AUTOMATIC LPG GAS LEAKAGE DETECTION SYSTEM USING MICROCONTROLLER WITH BLYNK-BASED MOBILE REAL-TIME MONITORING APPLICATION

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Abstract: *LPG (Liquefied Petroleum Gas) is an energy source that is widely used in households and industries, but LPG gas leaks can cause fire and explosion hazards. Therefore, an effective gas leak detection system is needed to improve safety. This study aims to create and develop an automatic LPG gas leak detector based on a microcontroller that can be monitored via a mobile application using Blynk. This tool uses an MQ-2 gas sensor to detect the presence of LPG gas in the air. The microcontroller used is the NodeMCU ESP32, which is equipped with a Wi-Fi module to send data to the Blynk application in real-time. This system will provide a warning via notification on the mobile application if a gas leak is detected. In addition, this tool is also equipped with a buzzer as a local sound alarm and an LED as a visual indicator to provide direct warnings at the location. The leak detector can scan the gas levels that can be monitored through the blnyk application with the provision of > 500 ppm means the danger of a gas leak that causes an explosion by providing information through a red LED light that will light up and the buzzer will sound an alarm and ESP32 will provide notification to the user via the blnyk application. > 300 ppm means be careful and the yellow LED light will light up and ESP32 will provide notification to the user via the blnyk application. < 300 ppm means safe and the green LED light will light up. The evaluation results show that this system is effective in detecting LPG gas leaks and providing a quick response to potential hazards, making it a practical and reliable solution in preventing LPG gas leaks. so this research is worthy of being used as an automatic LPG gas leak detector to avoid unwanted things such as explosions or poisoning caused by LPG gas leaks.*

Keywords: *LPG gas leaks, microcontroller, Blynk, automatic detection system, MQ-2*

Introduction

LPG gas leakage is a serious threat that can cause fires, explosions, and other hazards to the environment and human safety. Therefore, the development of an automatic LPG gas leakage detection device is crucial in preventing such unwanted incidents. In recent years, advancements in microcontroller technology and mobile-based applications have opened new opportunities for the development of smart devices for various applications (Hutagalung, 2022).

The use of microcontrollers connected to sensitive sensors enables fast and accurate detection of LPG gas leaks. In addition, integration with mobile applications such as Blynk allows users to monitor environmental conditions and receive real-time notifications, enabling quick and appropriate actions during emergency situations (Hutagalung, 2022; Putra et al., 2020).

Considering the urgency for a reliable and user-friendly LPG gas leakage detection system, the development of a device using a mobile-based microcontroller and the Blynk application is regarded as a relevant and effective step toward improving environmental safety and security. Therefore, this study aims to develop an automatic LPG gas leakage detection device utilizing mobile-based microcontroller technology integrated with the Blynk application, which is expected to provide significant contributions in preventing accidents caused by LPG gas leaks (Kurniawan et al., 2020).

Several previous studies have discussed the design of gas detection systems. Hutagalung conducted research on designing a gas leakage detection system using the MQ-6 sensor (Fauziyah et al., 2020). Other studies added an information system through GSM SMS to provide real-time monitoring of gas conditions (Inggi & Pangala, 2021). Additionally, other research designed a gas leakage detection device that relied only on sound produced by a buzzer and an LCD display for direct detection (Susana et al., 2015).

These differences highlight the uniqueness of this research, which uses the Blynk application as a real-time information platform for a mobile-based gas leakage detection system. This integration enables notification-based alerts and allows users to stay informed even when they are not at home.

Integration of Microcontrollers with the Blynk Application

The integration between a mobile-based microcontroller and the Blynk application involves configuring the connection and communication between the two. The microcontroller must be connected to the internet via WiFi or Ethernet and transmit data to the Blynk application through the TCP/IP protocol. The Blynk application receives data from the microcontroller and visually displays the information using appropriate widgets. In addition, the Blynk application can also send control commands to the microcontroller to activate alarms or perform other response actions (Iksal et al., 2022; Mustaqim et al., 2020).

Hardware and Software Preparation

In developing an automatic LPG gas leakage detection system using a mobile-based microcontroller with the Blynk application, several hardware and software preparations are required. The following are the preparation steps that can be carried out (Mluyati & Sadi, 2019).
Arduino is a popular hardware development platform with many variants, such as Arduino Uno, Arduino Mega, and Arduino Nano. Arduino uses an easy-to-understand programming language and provides a user-friendly development environment. It can be connected to additional hardware components such as sensors and communication modules, including WiFi or Ethernet modules, making it one of the most widely used and beginner-friendly microcontroller boards in electronic development.

Based on the ATmega328P microcontroller, the Arduino Uno features 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, and various other components such as a USB connection, a power jack, and an ICSP header. This board is commonly used in DIY projects, education, and electronic prototyping due to its ease of programming through the Arduino IDE, which is based on the C/C++ programming language. The Arduino Uno can be connected to various sensors, actuators, and communication modules to create a wide range of interactive projects (Mluyati & Sadi, 2019).

