Smart Sage: IoT-Driven Home Automation Framework with Predictive Machine Learning

1st Rayhan Al Shorif
Computer Science and Engineering
United International University (UIU)
Dhaka, Bangladesh
rayhanalshorif@gmail.com

2nd Dr. Khondaker Abdullah -Al-Mamun
Computer Science and Engineering
United International University (UIU)
Dhaka, Bangladesh
mamun@cse.uiu.ac.bd

***Abstract*—In the modern generation, the use of automation or AI has become an integral part of our lives. As a result, today it affects various aspects such as transportation and communication, communication, even starting from the rising of the sun every morning and household chores till sunset. Smart home apps are changing the standard of living of people and helping people to do any task very easily, considering this is our endeavor. Nowadays people are more and more attracted towards automation so this paper considers basically how to automate a home or office appliance using machine learning and Arduino Uno. Also, it measures the voltage of the electricity from them to give an idea or framework of what the future electricity demand might be for them.**

***Index Terms*—home automation, framework, future predictions, voltage measurements**

I. Introduction

The home self-regulation concept is growing in popularity for reducing human effort including errors and thus increasing efficiency. We can manage remote home appliances help of Home self-regulation.Over and above that, the home self-the regulation system can also integrate other ardors like alarms, emergency systems, security, etcetera. At the point when a self-regulation house was implicit in the good 'old days, At first, it utilized signals and electrical force transmission wires to naturally control the home appliances where each sign contained computerized information short radio-recurrence.Different types of home self-regulation systems such as Bluetooth Controlled, Internet Controlled, and so many others. All kinds of self-regulation systems have their favor and drawbacks. In our work, we have designed various automatically activated devices for smart homes. Our home self-regulation framework project is built on Arduino UNO, RIP motion sensor, Temperature Sensor, multimeter. The next section will interpret all framework modules on the project. The fundamental home self-regulation is shown in Figure 1. Even though there are many contending merchants, there is a developing exertion toward open-source frameworks. In any case, there are issues with the present status of self-regulation in IOT, including the absence of standard safety efforts and the degrading of more established gadgets Without reverse similarity, and thinking about this issue, our proposed framework structure has been created.

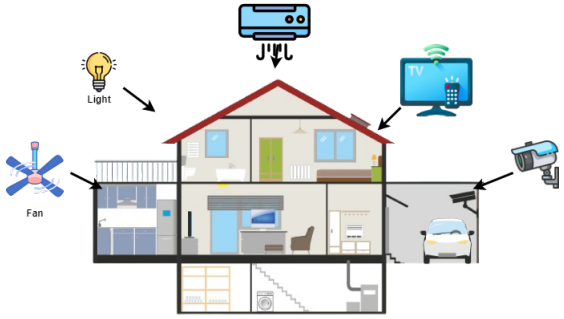

Fig. 1. A depiction of various electronic devices within a home, all of which are capable of automatic operation.

II. Related work

Nowadays technology has enriched every sector in many ways. In this recent world everything is automated like E-voting [1], [2], supply chain management [3],robotics [4], vehicle registration [5],national identity card management [6],sentiment analysis [7],applications for own security [8] and so more.Here, a concise narrative of the work done earlier and also discusses the automation systems based on all the sectors that have created various new systems using IoT and the application and technology were the main basis of their work. Himanshu Singh, Vishal Pallagani, Vedant Khandelwal, and Venkanna U. [9] used a wireless sensor node to automate home repose track of varied circumstance variables that exist and guides to work according to the user needs. A smart room based on the solar power system and Wago PLC was developed by Vibhuti and S. L. Shimi [10] with two processes. S. Mahmud, S. Ahmed, and K. Shikder [11] developed a smart home automation system with a metering system using IoT for user-controlled and monitored electronic devices. A portable, low-cost, and user-friendly IoT-based home automation system was proposed by Jabbar, W. A., Kian, T. K., Ramli, R. M., Zubir, S. N., Zamrizaman, N. S. M., Balfaqih, M., Alharbi, S [12]. A home automation system design by A. Fakih, U. Rais, S. Maniar, R. Naik, and H. Siddiqui, [13] that was working on offline Ethernet-based automation and a self-sustainable DC Solar power system. Gunarathne and Kalingamudali [14] had

