

Guardian Gate: A Smart, Sensor-Based Entry System with Arduino

Mohan Raj K R¹, Neharika R², Ragavarshini M³

Department of Information Technology, Velammal Engineering College

E-mail: ¹mohanraj@velammal.edu.in, ²neharikaraj7@gmail.com, ³ragavarshinim0109@gmail.com

Abstract

Addressing the need for enhanced convenience and security in home entry systems, the 'Guardian Gate' utilizes multiple sensors and output devices with Arduino Uno microcontroller technology. This system uses an infrared (IR) sensor as its main input mechanism to detect the presence of people or objects approaching the door. The system warns the homeowner by turning on multiple output devices, such as an LCD screen for visual feedback, an LED indication for visual cues, and a buzzer for auditory alerts, when an object is identified within the predetermined range. Because of its modular architecture, which enables smooth integration and adaptation to suit various household situations, the system is highly versatile and may be used either alone or in conjunction with pre-existing home automation systems. Regardless of their immediate surroundings or activities, users will always be instantly aware of any activity at their door thanks to our multi-sensory method.

Keywords: Automation, home security, accessibility, adaption, intruders.

1. Introduction

These days, the development of the internet and technology has undergone significant alteration. Among the most recent advancements is the Internet of Things (IoT), one of the modern world's technologies. IoT addresses object connectivity, encompassing various sensors and enabling remote usage, allowing people to live more easily, comfortably, and effectively.[1]

A doorbell is a necessity in a modest home. It is a type of signaling device frequently placed next to a building's entry door. When a visitor presses the button, an inside bell chimes, alerting the residents of their presence. It operates louder and clearer than a simple knock. Historically, a doorbell was an actual bell that required pulling a rope to sound, but today, they are mechanized and can announce your presence with just a button push.[2]

The basic beginnings of the classic doorbell have been surpassed, and it is now a portal for sophisticated communication and monitoring. This progress is exemplified by the Guardian Gate system, which incorporates state-of-the-art object detection capabilities for enhanced security and seamless user engagement. This device provides homeowners with instantaneous insights into activities at their doorstep, enabling timely and efficient responses to guests or potential threats.[3]

We examine the workings, design ideas, and potential applications of the Guardian Gate system as we delve into its complexities. Our objective is to provide a comprehensive understanding of how this innovative smart doorbell system functions by dissecting its constituent parts and elucidating its operational mechanisms. Additionally, we explore the broader implications of this technology in terms of home automation and security, emphasizing its significance in enhancing convenience and safety for homeowners.[4]

In addition to being a technological advancement, the Guardian Gate system signifies a paradigm shift in how we see and use home entrance systems. Its adaptability to various contexts and seamless integration with current smart home ecosystems highlight its versatility and potential effect. We set out on a quest to discover the Guardian Gate's revolutionary potential and how it will influence home automation and security in the future. [5]

2. Related Work

The primary objective of the study was to develop a doorbell system that individuals with physical limitations could easily use, thereby enhancing their accessibility and independence. Arduino microcontroller technology, known for its flexibility and simplicity in electronic system prototyping, was employed by the authors to achieve this aim. The suggested doorbell system included several features tailored to meet the unique needs of physically handicapped users. These features encompassed large, easy-to-press buttons or switches, visual

and auditory cues to confirm when the doorbell rings, and potentially wireless communication capabilities to alert individuals in other rooms of the house.[5]

This study examines the architecture of a cutting-edge ultrasonic doorbell system featuring object-detecting capabilities. The framework integrates ultrasonic sensors to enhance user comfort and security by detecting objects near the entrance. The device offers both visual and auditory feedback systems to promptly alert occupants when someone approaches the door. Through the utilization of ultrasonic technology, the suggested framework provides benefits such as accurate item recognition and adaptability to various environmental conditions. The authors contribute to the advancement of doorbell technology and home security systems by emphasizing the practical implementation of the system and outlining its potential applications in both residential and commercial settings.[6]