Microkontroler ESP32

The ESP32 is a WiFi-enabled microcontroller module that can be used to access internet networks. It is widely used in Internet of Things (IoT) projects due to its capability to connect to WiFi networks and communicate with cloud-based servers. The ESP32 is a powerful and

versatile microcontroller developed by Espressif Systems, equipped with various features such as GPIO, PWM, ADC, DAC, and communication interfaces including SPI, I2C, and UART.
With higher performance, the ESP32 is capable of handling more complex tasks and supports multithreading. Another advantage is its low power consumption, making it ideal for devices that require energy efficiency. Support for programming in C/C++ as well as Python (via MicroPython) makes the ESP32 a popular choice for IoT projects, home automation, and wireless devices (Mluyati & Sadi, 2019).

MQ-2 Gas Sensor

The MQ-2 gas sensor is a semiconductor gas sensor used to detect the presence of LPG gas in the environment. This sensor is sensitive to gases such as propane, butane, and methane. The MQ-2 operates based on the principle of resistance changes in its semiconductor sensing element when LPG gas is detected. The higher the LPG concentration, the lower the sensor's resistance.
The MQ-2 sensor features both analog and digital output pins. The analog output pin provides a voltage level that correlates with the detected LPG concentration, while the digital output pin provides a HIGH or LOW logic signal indicating whether the gas concentration has exceeded a predefined threshold (Sinaga et al., 2011).

To use the MQ-2 sensor, it must be connected to a microcontroller, such as an Arduino or ESP32, via its analog or digital pins. The sensor output values can then be processed to obtain information about the detected LPG concentration and trigger appropriate actions, such as sending notifications or activating an alarm. It is important to refer to the official MQ-2 documentation and understand the specifications and usage guidelines provided by the manufacturer.

In addition to the MQ-2 sensor, there are other gas sensor variants that can be used to detect LPG, such as the MQ-6 or MQ-5 sensors. Choose a sensor that fits the requirements of your project and ensure that you follow the manufacturer's recommended usage instructions (Mluyati & Sadi, 2019).

Blynk

Blynk adalah platform pengembangan aplikasi berbasis cloud yang dirancang khusus untuk proyek Internet of Things (IoT). Dengan Blynk, Anda dapat membuat aplikasi ponsel yang dapat terhubung dengan berbagai perangkat mikrokontroler, seperti Arduino, ESP 32, atau Raspberry Pi, untuk mengendalikan dan memantau perangkat tersebut melalui jaringan internet.(Mluyati & Sadi, 2019).

Arduino IDE

Arduino IDE (Integrated Development Environment) is a software development environment used to program Arduino microcontrollers. The Arduino IDE provides everything needed to write, edit, upload, and test program code for Arduino boards. With a simple and intuitive interface, the Arduino IDE allows users to write, edit, and upload code to various types of Arduino boards, including the Arduino Uno, Nano, and Mega (Joko Christian & Nurul Komar, 2013).

The programming language used in the Arduino IDE is a variant of C/C++, with many libraries provided to simplify integration with sensors, actuators, and communication modules. In addition, the Arduino IDE includes features such as a serial monitor for debugging and viewing real-time data output from the microcontroller. This IDE is available for free and can run on various operating systems such as Windows, macOS, and Linux, making it a popular tool for education, prototyping, and DIY electronics projects (Mluyati & Sadi, 2019).

Program Coding

Setelah rangkaian fisik dirancang, langkah selanjutnya adalah menulis kode program untuk mikrokontroler. Kode program akan mengatur pembacaan data dari sensor gas, mengaktifkan buzzer dan LED jika terdeteksi kelebukan gas, dan mengirim notifikasi ke aplikasi Blynk. Pengkodean dapat dilakukan menggunakan bahasa pemrograman yang kompatibel dengan mikrokontroler yang dipilih, seperti Arduino IDE atau platform pemrograman ESP-IDF untuk ESP32. Dalam pengkodean program yang digunakan dalam mikrokontroler untuk alat pendeteksi kelebukan gas LPG, terdapat beberapa hal yang perlu dideskripsikan. Ada beberapa poin yang dapat dijelaskan.(Suprianto et al., 2023).(SUSANA et al., 2015).

Gas Leak Detection Technology

Gas leak detection is an essential process for identifying and preventing gas leaks that may pose risks to both the environment and humans. Various technologies have been developed to detect gas leaks quickly and accurately. Two primary technologies commonly used in gas leak detection are conventional gas detectors and the Internet of Things (IoT)-based gas leak detection systems (Khakim et al., 2022; Roihan et al., 2022).

Dangers of LPG Leakage

LPG (Liquefied Petroleum Gas) leakage can pose various serious hazards that affect both human safety and the environment. One of the main dangers of LPG leakage is the risk of explosion. LPG is a highly flammable gas and can form an explosive mixture when combined with air at certain concentrations. If exposed to sparks or heat sources, this gas mixture can explode, causing severe damage to buildings and equipment, as well as endangering human lives (Eko Soemarsono et al., 2015).

In addition to explosion risks, LPG leakage also presents a significant fire hazard. The leaking gas can spread quickly, and if it comes into contact with an ignition source, it can immediately ignite. Fires caused by LPG are often difficult to extinguish and can spread rapidly, threatening the safety of nearby individuals and causing property damage (Eko Soemarsono et al., 2015).