improved a smart control system for controlling light, air conditioning, and ceiling fans in a room. An android application was connected with the control system through Wi-Fi across a cloud network.To fight the rising costs of electricity bills and the scarcity of resources type of system was implemented by T. Dhanush, B. Aswin Ramnath, M. Krishnakanth, and N. Bhalaji [15]. Also, this system was a great load of resources that can be saved by all the institutions their system.V. Lytvyn, V. Vysotska, V. Mykhailyshyn, I. Peleshchak, R. Peleshchak, and I. Kohut [16] were focused on developing the system which allowed to create reliable, fast optimized, easy to use systems with the mobile, and web-the based user interface.A system was developed by M. N. Murthy and P. AjaySaiKiran [17] based on Raspberry Pi model B for better automation in the office. It worked with the help of Android mobile. S. Hazra, N. Sengupta, A. Pal, S. Acharyya, and B. Satpati [18] improved a flexible home automation system based on the robotic programming environment RIDE that allows defining, monitoring, and debugging tasks modeled as Petri nets.P. Roy, J. Saha, N. Dutta, and S. Chandra [19] was designing also constructed the electrical appliances of a room used by C/C++ Language to compare temperature with standard temperature and set fan speed and their values displayed on LCD.Mohammad Hasnain. R, Rishabh.S, Mayank. P and Swapnil. G [20] discussed an approach that was able to detect humans in each segment and appliances can be controlled according to the presence or absence of humans in the room. They also used existing cameras to greatly reduce the hardware cost required for implementation. The current robotization frameworks dependent on Bluetooth are cost-effective and simple to execute/introduce yet aren't adaptable enough to the climate or just cannot utilized past a breaking point.By and large, a Bluetooth framework works under the scope of 0 to 15 meters. Additionally, from the client's perspective, Bluetooth is an obsolete innovation and probably has similar issues.ZigBee-based frameworks likewise have a comparable issue of reach as their application is restricted to indoor use. These frameworks are by and large utilized for LAN. In GSM-based home computerization framework, it isn't simply restricted to a shrewd cell phone all things being equal, however, you can likewise utilize a typically included telephone. Notwithstanding, the framework is network-needy and a particular organization is needed to send the message to control the machines. Execution of a mechanization framework with Z-wave is less convoluted and has a more prominent reach than the computerization framework actualized with ZigBee. In this way, it is acceptable to say that utilizing a straightforward convention, for example, Z-wave, the advancement of the computerization framework is simple and basic. Existing Home Automation Systems have the accompanying significant difficulties: - High Cost of Deployment, Lack of adaptability with client interest, and Poor Sensibility. The primary target of this paper is to build up a framework utilizing IOT which is equipped for controlling our family unit apparatuses using an easy-to-use web interface. The proposed framework has extraordinary similarity and adaptability with the current foundation utilizing Wi-Fi to associate home apparatuses with the worker. The proposed framework will limit the establishment cost and will improve the capacity to update the current framework. The target of this paper is to give an applicable, achievable, viable answer for the previously mentioned issue that the existing home computerization framework for the most part faces. Technology is changing as well as new and old technologies are merging in every aspect of technological work like in mobile computing [21], in the sector of wireless networking [22], bandwidth optimization [23], accident detection on road in low cost [24] and so on. Smart home is now a demand for smart lifestyle to increase the quality of life.

III. Prediction with Machine Learning

Machine learning research has become an advanced study to take artificial intelligence one step further. Scientists are trying to use machine learning to operate machines like humans. Machine learning is such a method that teaches how to operate a system like a human. "Prediction" alludes to the yield of a calculation after it has been prepared on an authentic data set and applied to new information when determining the probability of a specific result, for example, regardless of whether a client will stir in 30 days. Prediction is a major important part of Machine Learning because it denotes businesses to make highly accurate guesses. Moreover, it is based on many other data like historical customer churn likelihood, possible fraudulent activity, and so on. There are many types of prediction in machine learning.

Supervised Learning Algorithms: To teach mapping functions, which are primarily supervised using labeled training data which denotes the input variable is (A) into the output variable (B).On the other hand, that is containing for f in the following equation: B = f(A). This helps us to generate the output correctly while giving new input. Now we are going to briefly discuss two types of supervised learning algorithms, one is 'Regression' and the other is 'Classification'.The results of the given sample are used to predict when the output of the classification is in the form of variable sections. A classification model requires input data to predict "sick" or "healthy" labels. The output variable is in the form of the original values when regression is used to predict the outcome for any sample.

