International Journal of Research Publication and Reviews, Vol 5, no 3, pp 3896-3902 March 2024

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Safe Home from Fire and Control Home Appliance Based on Internet of Things (IOT)

Rejowan Ahmed Biplob [1], Abid Hasan Raju [2]

Department of Electrical and Electronic Engineering, Gono Bishwabidyalay, Dhaka-1344, Bangladesh [1,2]

DOI: https://doi.org/10.55248/gengpi.5.0324.0780

ABSTRACT:

In recent years, fire accidents have gradually increased in Bangladesh. Many valuable lives are lost and so many injured due to fire accidents every year. If we know at the beginning to set fire, we can save lots of life and wealth. In modern life people want comfort in their daily life using technology. We can provide tension-free life by controlling household tasks, saving time, and reducing waste of energy from any time at any place. So, we designed a safe home from fire and controlled home appliances remotely via the internet using IoT Technology. Internet of Things (IoT) based home automation system controlled through smartphones from remote areas using an ESP8266 NodeMCU Wi-Fi module. The system efficiently manages tasks such as controlling room lights, and fans and handling electrical loads via voice commands and smartphone apps synced with cloud management. We also ensured home safety from fire by detecting gas leakage and fire flame using flame and gas sensors. We have successfully built this project and show impressive accuracy rates of 91% for voice commands and 97% for app switch commands highlighting its reliability and practicality.

Keywords: IoT, Home Automation, Node MCU (ESP8266), Arduino Uno, Relay, Blynk App

1. INTRODUCTION

We cannot imagine a moment without technologies in today's world such as the Internet, smartphones, computers, televisions, and others. Because these technologies influence an essential part of our day-to-day lives [1]. These technologies significantly enhance communication, facilitating easier interaction among individuals. With their aid, we can effortlessly connect with friends and securely store personal data like photos, documents, music, and movies. To streamline daily activities, we connect numerous devices to the Internet, leveraging its capability to link billions of endpoints worldwide. This connectivity grants us access to information and devices from any location, ultimately saving time, energy, and money [2]. Home automation, also known as demotics, refers to controlling household appliances, activities, and features. By utilizing end devices from anywhere globally, home automation empowers users with remote control over their home devices. The Internet of Things (IoT) based Home Automation system extends this functionality by enabling control of smart home devices through internet protocols or cloud-based computing. This approach offers several advantages over traditional wired systems, including ease of use, simplified installation, avoidance of wire complexities and electrical faults, seamless fault detection, and, importantly, enhanced mobility [3-4].

Figure 1: IoT interconnection devices for communication [5]

2. DESIGN OF SYSTEM AND IMPLEMENTATION

In this designed home automation system, an Arduino board and a Node MCU ESP8266 are the three essential apparatus. Besides this, the software application connects the Arduino Integrated Development Environment (IDE) and a Node MCU ESP8266 terminal smartphone application, facilitating wireless communication between the smartphone and Node MCU ESP8266 over the internet. Flame and Gas sensors are interconnected into the system to improve safety and functionality.

2.1 HARDWARE DESIGN

An Arduino board, a smartphone, and an ESP8266 NodeMCU Wifi module are the major components of home automation. The smartphone is used as the intermediary for communication with the Node MCU ESP8266 and user interface, facilitated by a specialized smartphone application that is Blynk app which utilizes the internet. The ESP8266 NodeMCU and an Arduino Uno board are utilized for controlling the home appliance and safety.

Arduino Uno

Arduino Uno is the central part of this project that contains a microcontroller and interface NodeMCU wifi module, components, and other sensors. It has several digital input and output pins (14) and analog input pins. Its working voltage is 5V and quartz crystal frequency is 16MHz. It has 32KB flash memory for storing code, 1KB EEPROM for nonvolatile storage, and 2KB SRAM for data storage [6].

Figure 2: Arduino Uno

ESP8266 NodeMCU Wifi module

Figure 3: NodeMCU ESP8266 wifi module

NodeMCU ESP8266 Wi-Fi transceiver module is widely used for connecting the internet via a Wi-Fi network to build a connection with the physical device. In the era of IoT, the NodeMCU ESP8266 module is ideal for IoT applications. The Wi-Fi module is suitable with the 802.11 b/g/n standard at 2.4 GHz, has an integrated TCP/IP stack, 19.5 dB output power, data interface (UART / HSPI / I2C / I2S / Ir Remote Control GPIO /PWM and PCB antenna. A reset button and a micro USB also have it. The programming language LUA is used for Arduino IDE, it includes interpreters for processing commands [7].