Another danger of LPG leakage is the risk of asphyxiation. Although LPG itself is not toxic, it can displace oxygen in the air, leading to hypoxia (lack of oxygen), which may cause shortness of breath, dizziness, headaches, nausea, and in severe cases, loss of consciousness or death. High concentrations of LPG can quickly reduce the amount of available oxygen for breathing, especially in enclosed spaces (Joko Christian & Nurul Komar, 2013).

From an environmental perspective, LPG leakage can contribute to air pollution. Although LPG is cleaner than some other fossil fuels, it still contributes to air contamination when released in large amounts. Additionally, uncontrolled outdoor leaks can negatively affect the local ecosystem (Lestari et al., 2023).

Method

- Literature Review and Initial Data Collection is the first stage of the research aimed at understanding concepts, theories, and previous findings relevant to the topic being studied. Through literature review, researchers can identify gaps in previous studies.
- Concept Selection is an important step in the research process in which the researcher determines the key concepts that will become the focus of the study. These concepts may include ideas, theories, models, or variables directly related to the research topic. In this context, selecting the right concept is crucial to preventing LPG gas leaks and minimizing the risk of explosions and fires.

- Concept Development is the process in which researchers deepen their understanding of the key concepts to be used in the study and outline ways to apply them effectively. In this case, developing a mobile-based gas leakage detection system is highly relevant for long-distance monitoring.
- Device Construction in the context of research or engineering projects involves building a device or system designed to perform specific functions according to the research objectives or project requirements. The constructed device may be a physical tool or software.
- Arduino and ESP32 Programming is a crucial stage in the development of an automatic LPG gas leakage detection system using a mobile-based microcontroller with the Blynk application. This process involves using the Arduino IDE as the programming platform for both Arduino and ESP32. Arduino is programmed to manage libraries and set threshold levels such as > 500 ppm (danger), > 300 ppm (warning), and < 300 ppm (safe), while the ESP32 is programmed to send notifications to smartphones and enable monitoring through the Blynk application.
- Device Testing is an essential stage in the development process in which the constructed device is tested to ensure that it functions according to the intended specifications and meets the established objectives.
- Results and Development form the core of the research report or engineering project, as this section demonstrates the researcher's contribution to existing knowledge or practical advancements in building an automatic LPG gas leakage detection system using a mobile-based microcontroller with the Blynk application.
- Conclusion is the final outcome of the research or application process, where the performance of the device in detecting LPG gas leakage is evaluated, including the threshold values used in programming: > 500 ppm (danger), > 300 ppm (warning), and < 300 ppm (safe).

Research Instrument Design

In developing an automatic LPG gas leakage detection system using a mobile-based microcontroller with the Blynk application, a wiring diagram is required to simplify the process of building the device. An electronic wiring diagram is needed as a guide in assembling the electronic circuit. The wiring diagram is used to visualize the design of the electronic circuit and to assist in identifying problems during repair or maintenance.