Unsupervised Learning Algorithms: If we have only one variable as input called 'A' and no corresponding output variables, Unsupervised learning models have occurred. Now we are going to discuss many other types of unsupervised machine learning: To discover the possibility of the co-occurrence of items in the organization Associations. For analyzing the market is also used. As an example, an association model is a model that is discovered when someone purchases bread,s/he is 80% likely to also purchase eggs. Clustering is utilized to gather tests with the end goal that objects inside a similar group are more like each other than to the items from another group.To ensure that important data is still conveyed for reducing the number of variables of a data set is used Dimensionality Reduction.

Reinforcement learning: Reinforcement learning is a kind of AI calculation that permits a specialist to choose the best next activity dependent on its present status by learning behaviors that will maximize a reward.These algorithms are used for learning the optimal trial and error.In the example part, we say that in a video game in which the player needs to move to specific spots at specific occasions to procure focuses. A support calculation playing that game would begin by moving haphazardly however, over the long haul through experimentation, it would realize where and when it expected to move the in-game character to amplify its point complete.

IV. Proposed Work

In this section, Figures 2 and 3 illustrate the proposed system configuration and prototype, respectively. The proposed system elucidates the operational modules encompassed within the proposed solution.

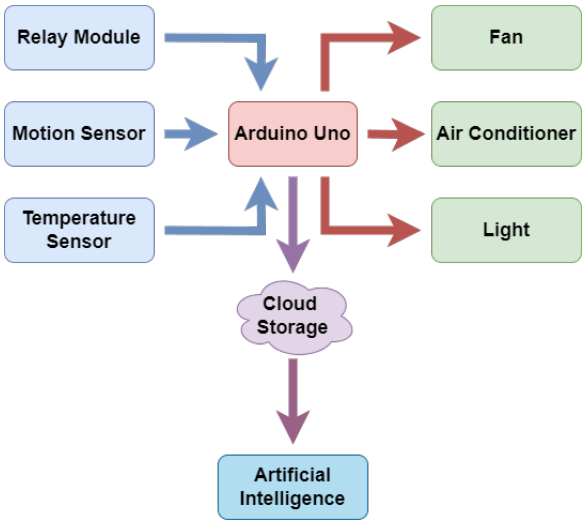

Fig 2: Block Diagram of the proposed system

A. System Design

Our proposed prototype is based on information obtained from various sensors. If we have this project in a room or a workplace it can be a factory, school, college, university, or any workplace, all the electronic things there will store the voltage used from it by controlling this project automatically. The stored voltage data will then be used to predict future exchange and usage at a future voltage using artificial intelligence. The project will identify any user who enters the room. After locating the user, the system will check if there are any lights open in the room. If not, our system will automatically send the data that we collect with the help of sensors and then the lights will turn on automatically. Next, it will detect the temperature of that room with the help of a temperature sensor. After detecting the temperature, if the temperature is higher than 24 degrees, the AC or fan in the room will turn on automatically. As long as no one is in the room, our system will work automatically by opening the fan, AC, or lighting system. When the user leaves the room at the end of the work, our system will collect the data again and turn off the home appliances automatically.

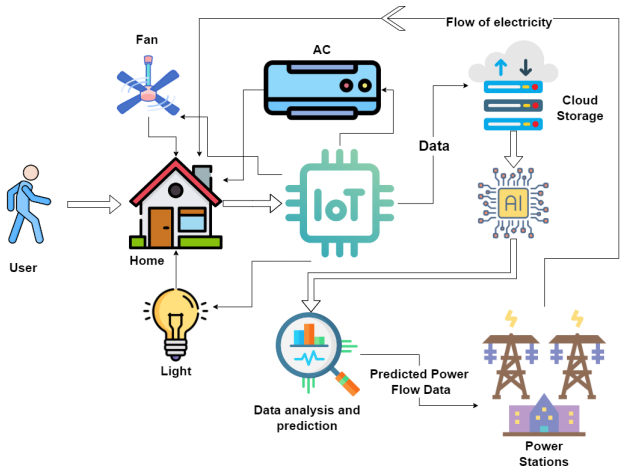

Fig 3: Prototype design of the proposed system

Here the appliances in the house prefer lights, the fan or air conditioner is connected to the relay triggers to operate with the Arduino Uno. The flow chart is portrayed in Fig. 4.