Introducing a cutting-edge solution aimed at enhancing convenience and home security, this system integrates mobile communication technologies. Combining an automated secure door lock mechanism with a smart visitor notification system, homeowners can remotely authorize access by receiving real-time notifications on their mobile devices when visitors arrive at their doorway. This implementation facilitates seamless interaction and control over premises access, leveraging the widespread use of mobile devices and wireless communication protocols. Representing a significant advancement in home security solutions, this system offers homeowners comfort and peace of mind by integrating cutting-edge technology with traditional protection measures.[7]

Defines a cutting-edge Internet of Things (IoT)-based smart door lock solution. The system aims to automate door locking and unlocking while enabling remote access control through IoT-enabled gadgets such as tablets and smartphones. Through the integration of IoT technology, the system offers customers improved security features and convenience by allowing them to remotely monitor and control access to their properties. The installation of this smart door lock system represents a significant advancement in home security solutions and illustrates how IoT technology can enhance day-to-day living.[8]

Describing a cutting-edge door lock system that integrates an Android app with a Raspberry Pi for enhanced convenience and security. The locking mechanism and communication between the Android application and the system are managed by the Raspberry

Pi, serving as the central processing unit. Users can remotely lock or unlock the door using the Android application, which wirelessly connects to the Raspberry Pi. To provide customers with comprehensive control and monitoring capabilities, the system also features advanced functions such as real-time notifications and access logs. This creative application demonstrates the potential of merging mobile technologies with Raspberry Pi to develop sophisticated and easily accessible home security systems [9].

Presents a cutting-edge, message-enabled house bell system for safety. By instantly notifying homeowners of any activity at their doorway and allowing them to receive notifications detailing the observed incident, this technology provides increased protection and convenience. By utilizing contemporary technology, the system guarantees timely notice using messages delivered to the homeowner's device, facilitating swift action and remote observation. This invention represents a significant improvement in domestic security systems as it improves communication and home safety by incorporating message-enabled elements into the conventional doorbell system.[10]. Finds a cutting-edge method of merging smart doorbell technology with home surveillance. With the help of this system, which combines sophisticated surveillance capabilities with the functionality of a typical doorbell, homeowners can keep an eye on their doorway from a distance using a smartphone or tablet. The integration of intelligent sensors and live streaming features in the smart doorbell improves home security by offering immediate notifications and visual confirmation of visits. A major development in home security solutions, the doorbell system's incorporation of smart surveillance technologies gives homeowners more control and peace of mind over their properties.[11]

The system includes functions that may be accessed using a smartphone interface, like door access control and alert systems. The system offers real-time monitoring and management over home security by integrating IoT devices, improving homeowners' convenience and safety. The system architecture, implementation procedure, and assessment of the system's efficacy in protecting residential properties are probably covered in full in this paper. By addressing the growing need for creative security measures in contemporary homes, our work adds to the expanding field of IoT-based solutions for smart home applications.[12].

Finds a unique method for utilizing smart doorbell technology. The Blynk platform is utilized by the system in conjunction with ESP32 Cam or ESP-Eye modules to facilitate remote monitoring and control. The integration of the YOLO (You Only Look Once) algorithm for

object detection is noteworthy as it improves the doorbell's ability to identify and notify users about things that are identified. The system architecture, implementation procedure, and experimental findings proving the viability of the suggested solution are probably described in the paper. This study advances smart home technology by integrating cutting-edge object recognition algorithms for improved usefulness and security, especially in the area of intelligent doorbell systems.[13]

3. Proposed Work

The creation of an automated doorbell system with integrated object detection features is the focus of the proposed project. By detecting and identifying individuals approaching the door, this system aims to enhance convenience and security. It achieves this by automatically activating doorbell alarms and notifying the user through a dedicated application. Utilizing object detection sensors, the system can recognize and categorize objects near the entrance, distinguishing between people, pets, cars, and other items. When a relevant object is detected, the system will sound the doorbell to notify residents of guest arrivals and provide instructions for them to wait or proceed [14-16].

The system is composed of sensors, and an LCD, among other hardware and software components.