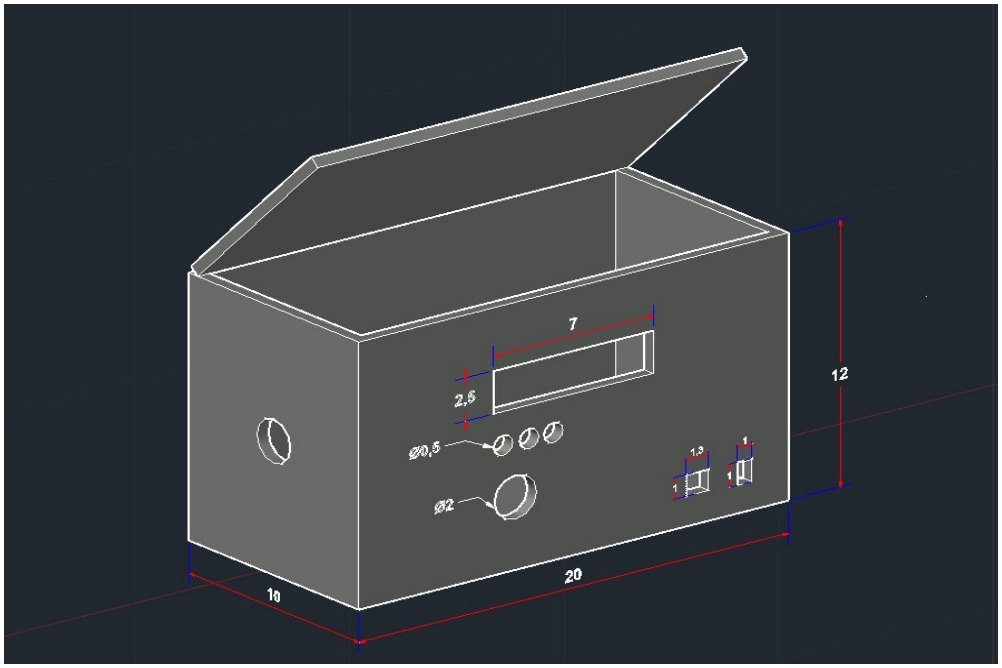

Figure 1. Research Instrument Design

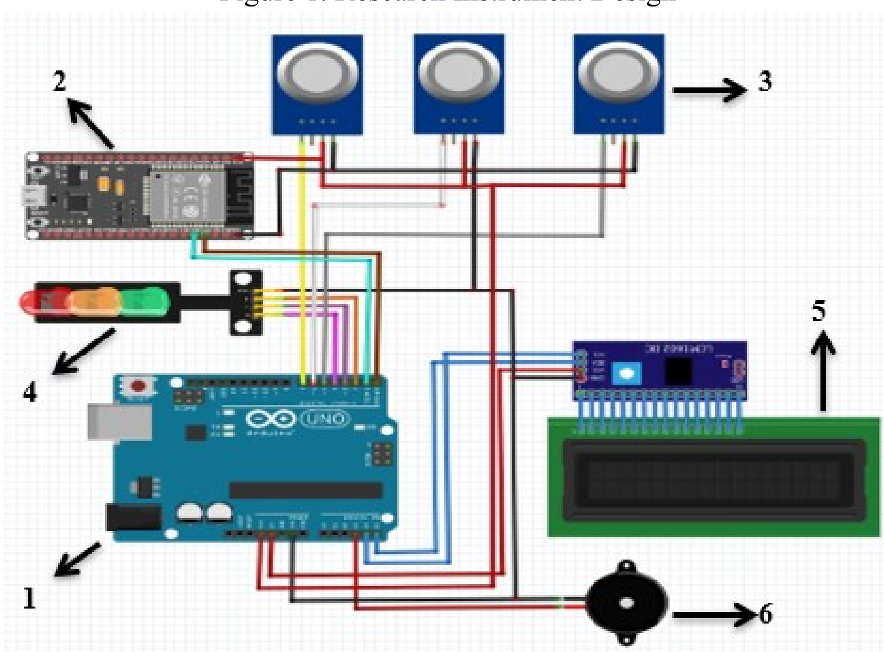

Figure 2. Research Design Schematic

Description:
1. Arduino Uno
2. ESP32
3. MQ-2 Sensor
4. LED Light
5. 16×2 LCD Display
6. Buzzer

Result and Discussion

Program Coding

Before entering the programming stage, the things that need to be prepared are the Arduino IDE software and a USB cable to upload the program from the Arduino IDE to the Arduino Uno. Arduino IDE is software used to create, edit, verify, and upload program code to the Arduino. In this device, the program is divided into four parts. Figure 3. shows the first part, followed by the second part shown in Figure 4, the third part shown in Figure 5.