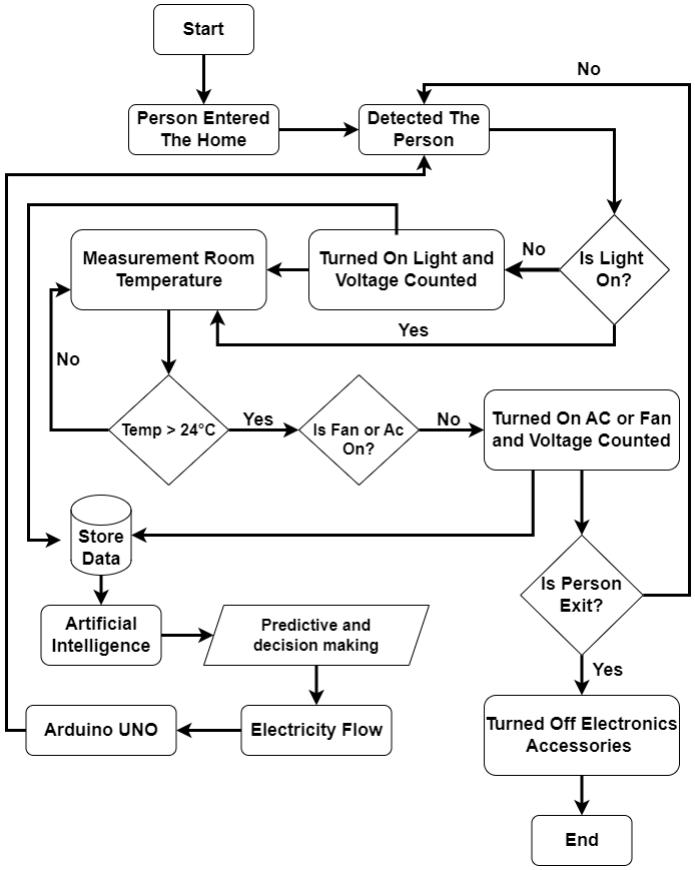

Fig 4: Data flow diagram of the proposed system

Arduino Uno: The Arduino Uno is an open-source microcontroller board dependent on the Microchip ATmega328P microcontroller and created by Arduino. The board is outfitted

with sets of advanced and simple information/yield (I/O) sticks that might be interfaced to different extension sheets (shields) and different circuits. The board has 14 advanced I/O pins (six equipped for PWM yield), 6 simple I/O sticks, and is programmable with the Arduino IDE (Integrated Development Environment), through a sort B USB link. It tends to be fueled by a USB link or by an outside 9-volt battery, however, it acknowledges voltages somewhere in the range of 7 and 20 volts. It is like the Arduino Nano and Leonardo. The equipment reference configuration is disseminated under a Creative Commons Attribution-Share-Alike 2.5 permit and is accessible on the Arduino site. Format and creation records for certain renditions of the equipment are likewise accessible.

Motion sensor:A movement finder is an electrical gadget that uses a sensor to identify close-by movement. Such a gadget is regularly coordinated as a segment of a framework that naturally plays out an assignment or alarms a client of movement in a zone. They structure an essential part of security, computerized lighting control, home control, energy effectiveness, and other valuable frameworks.

Temperature sensor: A temperature sensor is an electronic gadget that quantifies the temperature of its current circumstance and converts the info information into electronic information to record, screen, or sign temperature changes. There are various kinds of temperature sensors. Some temperature sensors require direct contact with the actual item that is being checked (contact temperature sensors), while others in a roundabout way measure the temperature of an article (non-contact temperature sensors).

Relay module: A force hand-off module is an electrical switch that is worked by an electromagnet. The electromagnet is actuated by a different low-power signal from a miniature regulator. At the point when actuated, the electromagnet pulls to one or the other open or close an electrical circuit. A basic transfer comprises of wire curl folded over a delicate iron center, or solenoid, an iron burden that conveys a low hesitance way for attractive motion, a versatile iron armature and at least one arrangements of contacts. The mobile armature is pivoted to the burden and connected to at least one bunch of the moving contacts. Held set up by a spring, the armature leaves a hole in the attractive circuit when the transfer is destimulated. While in this position, one of the two arrangements of contacts is shut while the other set remaining parts open.

