

Data Science and its Usage in the Application of Smart Home Environment

Sujata Veerangouda Patil

Research Scholar, Dept. of Computer Application, Radha Govind University, Ramgarh,
Jharkhand, India.

Dr. Neetu Agarwal

Research Guide, Dept. of Computer Application, Radha Govind University, Ramgarh,
Jharkhand, India

Article Info

Page Number: 65-74

Publication Issue:

Vol. 72 No. 2 (2023)

ABSTRACT

The Internet of Things (IoT) and Data Science are two of the most talked-about fields in today's rapidly developing digital industry, thanks to the qualities that have made them so attractive to businesses and industries across the board. Using IoT technology, we built a Smart Home Automation System with two distinct types of modules that control a wide range of sensors. The term "Internet of Things" refers to a technology that enables the transmission and reception of data between computing devices embedded in everyday things through the use of the internet. The initial section of this project is dedicated to the automatic regulation of fan speed in response to the ambient temperature. Similarly, the second component of our technology automatically modifies the intensity of the lights based on the ambient light. Sensors are just one of the many parts of these modules that help to generate data values at regular intervals. The numbers in that data set are now being analyzed via a web application. We have built a real-time data monitoring system within our web app. We can learn more about the modules' energy usage from the findings of the analyses we run. It is also helpful for power management. The addition of these modules elevates the overall quality of the project and helps to ensure uniformity in this technologically advanced era.

KEYWORDS: Internet of Things, LED, DC Fan, Automation, sensors, web application, Data Analysis.

Article History

Article Received: 15 February 2023

Revised: 20 April 2023

Accepted: 10 May 2023

INTRODUCTION

Safe and secure home automation systems are becoming increasingly popular. The automation of today's homes is so refined that even the smallest of changes in the functioning of any given item may be detected. With the development of home automation systems, smart home technology has become both energy-efficient and widely accessible [1]. Taking care of the comfort and happiness of the user is a primary focus of the design. The term "home automation" can also refer to a single system that can control and communicate with practically all parts of your home. The phrase "home automation" can be used to describe the coordinated operation of various home equipment and systems [2]. For instance, a single microcontroller panel may be able to handle the control of all the electricity and heating in the home. Some examples of home automation are controlling various home functions from

afar using a computer or mobile device, tailoring the operation of electronic appliances to a specific set of circumstances or predetermined set of events, or consolidating the management of a number of previously separate devices into a single point. The numerous programmable appliances must be linked together and able to exchange data with one another [3]. Managing and monitoring signals from various home appliances and essential services is the primary goal of home automation systems. A smart phone is used as a controller or monitor for the home's automated systems. The term "Home Automation" has been around for some time. The concept of connecting appliances in the home over a network has been widely adopted, and the phrases "smart home" and "intelligent home" have become synonymous with this idea [4]. Lighting, security, and other home systems can all be managed from a single location, and their statuses can be monitored from afar, with the use of a home automation system (HAS). HASs improve security systems, which in turn increases user comfort and ease of use. As a new industry, HASs are gaining traction and pique the curiosity of a wide range of end consumers. With HASs comes its own set of difficulties [5]. Even though they would profit much from it, users, especially the elderly and the disabled, are not seen to readily accept the system due to its perceived complexity and high cost.

SMART HOME TECHNOLOGY

All the home appliances and other gadgets act as receivers, while the transmitters are the keypads and other controls used to operate the system. To switch off a lamp in another room, the transmitter will send a message in numerical code that comprises the following. Although X10 makes it possible for all of this to occur in a fraction of a second, it does have some restrictions. There is a degree of unreliability when using electrical lines for communication due to the "noise" introduced by the various appliances they power [6]. An X10 gadget might respond to electronic interference because it thinks it's a command or it might not respond at all. While X10 products aren't going anywhere anytime soon, alternative home networking technologies have arisen to compete with them. Some systems interact not through the electrical cables but using radio waves, the same way that WiFi and cell phone signals work. However, due to the nature of automation commands being relatively brief messages, home automation networks do not necessitate the full bandwidth of a WiFi network. ZigBee and Z-Wave are the most widely used radio networks for home automation. These two systems share the characteristic of being mesh networks, which means that the information can go to its destination via several different paths.