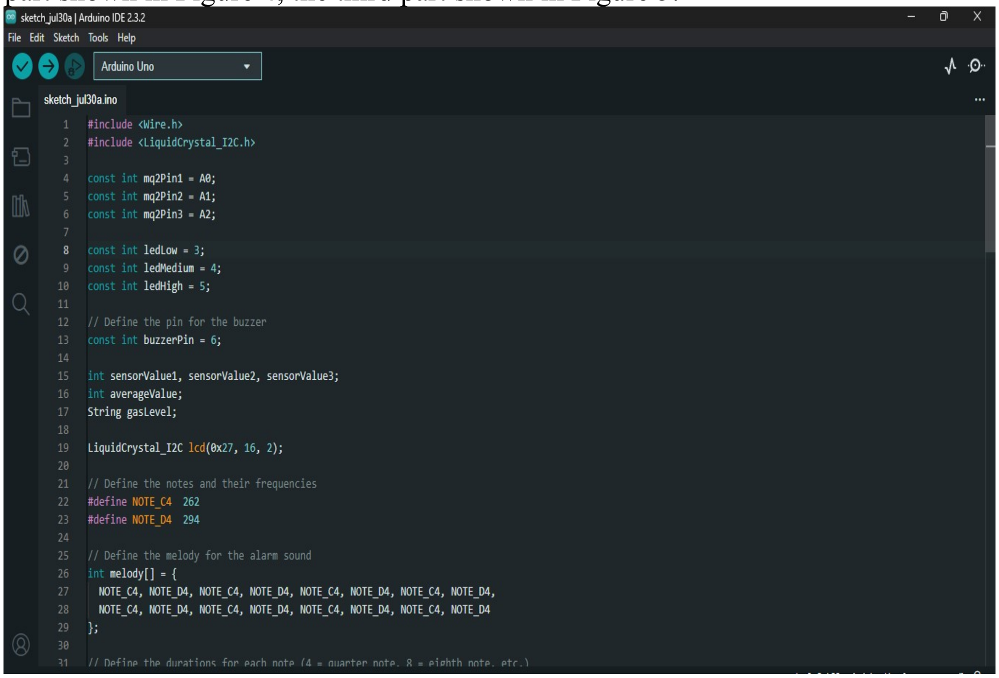

Figure 3. shows the first part

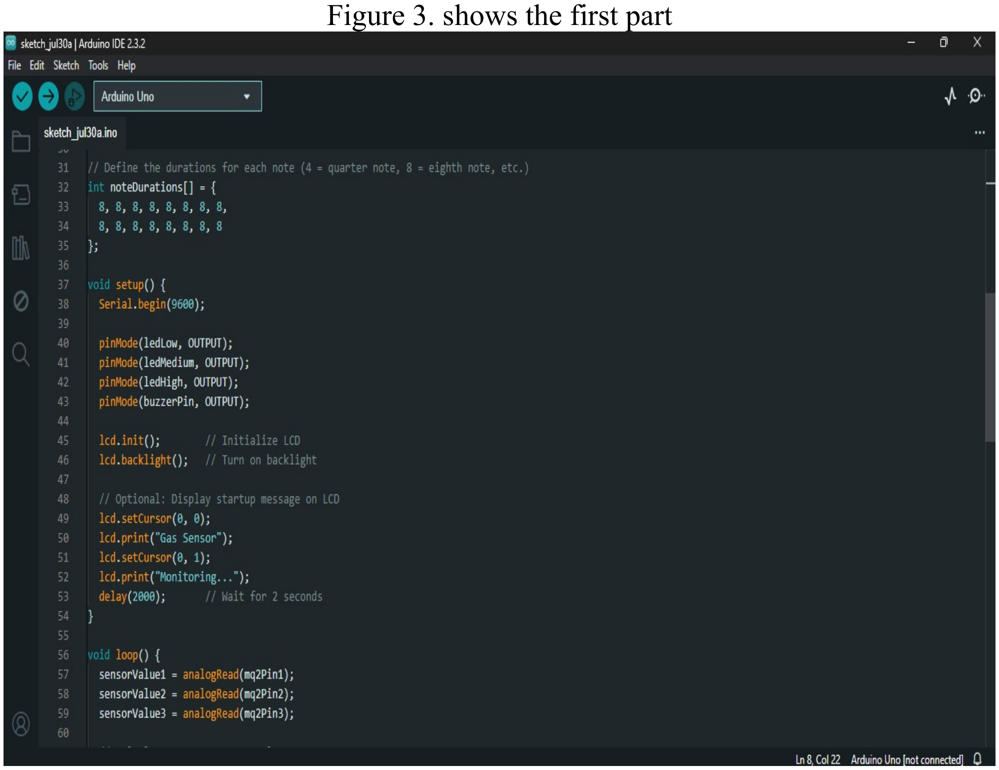

Figure 4. Second Arduino Uno Program

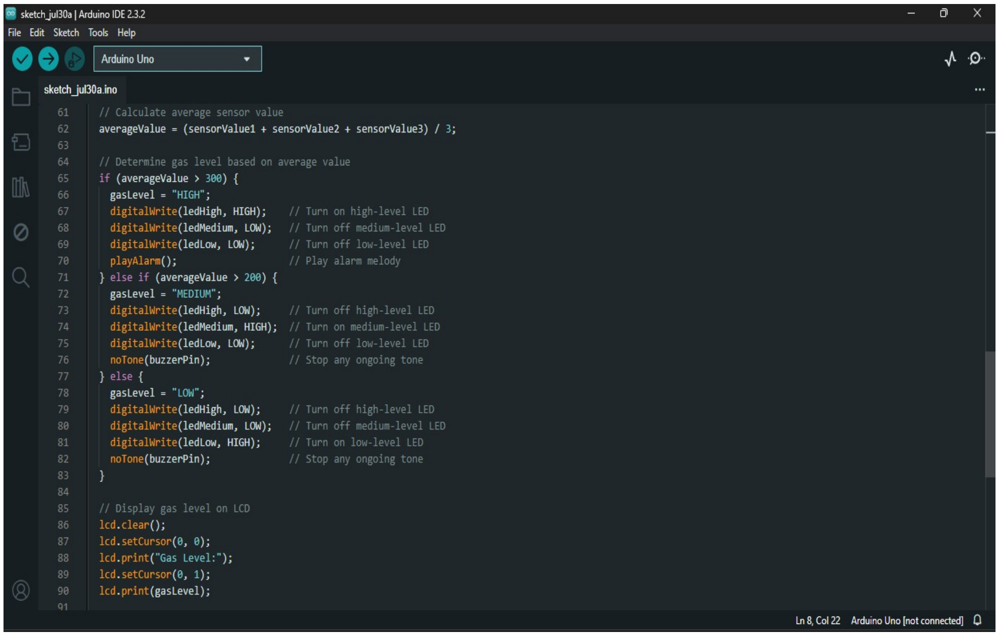

Figure 5. Third Program of Arduino Uno

ESP32 Program

Before proceeding to the programming stage, several things must be prepared, namely the Arduino IDE software and a USB cable to upload the program from the Arduino IDE to the ESP32. The Arduino IDE is software used to create, edit, verify, and upload program code to Arduino devices. In this system, the program is divided into five parts. Figure 6 shows the first part, followed by the second part in Figure 7, the third part in Figure 8.

