madhu, G. M., and C. Vyjayanthi. "Implementation of Cost Effective Smart Home Controller with Android Application Using Node MCU and Internet of Things (IOT)." *In 2018 2nd International Conference on Power, Energy and Environment: Towards Smart Technology (ICEPE)*, pp. 1-5. IEEE, 2018.
- [20] Hamdan, Omar, Hassan Shanableh, Inas Zaki, A. R. Al-Ali, and Tamer Shanableh. "IoT-based interactive dual mode smart home automation." *In 2019 IEEE International Conference on Consumer Electronics (ICCE)*, pp. 1-2. IEEE, 2019.
- [21] Vishwakarma, Satyendra K., Prashant Upadhyaya, Babita Kumari, and Arun Kumar Mishra. "Smart Energy Efficient Home Automation System Using IoT." *In 2019 4th International Conference on Internet of Things: Smart Innovation and Usages (IoT-SIU)*, pp. 1-4. IEEE, 2019.
- [22] Stojkoska, Biljana L. Risteska, and Kire V. Trivodaliev. "A review of Internet of Things for smart home: Challenges and solutions." *Journal of Cleaner Production* 140 (2017): 1454-1464.
- [23] Sarmah, Roshmi, Manasjyoti Bhuyan, and Monowar H. Bhuyan. "SURE-H: A Secure IoT Enabled Smart Home System." *In 2019 IEEE 5th World Forum on Internet of Things (WF-IoT)*, pp. 59-63. IEEE, 2019.
- [24] Mahamud, Md Sadad, Md Saniat Rahman Zishan, Syed Ishmam Ahmad, Ahmed Rezaur Rahman, Mehedi Hasan, and Md Lutfur Rahman. "Domicile-An IoT Based Smart Home Automation System." *In 2019 International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST)*, pp. 493-497. IEEE, 2019.
- [25] Mahmud, Sadi, Safayet Ahmed, and Kawshik Shikder. "A Smart Home Automation and Metering System using Internet of Things (IoT)." *In 2019 International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST)*, pp. 451-454. IEEE, 2019.
- [26] Roy, Priyo Nath, Maniza Armin, S. M. Kamruzzaman, and Md Emdadul Hoque. "A Supervisory Control of Home Appliances using Internet of Things." *In 2019 International Conference on Electrical, Computer and Communication Engineering (ECCE)*, pp. 1-6. IEEE, 2019.
- [27] Singh, Himanshu, Vishal Pallagani, Vedant Khandelwal, and U. Venkanna. "IoT based smart home automation system using sensor node." *In 2019 4th International Conference on Recent Advances in Information Technology (RAIT)*, pp. 1-5. IEEE, 2018.
- [28] Raju, K. Lova, V. Chandrani, SK Shahina Begum, and M. Pravalika Devi. "Home Automation and Security System with Node MCU using Internet of Things." *In 2019 International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN)*, pp. 1-5. IEEE, 2019.
- [29] Makhanya, S. P., E. M. Dogo, N. I. Nwulu, and U. Damisa. "A Smart Switch Control System Using ESP8266 Wi-Fi Module Integrated with an Android Application." *In 2019 IEEE 7th International Conference on Smart Energy Grid Engineering (SEGE)*, pp. 125-128. IEEE, 2019.
- [30] Bhatnagar, Harsh Vardhan, Praveen Kumar, Seema Rawat, and Tanupriya Choudhury. "Implementation model of Wi-Fi based Smart Home System." *In 2018 International Conference on Advances in Computing and Communication Engineering (ICACCE)*, pp. 23-28. IEEE, 2018.
- [31] Waleed, Jumana, Areej M. Abduldaim, Taha Mohammed Hasan, and Qutaiba Salih Mohaisin. "Smart home as a new trend, a simplicity led to revolution." *In 2018 1st International Scientific Conference of Engineering Sciences-3rd Scientific Conference of Engineering Science (ISCES)*, pp. 30-33. IEEE, 2018.
- [32] Hasan, Mehedi, Parag Biswas, MD Toufiqu Islam Bilash, and Md Ashik Zafar Dipto. "Smart Home Systems: Overview and Comparative Analysis." *In 2018 Fourth International Conference on Research in Computational Intelligence and Communication Networks (ICRCICN)*, pp. 264-268. IEEE, 2018.
- [33] Magar, Shubham, Varsha Saste, Ashwini Lahane, Sangram Konde, and Supriya Madne. "Smart home automation by GSM using android appli-cation." *In 2017 International conference on information communication and embedded systems (ICICES)*, pp. 1-4. IEEE, 2017.
- [34] Chen, Ming-Tang, and Che-Min Lin. "Development of a smart home energy saving system combining multiple smart devices." *In 2016 IEEE International Conference on Consumer Electronics-Taiwan (ICCE-TW)*, pp. 1-2. IEEE, 2016.
- [35] Jothi, T. Mahara, A. Periyannayagi, R. Srimathy, M. Vinotha, and G. Gopika. "GSM Based Home Environment Monitoring System." *In 2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI)*, pp. 1263-1268. IEEE, 2018.