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**Research Article**

# Frosting The Future: Innovations In Iot-Enabled Refrigeration Security

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**ABSTRACT**

In the realm of home automation, the Internet of Things is revolutionizing how households operate by interconnecting devices and systems for enhanced convenience, efficiency, and security. The data is gathered by the sensors and sent to a host so that it can be processed over the internet. The field of home automation is among the most exciting uses of IoT. The fridge is one example of a smarter gadget that is used in daily life due to rapid technological advancements. The fridge is a key component in the food preservation of modular kitchens and shops. There is a need of system which will checks the fridge door is properly closed or not. The proposed system will detects the gaps between the fridge doors. If there is gap then it will alert the user by giving notification to their mobile. Due to which users can avoid excessive electricity consumption and also food spoilage can be prevented.

**Keywords:** IoT, Home Automation, Fridge, Blynk, Node MCU, Magnetic Switch Sensor.

## 1. INTRODUCTION

IoT is a transformative concept that connects physical devices through the Internet, enabling them to share data and interact autonomously. The term IoT refers to a concept that facilitates the creation of a wireless network between various IP protocols and internet-accessible devices. Things in the IoT refer to devices like sensors, microcontrollers, and mobile phones that are connected to a wireless network. In essence, IoT builds an ecosystem among devices that makes it accessible remotely [1]. IoT encompasses a wide range of devices, from everyday household items to sophisticated industrial tools, all equipped with sensors and network connectivity. These devices communicate with each other and with users, facilitating tasks like data exchange, device control, and process automation. Key components of IoT include sensors for data collection, connectivity technologies like Wi-Fi and cellular networks, data processing and storage capabilities, analytics for insights generation, and user interfaces for device interaction. IoT's significance lies in its ability to revolutionize industries by enhancing efficiency, productivity, and customer experiences. Despite facing challenges like security vulnerabilities and privacy concerns, IoT continues to grow rapidly, offering new business models, improved decision-making through data insights, enhanced operational efficiency, and the potential for creating innovative products and services across various sectors. IoT, saves time by analysing data gathered from sensors and carrying out relevant tasks. The development of home automation systems was aided by the assurances given to individuals regarding the security and activities of their homes. Both the user and the system's data will be updated regularly [2]. The integration of the IoT into home automation systems revolutionizes the way people interact with their living spaces, offering unparalleled convenience, efficiency, and security.

Home automation is about using technology to create a smarter and more responsive living environment. It achieves this by interconnecting various devices in your house, like lights, thermostats, appliances, security systems, and more allowing them to be controlled and monitored through a central hub or WiFi network. This connectivity allows people to operate these devices remotely using smartphone, tablet, or even voice assistants granting people the ability to turn on lights, adjust the thermostat, lock doors, or even monitor security cameras – all from anywhere. In the last few years, home automation has become more popular. As a result of the rapid

advancement of technology, home automation systems have become ever more advanced and intelligent [3]. Furthermore, some smart devices have built-in sensors that can detect things like motion, temperature, or light. These sensors can trigger automated actions, like lights turning on as someone enters a room or the thermostat adjusting before anybody arrives home, enhancing convenience and efficiency. Ultimately, home automation offers a multitude of benefits. It can increase anyone's comfort and convenience by allowing remote control of the environment. It can improve security through features like smart locks and remote video monitoring. And, by optimizing the usage of appliances and lights, it can even contribute to increased energy efficiency in your home. Home automation provides an effective use of energy along with a future lifestyle where a person can use a smart phone to handle every aspect of their home, including locking and opening doors and turning on a TV. However, the expense of having such a system installed is prohibitive, which is a significant reason why home automation has not attracted much interest. The installation and configuration of the system are also quite complex [4]. By leveraging IoT components like Arduino UNO, ESP8266 Wi-Fi module, and Blynk app, users can efficiently manage their homes from anywhere globally. The Blynk app facilitates the creation of consumer-facing mobile apps for managing IoT devices effortlessly, offering features like device monitoring, data management, and user control while ensuring data security through encrypted communication channels. The future of home automation looks promising as IoT technology continues to revolutionize living spaces with enhanced connectivity and smart solutions tailored to the needs of homeowners. Any electrically plugged-in appliance can be remotely managed in an automated house, or it can be as basic as a cluster of switches.
Equipment, parts, furnishings, and custom installation are the primary expenses [14]. From autonomous LED lighting, power consumption, and waste management systems to infrastructure solutions like PV systems, IoT, and smart grid for households, connected technology enables everyone to go green, minimize carbon emissions, and reduce pollution [15].
The remainder of the paper is organized as follows : Literature review and related work is presented in Section 2, Section 3 comprises of methodology used for the proposed system; System implementation, the overall functioning and results of the system is being discussed in Section 4; The discussion and conclusion of the paper is being presented in Section 5.