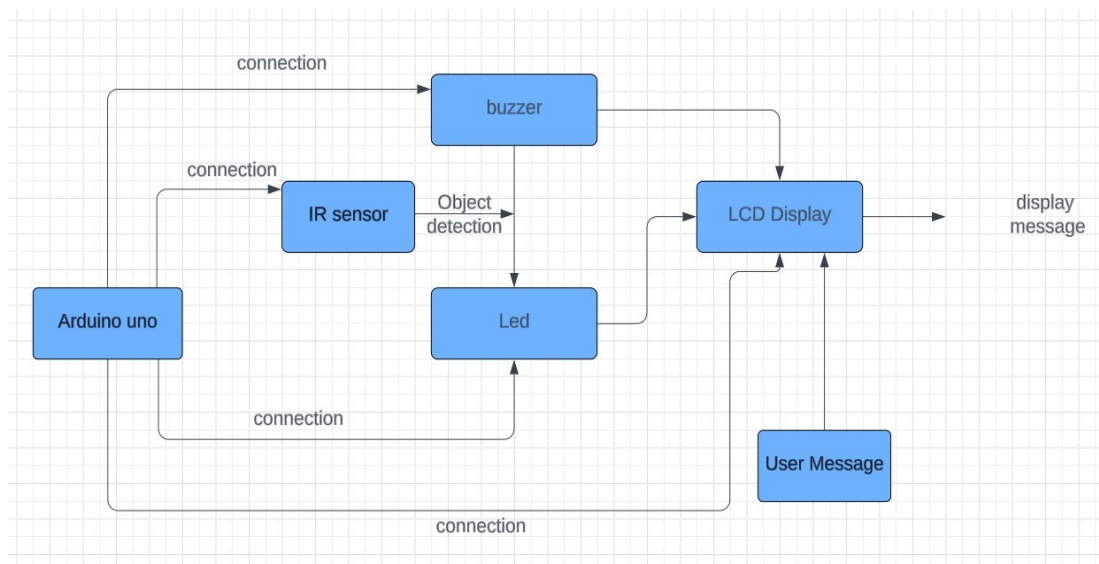


Figure 1. System Architecture

Figure 1 explains that the research aims to connect the above-specified components for an effective solution. The Arduino UNO used is to connect with every other component through different pins [17-20]. As described above the components are connected together with the help of Arduino board, as soon as the object detected by IR sensor the buzzer and LED will come in effect, after that LCD will display the message which the user prompts.

3.1 Flow Diagram for the Proposed System

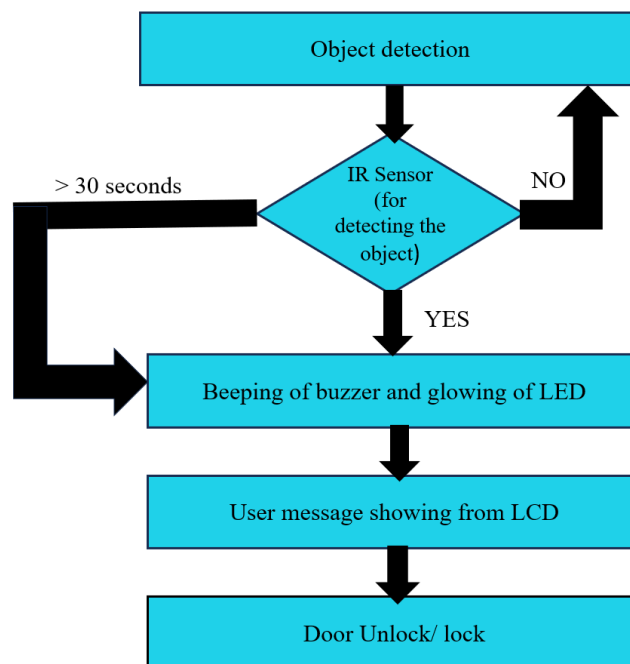


Figure 2. Work Flow

The system begins the object detection using IR sensor (which is connected to Arduino board) if the object is detected the led will glow along with the beeping of buzzer further the LCD will show the message as “Hello Welcome Home” and the user open the door(NOTE: all the components are connected through Arduino UNO board). The second scenario if the object is not detected properly the process repeats. The third case is, if the object is detected for more than 15 seconds the buzzer and LED will glow continuously indicating the display as “No Person At Home to Open the Door” as a LCD message thus indicating the door is locked. In this system we have used Arduino for connecting the other components, compilation and execution of code which is the backbone of the system. These user messages are given in the code which is compiled and uploaded in the board.