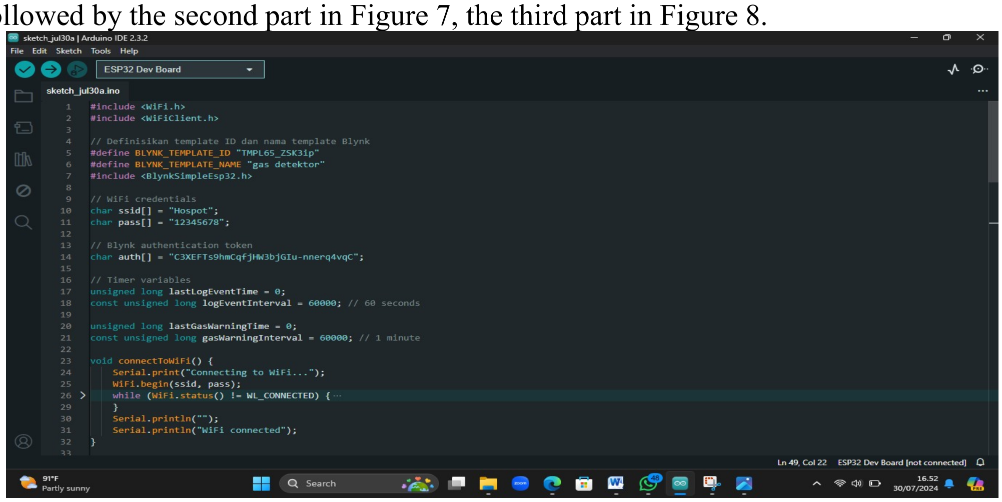

Figure Figure 6. First ESP32 Program

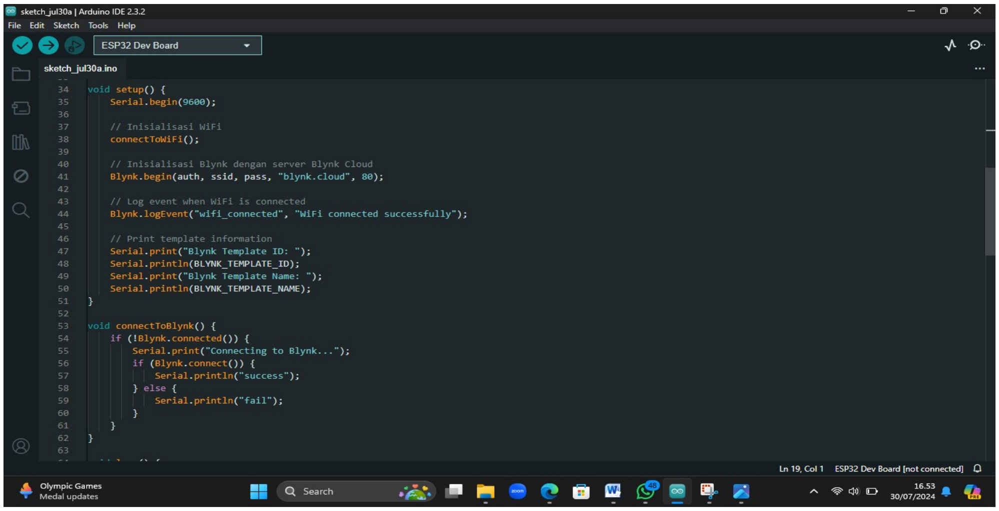

Figure 7. Second ESP32 Program

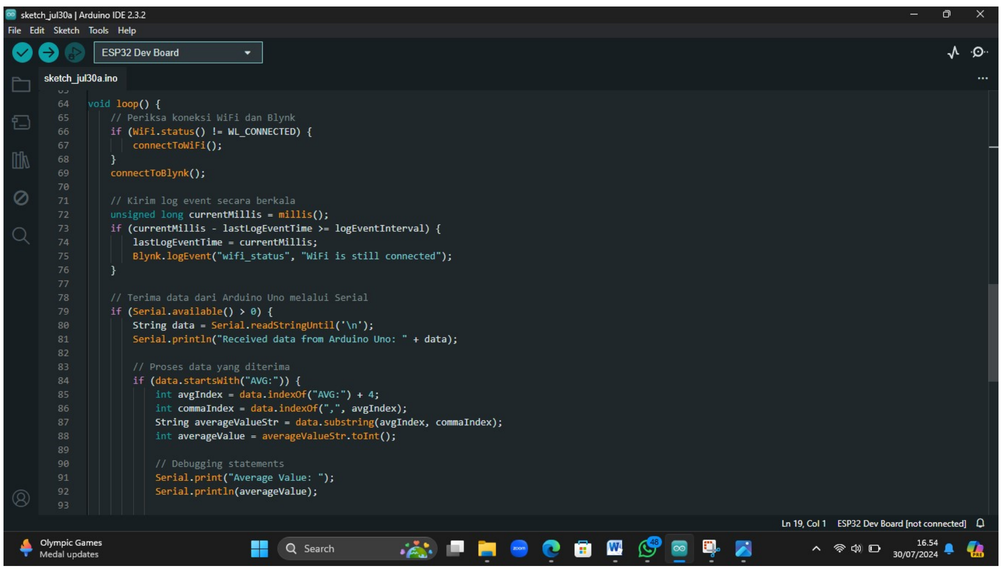

Figure 8. Third ESP32 Program

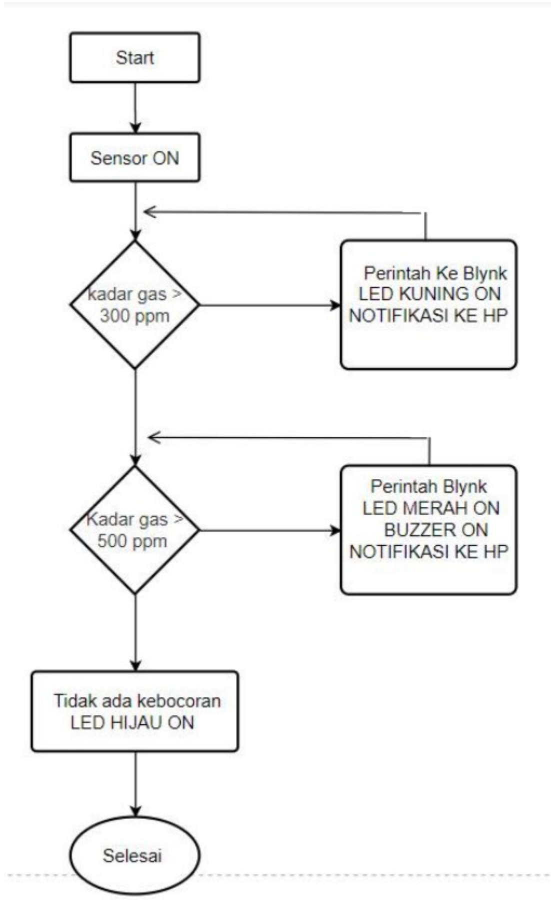

Figure 9. Data Transmission Process to Blynk

Discussion

mobile-based gas leakage detector can be operated using a 5V 2A adapter to power the module and connect the ESP32 to WiFi using its IP address.

WiFi credentials
char ssid[] = "Hotspot";
char pass[] = "12345678";

The gas leakage detector can measure gas concentration levels, which can be monitored through the Blynk application. The conditions are as follows:

> 500 ppm indicates a hazardous gas leak that may cause an explosion. In this condition, the red LED will turn on, the buzzer will sound an alarm, and the ESP32 will send a notification to the user through the Blynk app.

> 300 ppm indicates a caution level; the yellow LED will turn on, and the ESP32 will send a notification to the user through the Blynk app.

< 300 ppm indicates a safe condition, and the green LED will turn on.

This gas leakage detector is very easy to use. Simply plug the device into the adapter, and it will start functioning automatically. The ESP32 will connect to the Blynk application through the internet without requiring additional setup.

Conclusion

The gas leakage detector can measure gas concentration levels, which can be monitored through the Blynk application. The conditions are as follows:

> 500 ppm indicates a dangerous gas leak that may cause an explosion. In this condition, the red LED will turn on, the buzzer will sound an alarm, and the ESP32 will send a notification to the user through the Blynk application.

> 300 ppm indicates a caution level; the yellow LED will turn on, and the ESP32 will send a notification to the user through the Blynk application.