## 2. LITERATURE REVIEW

By giving each object a unique identity, the Internet of Things (IoT) can also be thought of as a worldwide network that facilitates communication between people, things, and things to things—that is, anything in the world. In the so-called Internet of Things, wired and wireless networks are used to connect sensors and actuators embedded in real objects, such as pacemakers and highways, frequently utilizing the same addresses. To access the Internet, use IP Internet. Massive amounts of data are produced by these networks and sent to computers for analysis. When an object has the ability to perceive and communicate with its surroundings, it can become an instrument for comprehending complexity and reacting rapidly to it. The revolutionary aspect of all this is that these physical information systems are beginning to be implemented now; some even run mostly without the need for human involvement. The Internet of Things (IoT) entails networking and encoding commonplace items and objects to enable online tracking and individual machine reading. Several wireless technologies have been utilized to introduce varying degrees of intelligence into the house, including Bluetooth, Wi-Fi, RFID, and cellular networks. These technologies make it possible to sense, control, and transmit data remotely. [16].
Since 1999, there have been extensive research and development efforts devoted to the application of Internet of Things technologies in refrigerators. In addition to tying the refrigerator to the internet, it can solve food waste problems and offer the user a number of helpful features. 1999 saw the release of the Electrolux Screen refrigerator. Although the device has not yet shipped, users of this networked refrigerator can place online purchases for groceries. [6]. In 2000, a Web pad refrigerator by Whirlpool/Cisco was unveiled, allowing customers to watch celebrity chefs. Users can look up recipes utilizing the food supplies they currently have by using the built-in web browser. The owner of a Whirlpool refrigerator may watch TV, play DVDs, listen to the radio, browse the Internet, send and receive emails, and even make phone calls after the refrigerator was converted into a multimedia communications center in 2002 [5]. In June 2000, LG unveiled the Internet Digital DIOS, the first internet refrigerator in history. An internet refrigerator, also called a smart refrigerator, is a refrigerator that has been set up to use barcode or RFID scanning to detect the products it contains and to keep track of its inventory [5]. Other manufacturers, like Samsung and Panasonic, also entered the fray and developed ideas for integrating cameras inside refrigerators to monitor food spoilage and enable users to check on leftovers without opening the door. But because they are so pricey, these refrigerators aren't widely sold. Many juice bottles, for instance, are transparent, which acts as a visual cue that a purchase will eventually be required. Similarly, transparent vegetable drawers, which hold items that are regularly removed from packaging, do away with the need for bar codes for inventory, which previously required the manual entry of dates and descriptions. Moreover, the use case of the device alerting users to upcoming purchases is typically unsolvable when there are regularly multiple buyers in a household who converse informally. [7]. Using gas detectors, PIR sensors, ultrasonic sensors, and GSM technologies, Oyekola developed a wireless remote security home surveillance system utilizing IoT and smartphones [19].

## 3. METHODOLOGY

The IoT-based fridge door alert system aims to deliver a seamless and user-friendly experience, emphasizing real-time monitoring, instant alerts. The intuitive interface, accessible through a mobile app or web platform, provides users with a clear visualization of the fridge door status and allows for effortless customization of alert settings. Scalability is addressed by supporting multiple fridges within a single user account. The system promotes customization, reliability, and comprehensive documentation. Block Diagram of the project is shown in Figure 3.1.