Z-Wave

Z-Wave employs a Source Routing Algorithm to find the most efficient path for sending data. When a Z-Wave device is inserted into the system, the network controller scans for the code stored in the device to detect its location and add it to the network [7]. The controller consults the algorithm whenever it receives a command to figure out the most efficient method of transmission. Because this sort of routing can consume a lot of data storage on a network, Z-Wave has implemented a device hierarchy: While some controllers can send out signals on their own, others can merely act as a conduit for and reply to communications.

ZigBee

Because ZigBee's communications zigzag like bees looking for the best way to the recipient, its name exemplifies the mesh networking concept. ZigBee's platform is based on the IEEE standard for wireless personal networks, while Z-Wave relies on a proprietary technology for system operation [8]. This allows any company to create a product that is compatible with ZigBee without having to pay licensing fees for the underlying technology, which could offer ZigBee an advantage in the market. ZigBee, like Z-Wave, contains both full- and half-functional devices (the latter of which route the message).

Insteon

Using a wireless network allows more freedom for positioning devices, but like electrical lines, they could have interference. Insteon offers a mechanism for your home network to communicate across both electrical cables and radio waves, making it a dual mesh network. When one method of communication fails, the system will switch to another. An Insteon device will broadcast the message instead of routing it, and the other devices will continue to do the same until the directive is carried out. Instead of one device operating as a stimulator and the other as a receptor, the two devices function as equals [9]. This means that the greater the number of Insteon devices on a network, the more powerful the signal.

SMART HOME ADVANTAGES

There's no denying that high-tech dwellings may simplify and streamline daily routines. Having a secure home network can also reduce stress. The smart home will keep you informed of what's happening whether you're at home or away, and customized security systems can be of tremendous assistance in the event of an emergency. In the event of a fire, for instance, the smart home might alert the occupants, open the doors, call the fire service, and turn on the lights to guide them to safety. There is a small but noticeable decrease in energy use in smart homes. Some gadgets may essentially "sleep" and then "wake up" when commands are delivered thanks to technologies like Z-Wave and ZigBee. To save money on electricity, lights can be set to turn off when a person leaves a room, and the temperature can be adjusted according to the number of people in the house at any given time. One astute homeowner brags that her heating costs are approximately a third of those for a typical home of the same square footage. Some gadgets can monitor your energy consumption and issue directives to your appliances to reduce their power consumption. Having access to smart home technologies holds great potential for the elderly who live alone. A smart home may send a reminder when it's time to take medication, contact medical personnel in the event of a fall, and keep tabs on how much food a person is consuming. The elderly person's forgetfulness may be mitigated by the smart home, which would do things like turn off the water before a tub overflowed or turn off the oven if the chef had wandered off. It also makes it easier for grown children to pitch in and help take care of a parent, even if they don't live nearby [10]. Those with physical limitations or disabilities would also benefit from simple automated devices. Most homeowners' first thought is to find ways to reduce their energy consumption. The proliferation of electronic devices and the rise in popularity of home appliances has led to a dramatic increase in overall energy consumption. Therefore, it is

essential that your home is energy efficient and that you take all measure possible to prevent energy waste. Using energy efficiently is easier than ever before thanks to the convenience of smart home technologies. With a smart home product, you can easily control and disconnect all of your machines, devices, and appliances after each use. Customizing your house's appliances and smart devices to fit your lifestyle is a breeze with a smart home automation system. You may adjust the temperature of your home's heating and cooling systems from the convenience of your mobile device, whether you're at work, on the go, in the shower, or in bed.