B. Implementation Details

Integrated Development Environment (IDE) software Arduino UNO is used in this work.

Arduino IDE: The Arduino IDE tool means an integrated development environment that assists in the entire programming for the proposed system.The bitrate is set to 9600 bits per second for communication to the Arduino UNO and the necessary home appliances.The code is used to receive many other data signals from the RIP Motion sensor and the temperature sensor are shown below.

Tracking Home appliances Opening Times

set $x \leftarrow 0$; x means Sensor detected User
set $lightOpenCount \leftarrow 0$, $fanOpenCount \leftarrow 0$
If $x > 0$ **then**
  Print Openning Light
  Added $lightOpenCount \leftarrow 1$
  If $deg > 24$ **then** ; deg means degree which is detecting temperature
    Print Openning Fan or AC
    Added $fanOpenCount \leftarrow 1$

set $year \leftarrow 2024$, $month \leftarrow 04$, $day \leftarrow 12$
If $lightOpenCount >$YMDCountLight[year][month][day] **then**
$YMDCountLight[year][month][day] \leftarrow$lightOpenCount
Else If $fanOpenCount >$YMDCountFan[year][month][day] **then**
$YMDCountFan[year][month][day] \leftarrow$fanOpenCount

Our proposed home automation framework system is hardware applied using Arduino Uno, RIP motion sensor, temperature sensor, multimeter, and relay module. Which are shown below through Figure 6 Schematic and Figure 7 PCB of the Proposed system.The RIP motion sensor signal pin is connected to the Arduino Uno digital input pin D8 and the power pin and ground pin are connected to the Arduino 5 volts and ground, respectively. On the other hand, both the power pin and the ground pin of the temper sensor are connected to the Arduino like the motion sensor, but its output end is connected to the A0. We have used a multimeter in our proposed framework as we can see how much voltage is being transmitted through it. One end of the multimeter is connected to the relay module and the upper end to the housing equipment. The relay module is attached to the D5 pin in Arduino UNO. When a signal comes from the RIP motion sensor signal pin to Arduino's pin D8, the light opens. It ends connetion of which are connected to the relay module and the ground pin of the Arduino Uno, respectively. The motion sensor signal pin continues to give signals as long as a user is present in the room. At that moment the temperature sensor also became active and the room temperature sensor started to be sensed. If the temperature of the room exceeds 24 degrees, the fan or AC in the room will open automatically. If the temperature of the room drops to 24 degrees, the fan or AC will be turned off. When the user leaves the room, the motion sensor signal will be zero and then the appliances of the house will be turned off automatically.