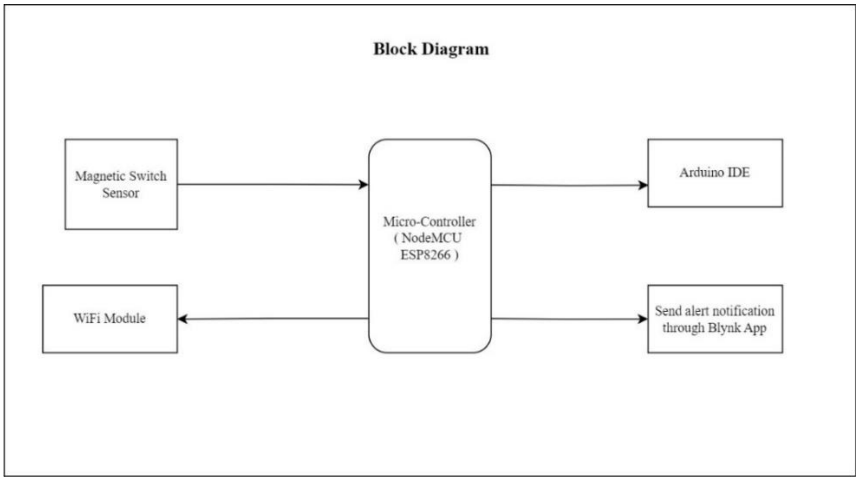


Figure 3.1: Block Diagram of the System

Among the various platforms that are currently available, ESP8266, WiFi, Arduino, and Bluetooth were discovered to be platforms on which home automation systems can be used. Proposed system is using ESP8266 instead of Arduino because the WiFi module on the ESP8266 is pre-installed, and the system are using WiFi instead of Bluetooth since WiFi has a wider network range than Bluetooth, which requires installation on the outside [8]. The reason these platforms were deemed most appropriate is because, when utilized for project's individual control home automation systems, they are inexpensive, reliable, and easy to use.

### 3.1. SOFTWARE REQUIREMENTS:

The software requirements needed for IoT based Fridge Door Alert System.

### A) Arduino IDE:

The Arduino integrated development environment (IDE) is a versatile application compatible with multiple operating systems such as Windows, macOS, and Linux. Created using Java programming language, it serves the purpose of coding and transferring programs to Arduino-compatible boards. Moreover, through the utilization of 3rd party cores, it extends its functionality to support a range of other vendor development boards. Figure 3.1.1 shows the interface of Arduino IDE [13].


Figure 3.1.1: Arduino IDE Interface

### B) Blynk IoT:

Blynk IoT is a platform that allows you to easily build IoT applications and projects. It provides a user-friendly interface and a range of tools and features to connect and control various hardware devices, sensors, and actuators. All cloud-based interactions between smartphones and embedded systems are made possible via the Blynk server [10]. The Blynk IoT app is shown in Figure 3.1.2 where user can see and receive live updates about the system.

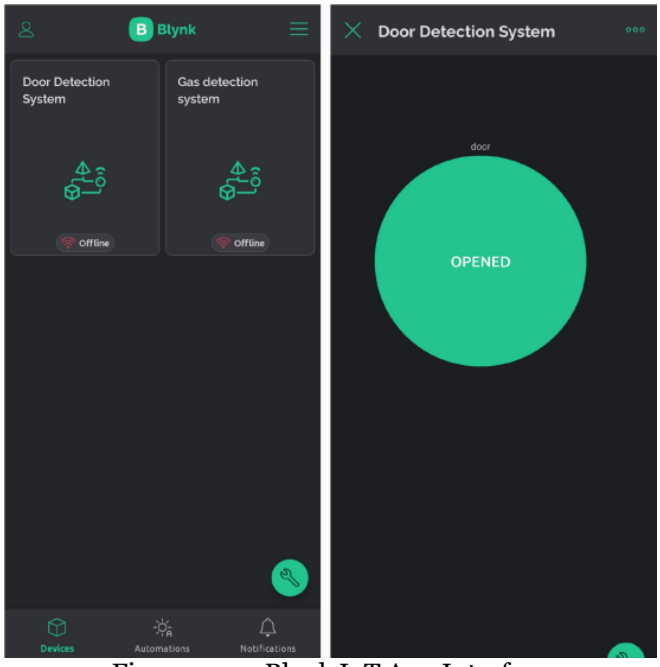


Figure 3.1.2: Blynk IoT App Interface

## a. HARDWARE REQUIREMENTS:

The Hardware Requirement needed for IoT based Fridge Door Alert System are:

### A) NodeMCU (ESP8266):

The NodeMCU ESP8266 is a versatile development board designed for IoT projects, boasting integrated Wi-Fi capabilities through the ESP8266 microcontroller. With its accessible GPIO pins and support for languages like Arduino IDE and Lua scripting, it facilitates seamless interaction with sensors and actuators. Operating at 3.3 volts and powered by USB or external sources, it serves as an ideal platform for prototyping and experimenting in the IoT space, bolstered by a robust community providing ample support and resources. The low-cost Wi-Fi chip is one of the advantages of developing the ESP8266 module. The module designed at the NodeMCU board has the ability to function on its own. This NodeMCU board's benefits and features make it an excellent choice for home automation systems [11]. The Figure 3.2.1 shows NodeMCU ESP8266 component.

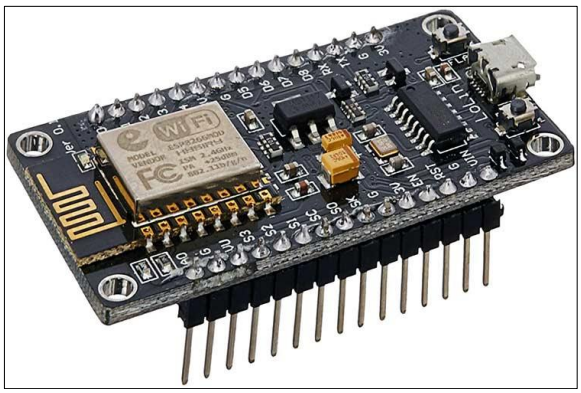

Figure 3.2.1: NodeMCU ESP8266

### B) Magnetic Switch Sensor:

Magnetic Switch Sensor (MC-38) is used for detection if door is properly closed or not. When they are moved apart, they provide a signal that gets supplied to the microcontroller to enable it to carry out the required operation. The magnet triggers the sensor. The MC-38 should be placed in important points throughout the house in order to give the owner regular alerts [12]. Figure 3.2.2 shows Magnetic Switch Sensor component.

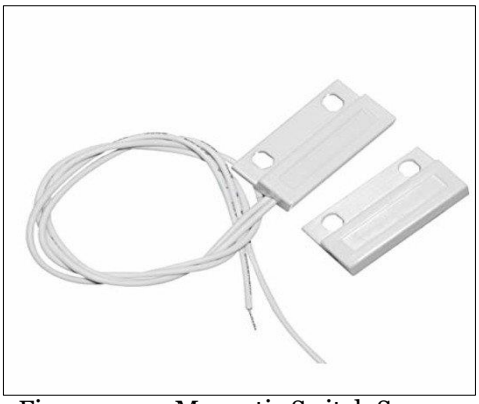

Figure 3.2.2: Magnetic Switch Sensor

### C) Breadboard:

In IoT projects, breadboards serve as essential tools for rapid prototyping and testing of circuit designs without soldering. They provide a platform for connecting sensors, actuators, and microcontrollers, facilitating the creation of temporary circuits for experimentation and development. This flexibility allows IoT developers to quickly iterate on designs, troubleshoot issues, and validate concepts before moving to more permanent hardware implementations. Figure 3.2.3 shows Breadboard component.

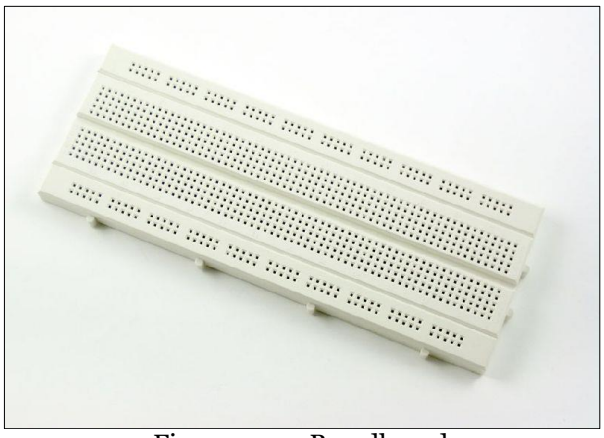

Figure 3.2.3: Breadboard

### D) Powerbank:

Powerbanks are integral to IoT projects involving microcontrollers, serving as portable power sources for these devices. They enable microcontrollers to operate autonomously without the need for direct mains power, enhancing their versatility and enabling deployment in remote or mobile settings. With rechargeable batteries and compact designs, powerbanks ensure reliable power supply for microcontrollers, facilitating their integration into various IoT applications. Figure 3.2.4 shows Powerbank.