LITERATURE REVIEW

Syeda Ayesha et al (2022), Home Automation System (HAS) with minimal cost and wireless system is shown in this project as its final design. Specifically, it considers the case of an Internet of Things (IoT)-based home automation system, which may either manually be programmed to respond to changes in the environment or be remotely controlled by a user. In this project, we plan for the implementation of firmware for smart home control that can be fully automated with as little human involvement as possible while yet maintaining the safety and security of all electrical components [16]. To put this strategy into action, we utilized automation by way of the widely used open source IoT platform NodeMCU. Different components of the system are visiting be conversant in control the appliance supported the user's input through NodeMCU. The most important mechanism makes use of wireless technology to enable mobile device access from afar. We are using a cloud server-based communication system, which could improve the project's viability by giving users free access to the equipment without regard to physical location. In order to build a more robust robot, we built a system for sharing information. This system was made to control home electrical appliances and gadgets, and it has a low-priced build, an easy-to-navigate interface, and a simple set-up process. The Android operating system allows for appliance management. This approach is meant to help the elderly and the disabled to have their needs met in the comfort of their own homes. In addition, the system's incorporation of the smart home idea raises the general quality of life.

Mrs.Jyotsna P et al (2017), Internet of Things (IoT) refers to the growth of online service availability, while the term "smart home" originally referred only to the centralized and semi-automated control of environmental systems. The Internet of Things is being used to more and more uses. The adoption rate of cutting-edge tech in the IoT setting is skyrocketing. The technology exists already in the field of industrial wireless sensor networks (WSN). One of the uses of the Internet of Things is in creating "smart" homes. Security at the server, security in smart homes, etc. are only a few examples of the new challenges that have emerged as a result of the rapid development of technology and advancements in architecture. The IoT architecture is described in this paper [17]. Appliances and other home gadgets in a "smart home" can be monitored and controlled from another location. The term "Smart Home in IoT environment" or "IoT based Smart Homes" is used to describe a system wherein various household equipment are linked to the internet via a well-designed network architecture and standardized protocols. The process of automating a smart house is simplified. Along with

identifying issues plaguing the Internet of Things and IoT-based smart home systems, this article also details a number of potential approaches to these difficulties.

RESEARCH METHODOLOGY

Except for the extremely unlikely occurrence of events beyond human control and some natural disasters, one's own home is thought to be the safest location on the planet. If, however, family members must leave the house in pursuit of employment, it is imperative that they make arrangements for the safety of all household valuables. When something out of the ordinary occurs at home, the home automation system is programmed to handle it automatically. Sensing nodes collect the information, therefore data mining is necessary. Big Data is a term developed by those working in IT to characterize the current data and information management landscape. However, there is still misunderstanding about what Big Data is and, more significantly, how businesses should approach Big Data internally. Big Data's heterogeneity, scale, timeliness, complexity, and privacy constraints slow down the entire data-value creation pipeline. Data capture is only the beginning; the data tsunami also forces us to make ad hoc choices about what data to preserve and what to discard, as well as how to store the data we do save in a reliable manner with the appropriate metadata, and this is where the troubles begin. More fundamental difficulties include data analysis, organizing, retrieval, and modeling. The analysis of data is often the limiting step in applications because of the complexity of the data itself and the inability of the underlying algorithms to scale. Last but not least, actionable knowledge extraction relies on presentation of results and interpretation by non-technical domain specialists. Recent advancements in sensor network technology have broadened their potential applications in areas including historical preservation, environmental monitoring, and human activity recognition. As more and larger sensor networks are put into use, the amount of data collected grows at an exponential rate, necessitating the development of new approaches that can handle this volume of data while still meeting the needs of specific applications. In order to use the data collected by these sensors effectively, it must be evaluated correctly. There is little doubt about the intrinsic interconnectedness of machine learning, statistics, and data mining. The three disciplines share the goal of discovering novel concepts or patterns in empirical data. Now, you can control your entire home with just one smartphone thanks to the proliferation of sensors, digital assistants, and other electronic helpers. There has been no revolutionary shift in my lifestyle as a result of the Internet's impact on technology. Smart homes and other connected items are just the beginning of how the lightning-fast connectivity of the Internet of Things will transform our world. With the help of the Internet of Things (IoT), a person's smartphone has become a kind of "global nervous system," able to handle a wide variety of tasks and keep its owner constantly connected no matter where he or she may be. This includes everything from making purchases and managing an astounding amount of personal data to ensuring that the lights stay on at home and keeping track of the weather.