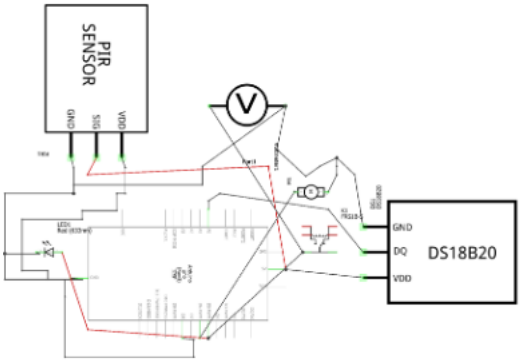

Figure 6: Schematic of proposed system

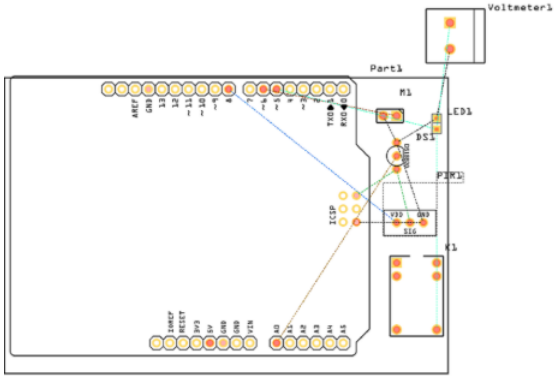

Figure 7: PCB of Proposed system

V. Result and Analysis

The proposed system is very helpful in monitoring and controlling the smart home environment. For automatically tracking or controlling the smart home environment, our proposed framework is very helpful. We have used the reinforcement learning algorithm of our proposed system. Because, after getting the information to manage the home equipment, this algorithm helps to make the next decisions appropriately. After successfully applying the above-described method, we can identify home appliances opening or monitoring data successfully. Figure 8 shown in our data that given below. From the output of our proposed system, which is in Figure 8, we can get an idea of how many household items are being used in a particular month of a year. In Figure 8(A), we can measure how many times the light is turned on every day in the month of January 2024, and in Figure 8(B) how many times a fan is turned on every day of the same month. If our system could be launched on an area-by-area basis, we would be able to measure the amount of electricity consumed to turn on a year-round home appliance in that area. This measured data will enable our system to measure how much electricity should be supplied to that area next year.

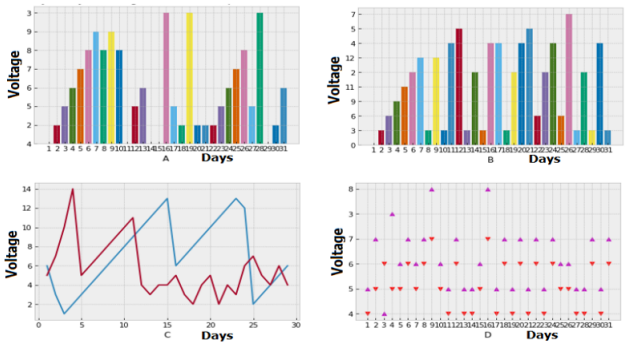

Figure 8: Month wise, Fan/Ac And Light voltage variation chart measurement

VI. Conclusion And future Possibility

The project is largely driven by the use of low power through various sensors that can provide ambient location data to enhance the accuracy and efficiency of a smart home. As well as managing home-based devices properly, they can save time when they are powered on. Which can be saved when turning on standalone or city-based stationery devices. As for future work, the system can be operated by all human activities such as whether a person enters a house, whether the person is known, provides different theories about the person and the devices in the house are not automatically synchronized. By doing this a system can be created that will handle things in the house.

References

[1] Biswas M, Mahi M, Nayeen J, Hossen R, Acharjee UK, Md W. BUVOTS: A Blockchain based Unmanipulated Voting Scheme. Rakib and Acharjee, Uzzal Kumar and Md, Whaiduzzaman, BUVOTS: A Blockchain Based Unmanipulated Voting Scheme (November 23, 2020). 2020 Nov 23.

[2] Mukherjee PP, Boshra AA, Ashraf MM, Biswas M. A Hyper-ledger Fabric Framework as a Service for Improved Quality E-voting System. In2020 IEEE Region 10 Symposium (TENSYMP) 2020 Jun 5 (pp. 394-397). IEEE.

[3] Al-Amin S, Sharkar SR, Kaiser MS, Biswas M. Towards a Blockchain-Based Supply Chain Management for E-Agro Business System. InProceedings of International Conference on Trends in Computational and Cognitive Engineering 2021 (pp. 329-339). Springer, Singapore.

[4] Akib AA, Ferdous MF, Biswas M, Khondokar HM. Artificial Intelligence Humanoid BONGO Robot in Bangladesh. In2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT) 2019 May 3 (pp. 1-6). IEEE.

[5] Hossain, M.P., Khaled, M., Saju, S.A., Roy, S., Biswas, M.: Vehicle registra-tion and information management using blockchain based distributed ledger frombangladesh perspective. In: 2020 IEEE Region 10 Symposium (TENSYMP). IEEE

[6] Datta P, Bhowmik A, Shome A, Biswas M. A Secured Smart National Identity Card Management Design using Blockchain. In2020 2nd International Conference on Advanced Information and Communication Technology (ICAICT) 2020 Nov 28 (pp. 291-296). IEEE.

[7] Mahi MJ, Hossain KM, Biswas M, Whaiduzzaman M. SENTRAC: A Novel Real Time Sentiment Analysis Approach Through Twitter Cloud Environment. InAdvances in Electrical and Computer Technologies 2020 (pp. 21-32). Springer, Singapore.

[8] Khatun S, Sarkar S, Biswas M. SecureIT–A weapon to protect you. Available at SSRN 3568797. 2020 Feb 25.