Figure 3.2.4: Powerbank

## 4. RESULTS

Many of us sometimes by mistakenly do not close the fridge door properly. This makes the fridge to go through several issues. The issue of not properly closed door of the fridge includes several reasons that can cause the

fridge door not to close properly. These reasons include blockage or damaged gasket or uneven surface or damaged hinge and overcrowding due to food items in fridge. These problems can lead to cold air escaping and forcing the refrigerator to overwork, introducing serious fridge problems. The proposed system develop's a smart system for detecting if the fridge door is properly closed or not. The sensor is connected to the microcontroller to detect the closing of door by checking if circuit is complete or not. WiFi module is used for transmitting the data from controller to mobile. The system is using a Magnetic switch sensor for detection of closed door. The use of sensor is to mainly detect if the door is close by checking if the magnetic switch sensors are closed to each other if they are the circuit is completed and when the sensors are far apart the circuit is broken and after a certain duration a alert message is sent to the users. The system can be easily installed by attaching the microcontroller to the side of the fridge. The wired part which connects to the microcontroller should be installed on the side of the fridge as shown in Figure 4.1 and the other part should be installed on the free moving door. Figure 4.1 shows the status of the door being closed in the blynk app.

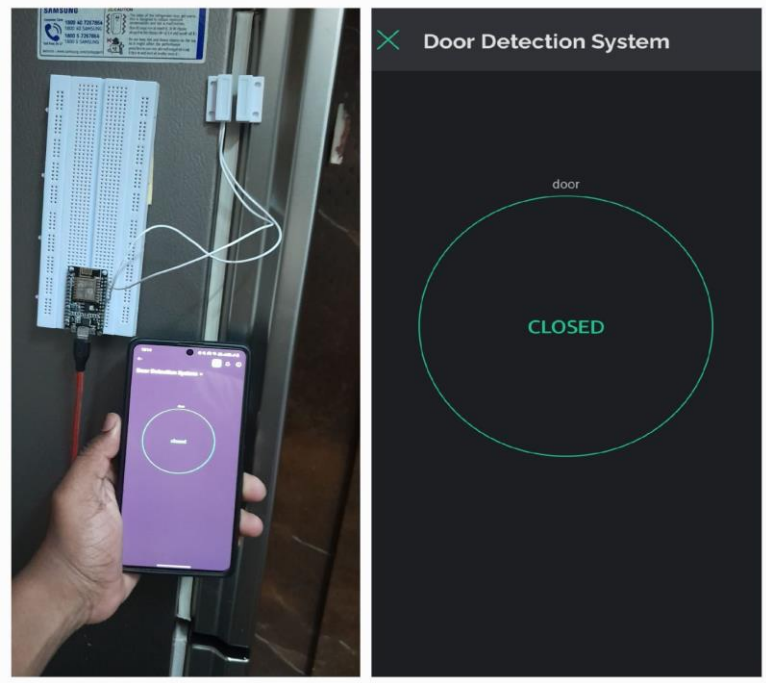


Figure 4.1: When door is closed

When the door is not closed for a certain amount of time the microcontroller passes a message to the user that their fridge door has not been closed so they can check on the fridge and can close their fridge on time to avoid any food spoilage Figure 4.2 shows the message received by the user when the fridge door is kept opened.