Figure 1.1 Securing the Smart and Connected Home with IOT

Third-party cloud storage systems, in which privacy is generally applicable to the cloud, are beneficial for storing any sensitive data, and are used by people, developers, and adapters alike. The Internet of Things will unquestionably extend the limits of all the current generation's networking systems, making our homes safer in the process [12, 13]. Since IoT is used on a daily basis to connect seemingly innocuous devices and information, such as those found in the home, it is ideally suited to provide security in the event of an emergency. The materialistic atmosphere of a cognitive home is the result of the house's ability to learn its inhabitants' habits and routines. Forecasts put the total number of "smart" houses worldwide at 193 million by 2020, up from an estimated 83 million in 2016. This estimate includes all smart appliances as well as smart home security systems and smart home energy equipment like smart thermostats and smart lights. Everything relies on the network of sensors and other devices that links the real world to the virtual one in the cloud. In this model, a central operating system is linked to a network of peripheral devices that perform various tasks for the system as a whole; from there, a series of other devices, including sensors and data trackers used to monitor the system's state and relay that information back to the main devices, are linked to the network via wires or wireless technology. In order to keep tabs on 218 potential dangers, for instance, four distinct Internet of Things (IoT) systems in an aeroplane employ a combination of sensors and actuators to compile and transmit data to the plane's primary control units, which then show it to the pilots. The system's primary user has access to a security warning system that can be activated in the event of a security breach. Instead of an app or graphical user interface, these home security systems communicate with you via the numeric keypad on your smartphone. This means that the system is platform-agnostic and can be accessed from a wide variety of devices. The user may also manage his household appliances without sensors being triggered thanks to the many other optional devices application. Some of the models developed for protecting a smart and connected house through the Internet of Things are depicted in the images below, along with some of the associated gadgets [14]. As one of the world's foremost researchers put it, "the Internet of Things is liberating us from the tedium of doing the same things over and over again or

creating things that were not possible before," freeing up human hands to focus on higher-order endeavours while leaving the mundane work to machines. This, of course, has both positive and negative consequences; however, the former can be mitigated by employing the technology in appropriate ways, and the latter can help mitigate the latter. Many problems have been associated with the Internet of Things, but there's no denying that it has also ushered in a more convenient way of life for future generations. There are a variety of smart house gadgets out there that offer home automation technologies, and many of the same tools found in conventional computer systems may now be included into "Smart Home" setups. The latest innovations and technological developments in the realm of Smart Homes are discussed here. Nowadays, consumers buy and use ubiquitous smart home equipment without a second thought. It's hard to find a household appliance these days that can't be automated in some way. The next phase in the development of home automation systems is the incorporation of programmability, automation, and artificial intelligence.

RESULT AND DISCUSSION

The concept of the smart and connected house has been around for a while, but outside of the DIY enthusiast subculture and the ultra-wealthy, home automation hasn't caught on with the masses. Due to the rapid evolution of technologies, compatibility is also a concern for the Smart Home, which requires high-speed Wi-Fi, a broadband connection, high-quality sensors, and a high definition camera. There appears to be a big data tale with a massive network of interconnected gadgets that continuously share and analyze rivers of unstructured data.