[9] Singh, H., Pallagani, V., Khandelwal, V. and Venkanna, U., 2018, March. IoT based smart home automation system using sensor node. In 2018 4th International Conference on Recent Advances in Information Technology (RAIT) (pp. 1-5). IEEE.

[10] Shimi, S.L., 2018, January. Implementation of smart class room using WAGO PLC. In 2018 2nd International Conference on Inventive Systems and Control (ICISC) (pp. 807-812). IEEE.
[11] Mahmud, S., Ahmed, S. and Shikder, K., 2019, January. 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.
[12] Jabbar, W.A., Kian, T.K., Ramli, R.M., Zubir, S.N., Zamrizaman, N.S., Balfaqih, M., Shepelev, V. and Alharbi, S., 2019. Design and fabrication of smart home with Internet of Things enabled automation system. IEEE Access, 7, pp.144059-144074.
[13] Fakih, A., Rais, U., Maniar, S., Naik, R. and Siddiqui, H., 2018, January. Implementation of a Self-Sustainable Infrastructure with remote power management. In 2018 International Conference on Smart City and Emerging Technology (ICSCET) (pp. 1-5). IEEE.
[14] Gunarathne, S.B.M.S.S. and Kalingamudali, S.R.D., 2019, February. Smart Automation System for Controlling Various Appliances using a Mobile Device. In 2019 IEEE International Conference on Industrial Technology (ICIT) (pp. 1585-1590). IEEE.
[15] Dhanush, T., Ramnath, B.A., Krishnakanth, M. and Bhalaji, N., 2018, July. Smart Rooms Automation System by Thermal Sensing. In 2018 International Conference on Inventive Research in Computing Applications (ICIRCA) (pp. 596-600). IEEE.
[16] Lytvyn, V., Vysotska, V., Mykhailyshyn, V., Peleshchak, I., Peleshchak, R. and Kohut, I., 2019, July. Intelligent system of a smart house. In 2019 3rd International Conference on Advanced Information and Communications Technologies (AICT) (pp. 282-287). IEEE.
[17] Murthy, M.N. and AjaySaiKiran, P., 2018, March. A smart office automation system using raspberry pi (model-b). In 2018 International Conference on Current Trends towards Converging Technologies (ICCTCT) (pp. 1-5). IEEE.
[18] Hazra, S., Sengupta, N., Pal, A., Acharyya, S. and Satpati, B., 2019, February. An Innovative Position Detection Pathway to Facilitate Low-Cost Home Automation. In 2019 Second International Conference on Advanced Computational and Communication Paradigms (ICACCP) (pp. 1-8). IEEE.
[19] Roy, P., Saha, J., Dutta, N. and Chandra, S., 2018, March. Microcontroller based automated room light and fan controller. In 2018 Emerging Trends in Electronic Devices and Computational Techniques (EDCT) (pp. 1-4). IEEE.
[20] Shaik, R.H. and Naidu, R., 2019, April. Performance analysis of multi-hop cooperative System under -μ shadowed fading channels. In 2019 International Conference on Communication and Signal Processing (ICCSP) (pp. 0587-0591). IEEE.
[21] Biswas, M. and Whaiduzzaman, M.D., 2018. Efficient mobile cloud computing through computation offloading. Int. J. Adv. Technol, 10(2).
[22] Islam, M., Biswas, M., Mahi, M., Nayeen, J. and Whaiduzzaman, M., 2018. LBRP: A Resilient Energy Harvesting Noise Aware Routing Protocol for Under Water Sensor Networks (UWSNS). International Journal in Foundations of Computer Science Technology (IJFCST) Vol, 8.
[23] Rahman, M.T., Mahi, M.J.N., Biswas, M., Kaiser, M.S. and Al Mamun, S., 2015, May. Performance evaluation of a portable PABX system through developing new bandwidth optimization technique. In 2015 International Conference on Electrical Engineering and Information Communication Technology (ICEEICT) (pp. 1-5). IEEE.
[24] Mahi, M.J., Rahad, K.A., Biswas, M., Islam, R. and Chowdhury, Z.I., 2016. An Accident Detection System for a Single VANET at Low Cost Module. IEEE, TechSym, 4(1), pp.44-45.