Relay Module

A single relay module designed to operate at 5 volts connected with an Arduino Uno board. It accepts input signals directly from the microcontroller output, which can function at either 3 volts or 5 volts, facilitating relay control. Every relay is capable of switching a range of AC or DC high current loads, high voltage, typically operating at 110V or 220V AC mains, such as lights, fans, and motors [8].

Figure 4: Relay module

Flame Sensor and Gas Sensor

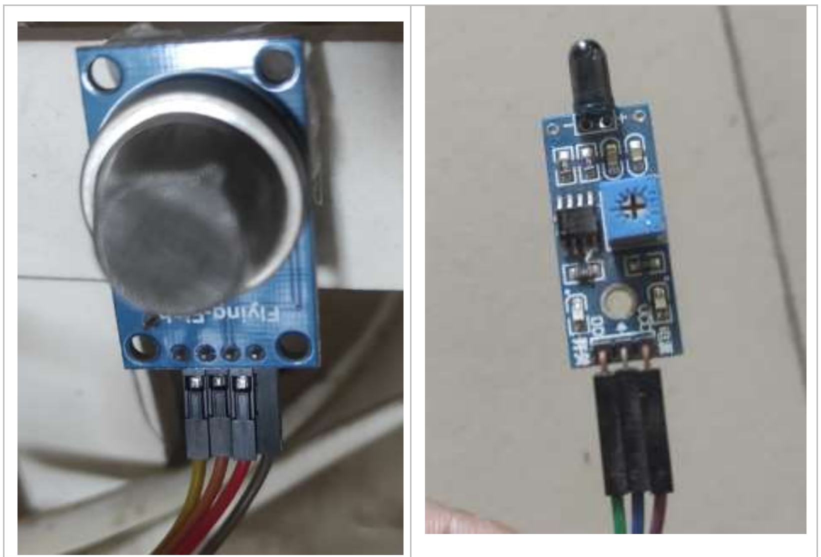

Figure 5: Gas Sensor and Flame Sensor

The Fire or Flame Sensor Module is veteran at detecting flames within the wavelength range of 760 nm to 1100 nm. It can effectively sense small flames, such as those from a lighter, at a distance of approximately 0.8 meters. With a detection angle of roughly 60 degrees, the sensor exhibits heightened sensitivity to the flame spectrum. The working voltage range of the Flame sensor is 3.3V to 5V and it has both digital and analog output options [9][12]. Gas sensors are used to identify the presence of particular gasses in the surroundings. MQ2 Gas sensor oversees 5V DC and draws around 800mW. It can identify LPG, Smoke, Methane, Propane, Alcohol, Hydrogen, and Carbon Monoxide fixations in some spots to the extent of 200 excessively [10-11]. For safety and preventing fire accidents at home or other workplaces, Gas and Flame sensors play a major role in identifying the presence of particular gasses in the surroundings.

2.2 SOFTWARE DESCRIPTION

In the presented system, various software tools are utilized for programming and controlling Smart Home Automation. An Integrated Development Environment (IDE), an open-source software, is employed for writing and uploading code into the Arduino and ESP8266 Wi-Fi Module. Additionally, an application named "Smart Home Automation" is developed using ESP8266 and the Blynk app, offering a platform for controlling purposes. Notably, for a visual representation of the flowchart outlining the smart home automation application shown in figure 6.