< 300 ppm indicates a safe condition, and the green LED will turn on.

To add the detector device to another user, the following credentials must be used:
Email: mikooke151@gmail.com

Password: miko12345

This demonstrates that the device has been successfully implemented to effectively detect gas leaks and send immediate alerts to the user's mobile device through the Blynk application. The system not only enhances safety by providing real-time notifications but also makes it easier for users to remotely monitor LPG gas conditions in their surroundings. With its reliability and ease of use, this system has great potential for application in various household and industrial settings

References

AC08599583, A. (Ed.). (1988). Journal of loss prevention in the process industries. Elsevier Science.

Aulia Rachman, L., & Hasbullah, H. (2022). Rancang Bangun Fearless (Fire Supression and Smart Alert System) pada Kebocoran Gas. Technomedia Journal, 7(2), 262–279. https://doi.org/10.33050/tmj.v7i2.1904

Eko Soemarsono, B., Listiasri, E., & Candra Kusuma, G. (2015). Alat Pendeteksi Dini Terhadap Kebocoran Gas LPG. Jurnal Tele, 13(1), 1–6.

Fauziyah, I. N., Harliana, H., & Gigih, M. B. (2020). Rancang Bangun Alat Pendeteksi Kebocoran Gas LPG Menggunakan Sensor MQ-6 Berbasis Arduino. Jurnal Ilmiah Intech : Information Technology Journal of UMUS, 2(01). https://doi.org/10.46772/intech.v2i01.185

Hakim, L., & Yonatan, V. (2017). Deteksi Kebocoran Gas LPG menggunakan Detektor Arduino dengan algoritma Fuzzy Logic Mandani. Jurnal RESTI (Rekayasa Sistem Dan Teknologi Informasi), 1(2), 114–121. https://doi.org/10.29207/resti.v1i2.35

Hutagalung, D. D. (2022). Rancang Bangun Alat Pendeteksi Kebocoran Gas Dan Api Dengan Menggunakan Sensor MQ2 Dan Flame Detector. Jurnal Rekayasa Informasi, 7(2), 1–11.