4. Experimental Analysis

4.1 Components Specifications

Table 1. Specifications

Components Used	Usage in our system
Arduino UNO	It is used for the connections along with other pins(eg . Connecting IR sensor with digital pin D9), code execution and compilation.
IR Sensor	It is used to detect the object front of the device(range upto 30cms)
Buzzer	It is used to give a beeping alarm sound to alert the user about the person at the door.
Led	It is used as a light indicating the person presences at the door
Arduino IDE	It is the software for the Arduino board where the compilation and uploading of code take place.

The above Table.1 specifies the various components used in the system along with the usage of them in system. The Arduino is the main element in the system where the program for the system is stored, and complied.

The proposed system was tested under three different cases and their particular outcomes are recorded individually.

Table 2. Test Cases

Scenario	Test type	Outcome
When a person stands longer than 15 sec	Sensor Test	A display message through LCD to the visitor
Visitor standing in front of the door	Sensor Test	Bell rings and a display message is shown via LCD
When the visitor does not stand for the specified time and roams around the place	Moving Visitor's Test	The sensor does not detect the visitor

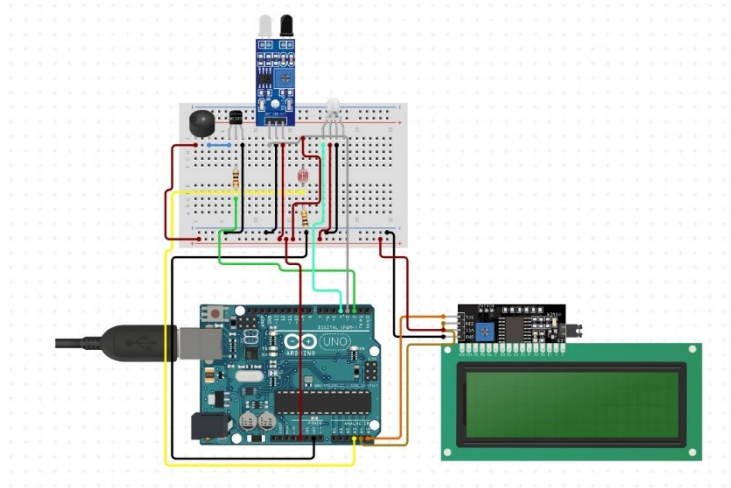


Figure 3. Circuit Diagram

Figure 3 explains the connections between different components. Arduino UNO is connected to both the IR sensor and LCD through board connection using jumper wires.

4.2 Components Configurations

A. Arduino Board Configurations

Twenty input/output pins in total make up the Arduino UNO. These pins can be used for digital input/output, Analog input, PWM (Pulse Width Modulation) output, I2C (Inter-Integrated Circuit) communication, SPI (Serial Peripheral Interface), UART (Universal Asynchronous Receiver-Transmitter) communication, and other uses. The Arduino UNO's pin arrangement is as follows where each pin is described with its definition and connection in the system.

B. D0-D13 Digital Pins

The digital input/output pins are D0 through D13. Additionally, pins D0 and D1 are used as RX and TX pins in serial communication (UART). PWM output is enabled on pins D3, D5, D6, D9, D10, and D11. Outer interrupts are supported on pins D2 and D3.

C. Pins for Analog (A0-A5)

A0 through A5 are pins for Analog input. These pins, often known as A0 to A5, can be utilized as digital input/output pins.

D. Unique Pins

Analog Reference Voltage pin, or AREF: One use for it is to establish an external reference voltage. RESET: Pin reset. Resetting the microcontroller is done with it.