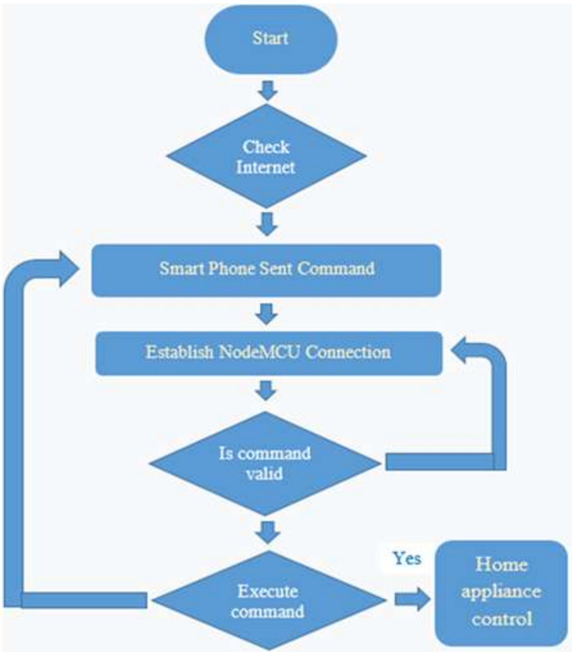

Figure 6: Flow chart of designed home automation system

2.3 IMPLEMENTATION SETUP

The implementation of the Smart Home Automation system is illustrated through hardware configurations. This setup encompasses various hardware modules interconnected via the ESP8266 Wi-Fi Module and Arduino microcontroller, facilitating control over home appliances and ensuring home safety and security against potential hazards such as accidental fires and short circuits.

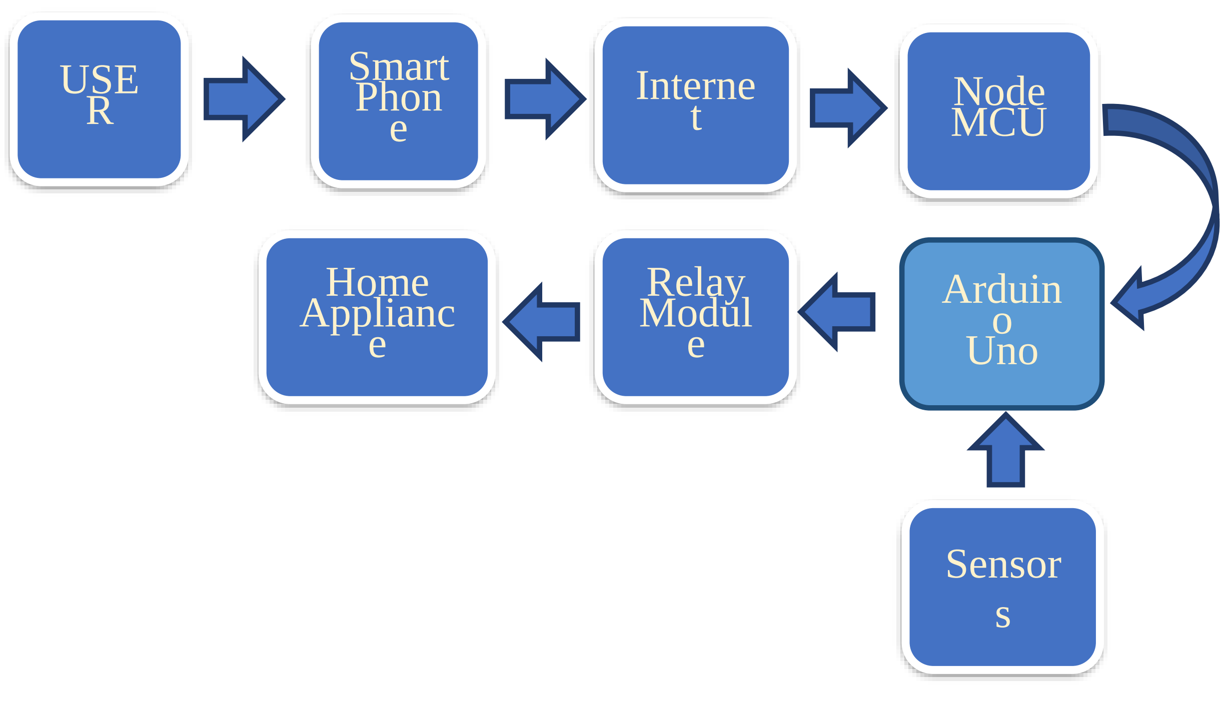

Figure 7: Block diagram of designed system

The entire hardware and software setup is classified into three segments. First, the integration of ESP8266 Wi-Fi with Arduino Uno, Second, connects ESP8266 to the Blynk application for transmission and reception of data from the user interface and finally connects all other sensors and components for controlling the home appliances. Before connecting every module or component we need to program Arduino Uno for all internal and external configurations. Demonstrate the multifaceted capabilities of the home automation system, ranging from basic home automation functionalities to advanced safety and security features leveraging IoT technologies.