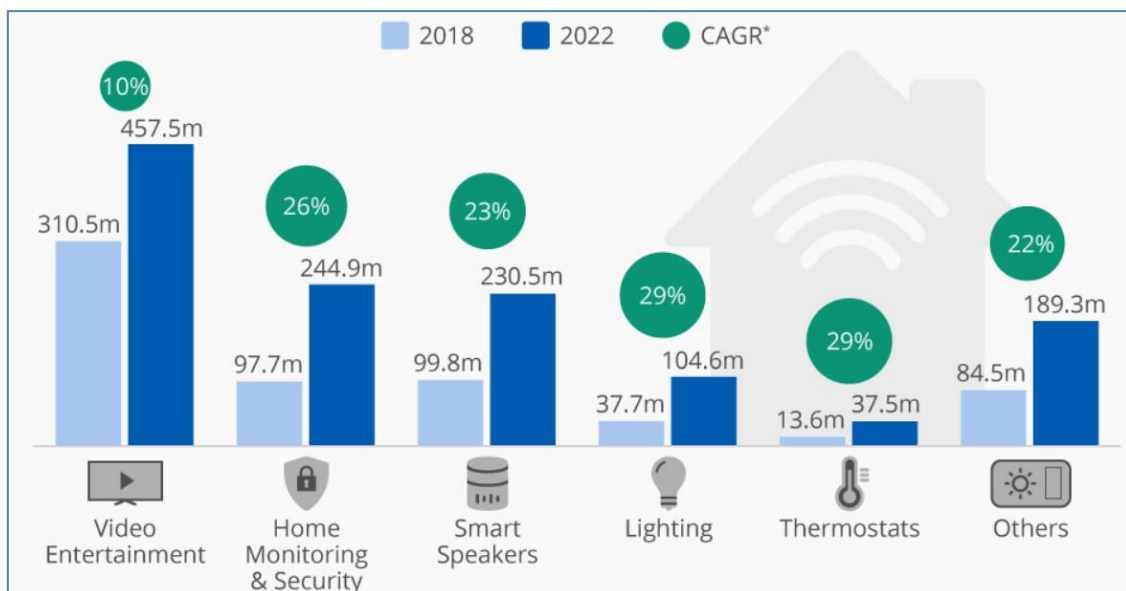


Figure 3. Growth of Smart Home Technology

A variety of health-related applications, like the aforementioned data-sharing bathroom scale, may become possible if consumers embraced Smart-home services and gadgets. Different methods for IoT analytics based on machine learning have been compared with one another. There are a number of problems with IoT analytics methods despite the fact that they perform better than the alternatives. In particular, hyper parameter tweaking, over-fitting, and the

security of data from remotely monitored household appliances are problems that need to be addressed. All we've done is do some comparisons between the various existing approaches to IoT analytics; we haven't come up with anything new. Because of this, we plan to develop an innovative approach to IoT analytics that takes into account security, assembly to avoid over-fitting, and soft computing to fine-tune hyper parameters. Home security systems are an integral part of any state-of-the-art smart home setup. These days, you can get anything from a wireless doorbell with a built-in camera that lets you keep tabs on guests from anywhere in the world to high-tech alarms that are linked to the police. Key components of any modern smart house now include diagnostic technology that alerts homeowners to potential dangers, such as a leaky pipe or a fire. It comes as no surprise that the smart home security market has seen significant growth in value over the past few years. According to Statist's Digital Market Outlook, sales are predicted to reach \$5 billion in 2021 and \$8.2 billion in 2025.