E. Power Pins

5V: Offers a controlled 5V output for supplying electricity to external devices.
3.3V: Offers a controlled 3.3V output to power external devices.
Vin: Pin for input voltage. It is linked to an external power source, usually between 7 and 12 volts. GND: They are defined as the Pins on the ground it is of two types named as GND1 and GND2.

F. Pins for Communication

Pins for serial transmission (UART) are RX (D0) and TX (D1). SCL (A5) and SDA (A4) are I2C communication pins. SPI communication pins are MOSI (D11), SCK (D13), and MISO (D12).

G. Connections

1.IR Sensor

The VCC of IR sensor is connected to the 5v of Arduino board.

The GND is connected to the GND 2 of the board.

The OUT pin is connected to the digital pin D9 to the Arduino board.

2. LCD Display

The SDA pin is connected to the Analog pin A4 of the board.

The SCL is connected to the Analog pin A5 of the board.

The VCC is connected to the 5v of the board.

The GND is connected to the GND2 pin of the board.

3. Buzzer and LED

Buzzer is connected with the digital pin D13 of the board.

Led is connected with the digital pin D10 of the board.

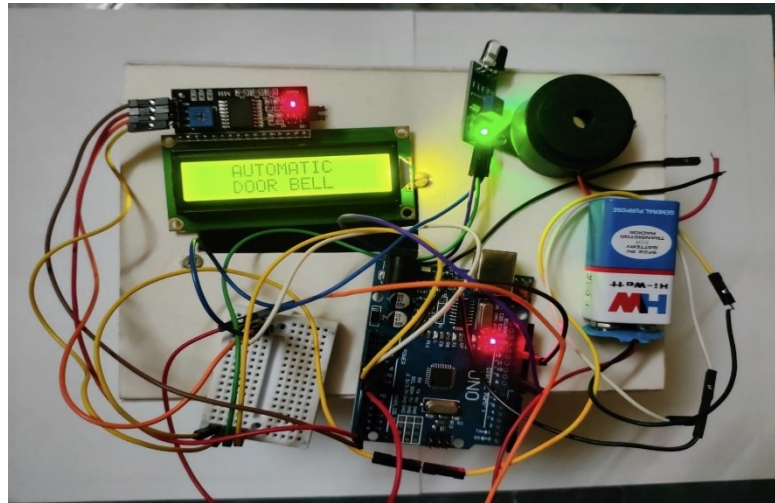


Figure 4. Starting of Device

The Figure.4 shows the entire connection. “Automatic Door Bell” displays when the device is connected to the power supply

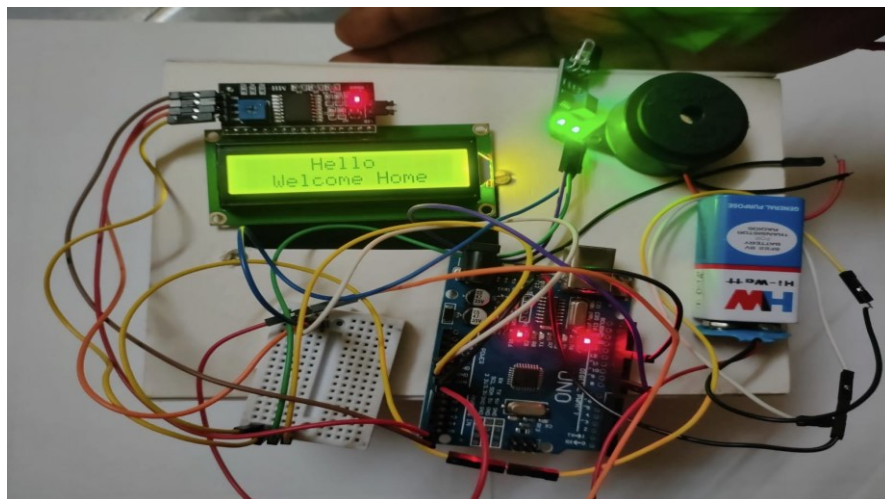


Figure 5. Object Detection

Figure 5 explains that when an object is detected through the IR Sensor the display prompts a message of “Hello Welcome Home”, indicating the opening of the door and the user inside the home.