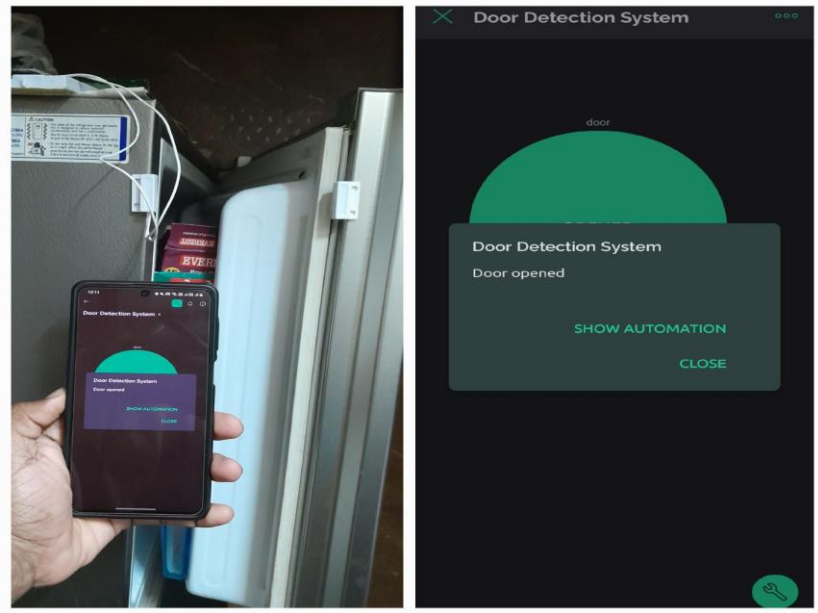


Figure 9: When the door is opened

Upon detecting an open fridge door, the sensor relays the information to the microcontroller, which initiates the alert mechanism. The microcontroller triggers notifications through the connected network, informing users of the door status. Users receive alerts on their smartphones or other designated devices, prompting them to take corrective action, such as closing the door or addressing potential issues with the fridge.

### Potential Applications and Benefits:

The IoT-based open fridge door alert system offers several applications and benefits, including:

1. Food Safety: Timely alerts help prevent food spoilage by minimizing the duration of door openings, preserving the freshness of stored items.
2. Energy Efficiency: By reducing unnecessary cooling loss, the system contributes to energy conservation and lower utility bills.
3. User Convenience: Remote monitoring and alerts enable users to stay informed about their fridge status, even when away from home, enhancing convenience and peace of mind.
4. Data Insights: The system may collect data on door opening patterns, enabling users to analyze usage habits and optimize refrigerator operations.

## 5. DISCUSSION & CONCLUSION

In conclusion, the IoT-based fridge door alert system represents a cutting-edge solution that seamlessly integrates technology into everyday life. With a focus on real-time monitoring, powerful alert systems, and user-friendly interfaces, the project seeks to give users fast access to status updates on their refrigerators. Its user-centric design is further demonstrated by the product's dedication to customization, dependability, and thorough documentation. Fundamentally, the goal of this project is to completely transform the way consumers interact with refrigeration appliances by providing a smart, networked solution that not only overcomes the drawbacks of conventional systems but also anticipates the changing demands of a convenience- and tech-savvy customer base.

## 6. FUTURE SCOPE

The future scope of the IoT-based fridge door alert system is poised for exciting developments, offering opportunities for expansion and integration with emerging technologies. With opportunities for advancement and integration with modern technology, the IoT-based refrigerator door alert system is prepared for remarkable future expansion. If the project continues to interact with popular smart home ecosystems like Google Home and Amazon Alexa, refrigerator monitoring might become a seamless component of whole home automation. The system's sustainability may be increased by in-depth study of cutting-edge energy-saving technology like energy harvesting or low-power communication protocols. Encouraging appliance manufacturers to work with refrigerator manufacturers to integrate IoT capabilities directly into future refrigerator models could expedite the process.

### Declaration and Conflict of Interest

We declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere. We know of no conflicts of interest associated with this publication, and there has been no significant financial support for this work that could have influenced its outcome. As corresponding author, I confirm that the manuscript has been read and approved for submission by all the named authors.