3. RESULTS AND DISCUSSION

The hardware implementation of the system utilizing the ESP8266 Wi-Fi module is illustrated in Figure 8. This setup demonstrates the switching of various home appliances rated at 230V and 5A, providing easy access and control to multiple users from anywhere, whenever needed [13]. This encapsulates the full advantages of a home automation system. Smart lighting switching and control contribute to efficient energy usage by automatically toggling lights on/off as required.

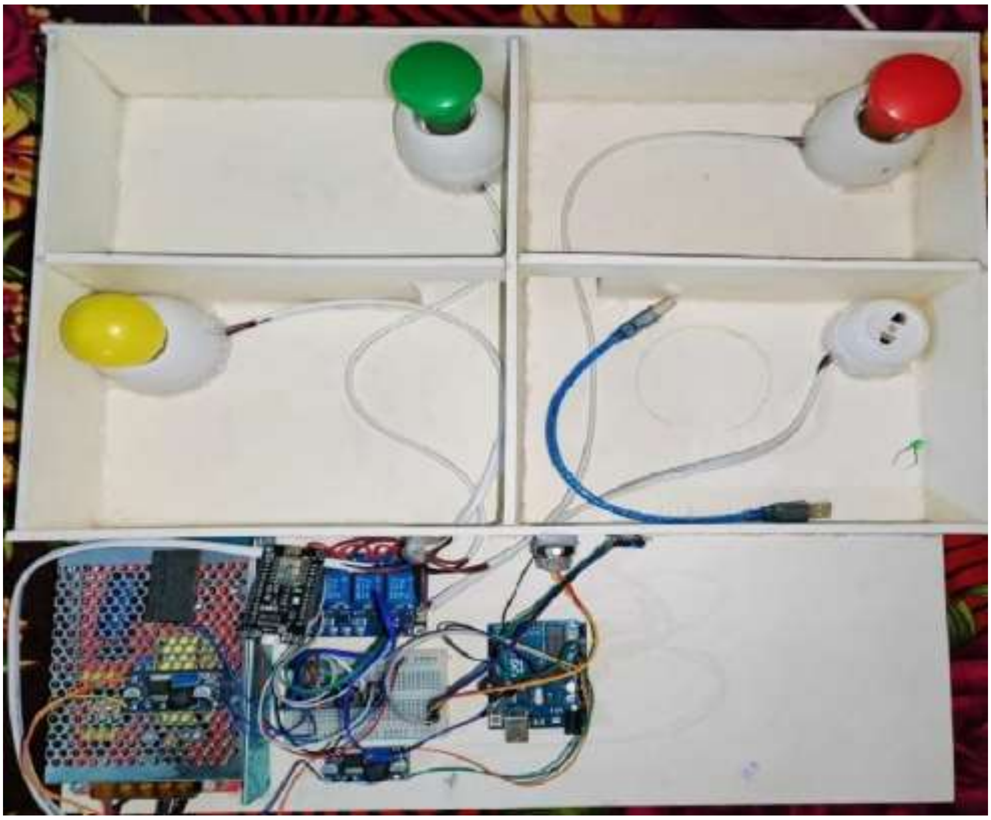

Figure 8: The hardware setup of Smart Home Automation with Wi-Fi Connection

The outcome of this system is accessed through the Smart Home Automation application utilizing the Blynk app. The interface of the smart home automation using the Blynk application enables the switching of lights in different rooms, providing users with the ability to control lighting from anywhere within or outside the home, as long as the system remains connected to Wi-Fi through the internet.

Table 1: Voice command accuracy rate

Total Command	Success	Failed	Accuracy
100	91	9	91%

Table 1 shows the accuracy of voice command through smartphone from Google Assistant 100 times it executes 91 times and 9 times failed. The accuracy of the voice command is 91%. Noise and change of voice tune are responsible for failed voice commands.