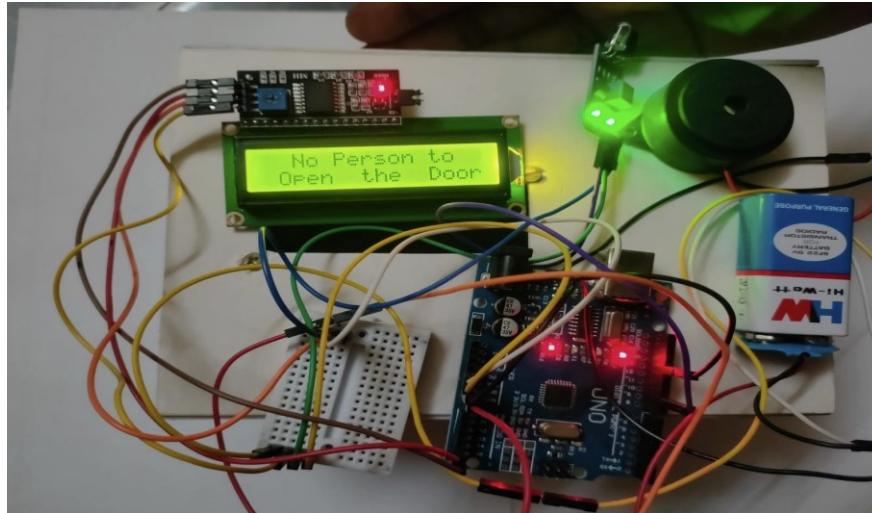


Figure 6. Not at Home

Figure 6 shows a display message as “NO Person to open the door”, this happens when the object is detected for more than 15 seconds indicating no one is at home to open the door.

5. Conclusion and Future Work

The conclusion of "Guardian Gate" offers a complete solution that skill fully combines sophisticated object detection with simple user feedback mechanisms, thereby representing a paradigm leap in smart doorbell technology. With the help of the Arduino Uno, IR sensors, LCD screens, LEDs, buzzers, and other components, this system offers homeowners unmatched security and convenience right at their front entrance. Its versatility to different household contexts is ensured by its modular architecture and adjustable features, making it appropriate for a broad spectrum of users. The Guardian Gate is an excellent tool for providing proactive security measures and real-time awareness, whether it is used as a stand-alone solution or integrated into already-existing home automation systems. Smarter, more connected homes where convenience and security go hand in hand are made possible by technological advancements like the Guardian Gate. The Guardian Gate promises a safer and more secure

living environment for everyone, setting a new benchmark for contemporary gateway systems with its strong functionality and user-centric design.

As future work added to the "Guardian Gate" smart doorbell system. Integration with Smartphone Apps: Create companion apps for iOS and Android smartphones so that consumers can watch and manage the doorbell system from a distance. Users would be able to see live video feeds (if integrated), get real-time notifications, and even have remote conversations with guests. Integrate a camera module into the system to take pictures or videos of any items or people that are detected. Enabling facial recognition or additional examination of objects observed, would improve security and give people visual evidence of activity at their doorstep and we can also store the footage in the cloud for history logs.

References

- [1] CM Nalayini, P Sreemathi, B Nanditha, "Deterrence of Accident Using IoT", Journal of Trends in Computer Science and Smart Technology (ISSN: 2582-4104), Volume 4, Issue 2, pp 96-105, July 2022,
- [2] Barañao, Elmerson L., Darleen F. Alayon, Sofia Gabrielle V. Pelaez, and Reese David P. Larrauri. "Contactless Doorbell with the Use of an Ultrasonic Sensor." Contactless Doorbell with the Use of an Ultrasonic Sensor 97, no. 1 (2022): 13-13.
- [3] Kumar, E. Govinda. "Design of Arduino Based Door Bell for Physically Challenged People." Turkish Journal of Computer and Mathematics Education (TURCOMAT) 12, no. 10 (2021): 1398-1402.
- [4] Khalid, Marwa, and Sadia Majeed. "A smart visitors' notification system with automatic secure door lock using mobile communication technology." International Journal of Computer Science and Information Security 16, no. 4 (2016): 97-101.
- [5] Govinda Kumar et al, "Design of Arduino Based Door Bell for Physically Challenged People", Turkish Journal of Computer and Mathematics Education, Vol.12,1398 – 1402, (2010),