Iksal, I., Sumiati, S., & Harizal, H. (2022). Rancang Bangun Prototype Penanganan Dini Dan Pendeteksi Kebocoran Lpg Berbasis Mikrokontroler Melalui Sms. Jurnal PROSISKO, 3(2), 26–32.

Inggi, R., & Pangala, J. (2021). Perancangan Alat Pendeteksi Kebocoran Gas LPG Menggunakan Sensor MQ-2 Berbasis Arduino. Simkom, 6(1), 12–22. https://doi.org/10.51717/simkom.v6i1.51

Joko Christian, & Nurul Komar. (2013). Prototipe Sistem Pendeteksi Kebocoran Gas LPG Menggunakan Sensor Gas MQ2, Board Arduino Duemilanove, Buzzer, dan Arduino GSM Shield pada PT. Alfa Retailindo (Carrefour Pasar Minggu). Jurnal Ticom, 2(1), 58–64.

Khakim, L., Afriliana, I., Nurohim, N., & Rakhman, A. (2022). Proteksi Kebocoran Gas LPG Rumah Tangga Berbasis Mikrokontroler. Komputika : Jurnal Sistem Komputer, 11(1), 40–47. https://doi.org/10.34010/komputika.v11i1.4977

Kurnia Hadi, T. (2022). Analisis Perancangan Alat Pendeteksi Kebocoran Gas LPG Berbasis Sensor MQ-2 dan Arduino Uno. Jurnal Minfo Polgan, 11(2), 105–108. https://doi.org/10.33395/jmp.v11i2.11804

Kurniawan, A. eka, Kasrani, M. W., & B, A. asni. (2020). PERANCANGAN PROTOTYPE ALAT PENDETEKSI KEBOCORAN GAS LPG BERBASIS ARDUINO UNO R3 DENGAN MODUL SIM800L DAN ESP8266 SEBAGAI MEDIA INFORMASI. Jurnal Teknik Elektro Uniba (JTE UNIBA), 4(2), 47–53. https://doi.org/10.36277/jteuniba.v4i2.62

Lestari, P. W., Ferdyhanza Pamungkas, V., Guntoro, P., & Dewanto, A. A. (2023). Penyuluhan Dan Simulasi Bahaya Kebakaran Akibat Gas dan Listrik di Kelurahan Kebon Pala, Jakarta Timur. LENTERA (Jurnal Pengabdian), 3(1), 16–23.

Mluyati, S., & Sadi, S. (2019). INTERNET OF THINGS (IoT) PADA PROTOTIPE PENDETEKSI KEBOCORAN GAS BERBASIS MQ-2 dan SIM800L. Jurnal Teknik, 7(2). https://doi.org/10.31000/jt.v7i2.1358

Mustaqim, A. S., Kurnianto, D., & Syifa, F. T. (2020). Implementasi Teknologi Internet of Things Pada Sistem Pemantauan Kebocoran Gas LPG dan Kebakaran Menggunakan Database Pada Google Firebase. Elektron : Jurnal Ilmiah, 12(1), 34–40. https://doi.org/10.30630/eji.12.1.161

Putra, M. F., Kridalaksana, A. H., & Arifin, Z. (2020). Rancang Bangun Alat Pendeteksi Kebocoran Gas LPG Dengan Sensor Mq-6 Berbasis Mikrokontroler Melalui Smartphone Android Sebagai Media Informasi. Informatika Mulawarman : Jurnal Ilmiah Ilmu Komputer, 12(1), 1. https://doi.org/10.30872/jim.v12i1.215

Roihan, A., Permana, A., & Mila, D. (2022). MONITORING KEBOCORAN GAS MENGGUNAKAN MIKROKONTROLER ARDUINO UNO dan ESP8266 BERBASIS INTERNET OF THINGS. ICIT Journal, 2(2), 170–183. https://doi.org/10.33050/icit.v2i2.30

Sinaga, S. F., Kurniawan Lase, B., Sagga Putta, P., Partiwin, J., & Azmi, F. (2011). 1, Agustus, pp 51-55 Terakreditasi DIKTI No.SK 1,2,3,4 Mahasiswa Teknik Informatika. Indonesia Jalan Sekip Sikambing, 3(1), 51.

Suprianto, G., Alya Rizky Natasya, & Arfi Indra Riskiawan. (2023). Sistem Pendeteksi Kebocoran Gas Berbasis IoT Sebagai Alat Bantu Pada UMKM. Journal Zetroem, 5(1), 62–67. https://doi.org/10.36526/ztr.v5i1.2631

SUSANA, R., NATALIANA, D., & ATIAH, U. (2015). Sistem Monitoring Pendeteksi Kebocoran LPG berbasis Mikrokontroller ATmega16 menggunakan RF APC220. ELKOMIKA: Jurnal Teknik Energi Elektrik, Teknik Telekomunikasi, & Teknik Elektronika, 3(2), 191. https://doi.org/10.26760/elkomika.v3i2.191