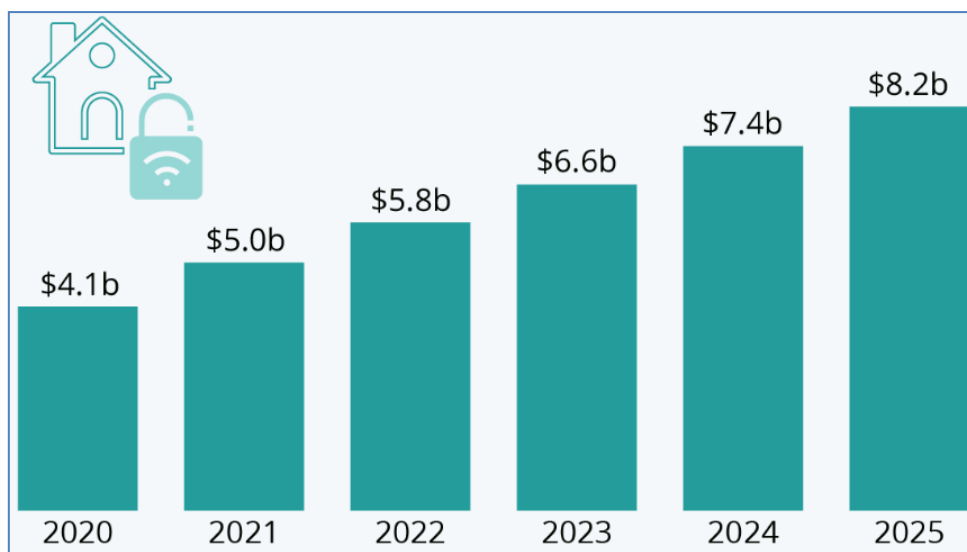


Figure 2. Demand Growing For Smart Home Security Systems

Although home automation has been around for some time, it has recently seen a surge in popularity because to internet-enabled gadgets that allow for remote control of every aspect of a home. People are actively purchasing smart devices, or planning to do so in the near future, in the quest of ease, security, and efficiency in household management. Through the development of the IoT, "smart home" technology has become a reality. This refers to a network of interconnected household equipment. Whether at home or out, it uses sensors, networks, centralized processing centers, and command remotes to carry out the users' desired actions. In many cases, smart phones or smart speakers will be used to manage and keep tabs on these gadgets. These gadgets help individuals conserve energy and feel safe in their homes. By keeping tabs on people's health and helping them with their unique requirements, it also improves their general sense of happiness. Also, there are a dozen other types of smart home technologies, allowing homeowners to regulate anything from the aesthetics of their homes to the safety of their families. Good Firms surveyed 350+ people to better understand how people use smart devices for home and what aspects encourage them to acquire such gadgets, even though this trend has already been established.

CONCLUSION

In this paper, we explored the concept of smart homes and showed how they work along with the use of Big Data and the tools that support them. In smart homes, the Internet of Things is used to link together appliances and sensors to improve our quality of life. A large quantity of data may be generated daily by all the linked devices, yet this data can be simply stored, processed, and analyzed to yield insights for the homeowner. Utilizing big data in smart homes is not only efficient, but also gives homeowners access to the resources of Hadoop. Safety and access controls, optimal energy use, storing and analyzing data from smart air purifiers and lighting systems are just a few of the many ways in which Big Data is used in smart home design. The quality of sensors, the cost issue, vendor-related concerns, device compatibility issues, servers for the data storage, security challenges, etc. are all discussed in this article as important issues and challenges for the application of Big Data technology in smart homes. and last, a basic framework for integrating big data methods into the smart home was provided. With this, you may adjust your Smart Home's temperature, lighting, and other features using your smartphone or other Internet-connected device. The framework is divided into three main sections: the "Application" section, the "Big Data" section, and the "Home Appliances and Devices" section. Connect and set up your smart home appliances with the help of the home appliances/devices module. Big Data file systems are utilized by these devices to store the humongous amounts of data that are then analyzed using the big data module and the application data module. To address the concerns expressed, future work may centre on creating a private cloud system for storing smart home data in big data file systems, employing analytical tools locally to prevent security breaches, and establishing a remote, encrypted connection to the service provider.