- [6] Muktar, Ahmed, AbdulAziz Ahmed, and Ahmed Salad. "A framework for ultrasonic doorbell system with object detection." *Somali Journal of Engineering and Science* 2, no. 1 (2017): 1-6.
- [7] Abhishekgowda, K. S., and U. Nikhil. "Automated Smart Door Lock system using IoT Technologies." *Journal of Science, Computing and Engineering Research* 6, no. 6 (2023): 26-29.
- [8] G. Vignesh, S. Abarna, A. S. Hareni, C. Devipriya, "Intelligent Door Lock Using Raspberry Pi and Android Application" *International Journal of Research in Engineering, Science and Management*, Volume-3, Issue-2,(2020), 820-824.
- [9] T . Venkat Narayana Rao et al , "Automatic Safety Home Bell System with Message Enabled Features", *IJCSET* ,| Vol 6, Issue 12, 410-413 ,(2016)
- [10] Lalitha, R. V. S., Kayiram Kavitha, NV Krishna Rao, G. Rama Mounika, and V. Sandhya. "Smart surveillance with smart doorbell." *Int. J. Innovative Technol. Explor. Eng.(IJITEE)* 8, no. 8 (2019): 1841.
- [11] Anwar, Shaik, and D. Kishore. "IOT based smart home security system with alert and door access control using smart phone." *International Journal of Engineering Research & Technology (IJERT)* 5, no. 12 (2016): 504-509.
- [12] Patilano, Hazel San L, 1Algaba, Vanessa Rose E. , Deslate, Krezzel F. , Dominguez, Novley A. , Francisco, Kenneth M. ,Gamboa, John L. , Ison, Gerad John C. , Leon, Jeren C, "Smart Doofrbell Using Esp32 Cam/Esp-Eye and Blynk with Object Recognition Using Yolo Algorithm" , *International Journal of Innovative Science and Research Technology* , Volume 7, ISSN No:-2456-2165, (2022)
- [13] Ohsung Doh, Ilkyu Ha "A Digital Door Lock System for the Internet of Things with Improved Security and Usability" *Advanced Science and Technology Letters* Vol.109 (Security, Reliability and Safety 2015), pp.33-38
- [14] Dey, Subhajit, Tamaghna Kundu, Sourav Mukherjee, and Mili Sarkar. "Web based real-time home automation and security system." *International Journal of Electrical and Electronic Engineering & Telecommunications* 4, no. 3 (2015): 1-8.

- [15] Bekara “Security Issues and Challenges for the IoT-based Smart Grid” SCIENCE DIRECT Procedia Computer Science 34 (2014) 532 – 537
- [16] Ilkyu Ha “Security and Usability Improvement on a Digital Door Lock System based on Internet of Things” International Journal of Security and Its Applications Vol.9, No.8 (2015), pp.45-54
- [17] Safa, H., N. Priyanka, Vikkashini Gokul Priya, B. Vishnupriya, and T. Boobalan. "Iot based theft preemption and security system." International Journal of Innovative Research in Science, Engineering and Technology 5, no. 3 (2016): 4312-4317.
- [18] Kunal, Tushar, Pooja, Vaibhav, Lodha “Smart Home Automation using IOT” International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 2, February 2016 1108-1112
- [19] Palaniappan, Hariharan, Kesh, Vidhyalakshimi “Home Automation Systems - A Study” International Journal of Computer Applications Volume 116 – No. 11, April 2015 .11-18
- [20] Bhadane, Wani, Shukla, Yeole “A Review on Home Control Automation Using GSM and Bluetooth”, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 5, Issue 2, February 2015. 41-44