Table 2: Blynk app command accuracy rate

Total Switching	Success	Failed	Accuracy
100	97	3	97%

Table 2 shows the accuracy of apps-based commands over the internet from the smartphone. In 100 times it worked properly 97 times and failed 3 times. The accuracy of app switches is 97%. We show that app switching is more accurate than voice command.

Table 3: Gas sensor working PPM value and Buzzer state

Gas Value for PPM	Buzzer
When gas <300	off
When gas >300	on

Table 3 shows Gas sensor working PPM value and Buzzer state. When the gas value is less than 300 ppm the buzzer is off and if the gas value is greater than 300 ppm the buzzer is on. Buzzer dedicates the gas to the high.

Table 4: Flame Sensor working distance and action

Fire Distance(cm)	Relay	Emergency light
When Distance>300	Off	off
When Distance<300	On	on

Table 4 shows the fire distance and emergency light on and off condition. When the fire distance is greater than 300cm of the fire sensor the emergency light is off and the fire distance is less than 300 cm of the fire sensor the emergency light is on.

Table 4: Delay Time Calculation

Execution Time (millisecond)			Delay Time (millisecond)	Average Delay time (millisecond)
No.	Start Time	Stop Time		
1	0	3	3	
2	0	3	3	
3	0	3	3	
4	0	4	4	
5	0	3	3	3.4
6	0	4	4	
7	0	3	3	
8	0	3	3	
9	0	5	5	
10	0	3	3	

Table 5 shows the delay time and average delay time to execute time from input command time. The average delay time is 3.4 milliseconds.

4. CONCLUSION

The Home Automation system has proven to be highly effective, powered by the ESP8266 Wi-Fi module and accessible via mobile phones, tablets, and laptops, has demonstrated remarkable effectiveness. In addition to its core function of appliance control, the system integrates sensors for enhanced monitoring, prioritizing safety and security. This prototype showcases Wi-Fi technology for smart home automation and can control more devices through the app. It also improves home safety and security by analyzing it over the internet, paving the way for future upgrades.

Reference

[1] P. Damacharla, A. Y. Javaid, J. J. Gallimore and V. K. Devabhaktuni, ”Common Metrics to Benchmark Human-Machine Teams (HMT): A Review,” in IEEE Access, vol. 6, pp. 38637-38655, 2018.

[2] Q. F. Hassan, ”Introduction to the Internet of Things,” in Internet of Things A to Z: Technologies and Applications , IEEE, 2018.

[3] S. Ziegler, S. Nikoletsea, S. Krco, J. Rolim and J. Fernandes, ”Internet of Things and crowd sourcing - a paradigm change for the research on the Internet of Things,” 2015 IEEE 2nd World Forum on Internet of Things (WF-IoT), Milan, 2015, pp. 395-399.

[4] J. Voas, B. Agresti and P. A. Laplante, ”A Closer Look at IoT ’s Things,” in IT Professional, vol. 20, no. 3, pp. 11-14, May./Jun. 2018.

[5] https://stock.adobe.com/search?k=iot&asset_id=150511712

[6] https://store.arduino.cc/products/arduino-uno-rev3

[7] https://www.nodemcu.com/index_en.html#fr_54747661d775ef1a3600009e

[8]https://en.wikipedia.org/wiki/Relay#:~:text=A%20relay%20is%20an%20electrically,break%20contacts%2C%20or%20combinations%20thereof.

[9] https://doi.org/10.1016/j.firesaf.2022.103673

[10] https://www.sciencedirect.com/topics/chemistry/gas-sensor

[11]https://www.winsen-sensor.com/sensors/combustible-sensor/mq2.html?campaignid=10463189402&adgroupid=106436716929&feeditemid=&targetid=kwd-331922829564&device=c&creative=446277586317&keyword=mq2%20gas%20sensor&gad_source=1&gclid=CjwKCAjw17qvBhBrEiwA1rU9w1XcTv0fuai_OQCBdZglQSpcH86GBhYUNSfe_b2QKM7x4h1ROOGFihoC7joQAvD_BwE

[12] doi: 10.3390/s22093310

[13] M. B. Yassein, W. Mardini and A. Khalil, "Smart homes automation using Z-wave protocol," 2016 International Conference on Engineering & MIS (iCEMTS) , Agadir, 2016, pp. 1-6.