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## REFERENCES

1. Ranjithkumar. R, Rathish Ganesh. S, Ram Vikash. K, Manikandan. M, “IoT Based Home Automation using PIR Motion Sensor and Node MCU”, International Journal of Engineering and Advanced Technology, April 2020.
2. Ravi Kishore Kodali, Vishal Jain, Suvadeep Bose and Lakshmi Boppana. “IoT Based Smart Security and Home Automation System”, 2016.
3. Himanshu Singh, Vishal Pallagani, Vedant Khandelwal, Venkanna U. “IoT based Smart Home Automation System using Sensor Node”, 2018
4. G.Mahalakshmi, M.Vigneshwaran, “IOT Based Home Automation Using Arduino”, International Journal of Engineering and Advanced Research Technology (IJEART), 2017.
5. Suhuai Luo, Jesse S. Jin, and Jiaming Li, “A Smart Fridge with an Ability to Enhance Health and Enable BetterNutrition” published in International Journal of Multimedia and Ubiquitous EngineeringVol. 4, No. 2, April, 2009

6. Y Zhai, Y Liu, M Yang, F Long, J Virkki, “A Survey Study of the Usefulness and Concerns about Smart Home Applications” Open Journal of Social Sciences Vol.02 No.11(2014), Article ID:51898,7 pages 10.4236/jss.2014.211017
7. Alolayan Bushra (2014). Do I Really Have to Accept Smart Fridges? An empirical study. In the Proceedings of the Seventh International Conference on Advances in Computer-Human Interactions (ACHI 2014) pp186-191
8. Ayush Choudhary, Shivansh Yadu, Bhawna Raj, Deepshikha, Dr. Rajkumar Jhapte, “HOME AUTOMATION USING IOT BY NODEMCU ESP8266”, International Research Journal of Modernization in Engineering Technology and Science (IRJMETS), 2023.
9. Mehta, M. (2015, August). ESP 8266: A BREAKTHROUGH IN WIRELESS SENSOR NETWORKS AND INTERNET OF THINGS. International Journal of Electronics and Communication Engineering & Technology, 6(8),
10. Nikhil Kakade, Prof. (Dr.) S. D. Lokhande. (2016, June). IoT based Intelligent home using Smart Devices. International Journal of Innovative Research in Computer and Communication Engineering, 4(6), 8.
11. Noor Kareem Jumaa, Younus Mohammed Abdulkhaleq, Muntadher Asaad Nadhim, Tariq Aziz Abbas, “IoT Based Gas Leakage Detection and Alarming System using Blynk platforms”, Iraqi Journal for Electrical and Electronic Engineering (IJEE), February 2022.
12. Nabilah binti Mazalan, Jabatan Kejuruteraan Elektrik, Politeknik Merlimau, “Application of Wireless Internet in Networking using NodeMCU and Blynk App”, Seminar LIS at Politeknik Mersing Johor, 2019.
13. Nagaraj Doddam Reddy, “Home Security Automation and Energy Conservation using Smart Application”, NEUROQUANTOLOGY, November 2022.
14. Siddharth Wadhwani, Uday Singh, Prakash Singh, Shraddha Dwivedi, “Smart Home Automation and Security System using Arduino and IOT”, International Research Journal of Engineering and Technology (IRJET), February 2018.
15. Inderpreet Kaur, “Microcontroller Based Home Automation System With Security” at IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 1, No. 6, December 2010
16. Ayush Gajjar, Deepak Mishra, Shubham Ingale, Aniket Kore, “SMART HOME SYSTEM.” Presented at International Research Journal of Engineering and Technology (IRJET) , 01|Jan-2019.
17. M. A. Al-Qutayri and J. S. Jeedella, "Integrated Wireless Technologies for Smart Homes Applications," in Smart Home Systems, M. A. Al-Qutayri, Ed., ed: Intech, 2010.
18. A. Hussain, M. Hasnain, M. Faseeh-Ul-Haq, and F. Hussain, “Door unlock by face recognition (DUFR),” International Journal of Computer Science and Software Engineering, vol. 8, no. 12, pp. 294–303,2019.
19. S. GUPTA, L. TEJASWI, G. RAKESH, and M. R. KUMAR, “Smart home security system using Arduino and GSM,” Journal of Engineering Sciences, vol. 14, no. 06, 2023.
20. P. Oyekola, T. Oyewo, A. Oyekola, and A. Mohamed, “Arduino based smart home security system,” Int. J. Innov. Technol. Explor. Eng, vol. 8, no. 12, pp. 2880–2884, 2019.
21. Blynk Inc., https://blynk.io/getting-started