REFERENCES

1. Suraj Kaushik, Yuvraj Singh Chouhan, Nagendra Sharma, Shreyansh Singh, P Suganya, "Automatic Fan Speed Control Using Temperature And Humidity Sensor And Arduino" International Journal of Advance Research, Ideas and Innovations In Technology, Volume 4, Issue 2, 2018.
2. Fathima Dheena p.p, Greema S Raj, Gopika Dutt, Vinila Jinny, "IOT Based Smart Street Light Management System" Proceedings of 2017 IEEE International Conference on Circuits and Systems (ICCS2017).
3. A.R. Al-Ali, Imran A. Zualkernan, Mohammed Rashid, Ragini Gupta, Mazin AliKarar, "A Smart Home Energy Management System using IOT and Big Data Analytics Approach" IEEE Transactions on Consumer Electronics, Vol.63, No.4, November 2017.
4. Yunchuan Sun, Houbing Sun, Antonio J. Jara, Rongfang Bie, "Internet of Things and Big Data Analytics For Smart & Connected Communities" IEEE Access, Special Section of Smart Cities, Volume 4, February 12, 2016.
5. Parkash, Prabu V, Dandu Rajendra, "Internet Of Things Based Intelligent Street Lighting System For Smart City" International Journal of Innovative Research in Science, Engineering & Technology, Vol.5, Issue 5, May 2016.

6. Shreesh Mishra, Shivakant Gupta, Santosh Singh, Tripuresh Tiwari, Anand Mohan, "Arduino Based LED Street Light Auto Intensity Control System" International Journal of Advanced Research in Engineering, Volume 3, Issue-4, April-2016.
7. K. Dittawit and F. A. Aagesen, "Home energy management system for electricity cost savings and comfort preservation," 2014 IEEE Fourth International Conference on Consumer Electronics Berlin (ICCE Berlin), Berlin, 2014, pp. 309-313.
8. Y. T. Lee, W. H. Hsiao, C. M. Huang and S. C. T. Chou, "An integrated cloud-based smart home management system with community hierarchy," IEEE Trans. Consumer Electron, vol. 62, no. 1, pp. 1-9, Feb. 2016.
9. J. Wang, J. Huang, W. Chen, J. Liu and D. Xu, "Design of IoT-based energy efficiency management system for building ceramics production line," 2016 IEEE 11th Conference on Industrial Electronics and Applications (ICIEA), Hefei, 2016, pp. 912-917.
10. Kool, Ish, Dharmendra Kumar, and ShovanBarma. "Visual Machine Intelligence for Home Automation." In 2018 3rd International Conference On Internet of Things: Smart Innovation and Usages (IoT-SIU), pp. 1-6. IEEE, 2018.
11. Bertino, Elisa, Kim-Kwang Raymond Choo, DimitriosGeorgakopolous, and Surya Nepal. "Internet of things (iot): Smart and secure service delivery." ACM Transactions on Internet Technology (TOIT) 16, no. 4 (2016): 22.
12. Brich, Julia, Marcel Walch, Michael Rietzler, Michael Weber, and Florian Schaub. "Exploring end user programming needs in home automation." ACM Transactions on Computer-Human Interaction(TOCHI) 24, no. 2 (2017): 11.
13. Guebli, Wassil, and AbdelkaderBelkhir. "TV home-box based IoT for smart home." In Proceedings of the Mediterranean Symposium on Smart City Application, p. 12.ACM, 2017.
14. Jakobi, Timo, Gunnar Stevens, NicoCastelli, CorinnaOgonowski, Florian Schaub, Nils Vindice, Dave Randall, Peter Tolmie, and Volker Wulf. "Evolving Needs in IoT Control and Accountability: A Longitudinal Study on Smart Home Intelligibility." Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies 2, no. 4 (2018): 171.
15. Zhao, Yiran, Shuochao Yao, Shen Li, Shaohan Hu, Huajie Shao, and Tarek F. Abdelzaher. "VibeBin: A vibration-based waste bin level detection system." Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies 1, no. 3 (2017).
16. Syeda Ayesha Unisa, "Smart Home Control", International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538 Volume 10 Issue VII July 2022.
17. Mr. Pranay P. Gaikwad, Mrs. Jyotsna P. Gabhane, Mrs. Snehal S. "A Survey based on Smart Homes System Using InternetofThings", 2015 INTERNATIONAL CONFERENCE ON COMPUTATION OF POWER, ENERGY, INFORMATION AND COMMUNICATION, pp. 330-335.