
“GREEN GUARDIAN” APPLICATION DEVICE FOR EARLY WARNING DISASTER NOTIFICATION IN BASEMENT PARKING

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Abstract

The "Green Guardian" is an innovative application device designed for early disaster notification in underground parking facilities. Unlike traditional systems, this solution integrates four key sensors: rain, infrared (IR) for detecting vehicle movement, and gas sensors to identify carbon monoxide and nitrogen oxide emissions from vehicle exhaust. This combination provides a comprehensive early warning monitoring system that enhances safety and efficiency in underground parking management. Leveraging solar-powered green technology, the "Green Guardian" ensures sustainability and reliability in operations. The system enables building managers to monitor hazards through mobile devices via the BlynkApp platform. By setting up an account using their management email, users can access real-time notifications and crucial data displayed on an LCD within the parking area. This allows for immediate responses to potential threats, ensuring swift evacuation or preventive measures while improving the parking experience and efficiency. Preliminary findings highlight significant advantages of the "Green Guardian" system. It enhances user confidence and comfort by addressing safety concerns and environmental risks in underground parking spaces. The integrated notification system empowers users with real-time updates, reducing anxiety and improving convenience. Future developments aim to refine system functionality, integrating it with smart home systems and exploring broader applications of green technology. These enhancements will further improve the "Green Guardian" as a sustainable and intelligent solution for urban infrastructure. By aligning with modern environmental and technological objectives, this innovation holds immense potential to transform the safety and usability of underground parking facilities.

Keywords: Early warning, Integrated notification system, Underground parking.

INTRODUCTION

Underground parking spaces provide sheltered areas for vehicles and are often constructed beneath buildings to optimize land use. However, these spaces are frequently plagued by recurring issues. One of the primary concerns is inadequate ventilation, which leads to elevated temperatures and poor air quality. Limited airflow in such areas can result in the accumulation of gases such as nitrogen dioxide and carbon monoxide from vehicle exhaust emissions. Additionally, underground parking facilities are prone to sudden flash floods, which occur unpredictably and pose significant risks to both vehicles and users. Furthermore, the presence of methane gas, a flammable substance generated from nearby sewage systems, adds another layer of hazard within the parking area. These challenges not only compromise user comfort but also pose serious safety threats if left unaddressed.

During heavy rainfall in densely populated areas, users often express concerns about parking their vehicles in underground parking facilities. This is because flash floods can occur in these spaces, potentially damaging vehicles within the building. Additionally, vehicle exhaust emissions contain harmful gases such as carbon monoxide (CO) and nitrogen dioxide (NO₂), which pose serious health risks when exposed in high concentrations. The situation becomes even more dangerous when these gases accumulate in enclosed spaces like underground parking lots, where ventilation is often inadequate.

Furthermore, high temperatures and heat in underground parking areas create discomfort for users. This can lead to various health issues such as heat strokes, dehydration, fatigue, and exhaustion. Therefore, the elevated temperatures present a serious risk to human health, especially when individuals are exposed to such conditions for extended periods. These factors highlight the significant challenges faced by underground parking spaces, which require effective solutions for safety, air quality, and temperature control.

LITERATURE REVIEW

The development and implementation of Early Warning Systems (EWS) for natural hazards has repeatedly been cited as an area in disaster risk reduction where substantial progress has been made over the last decade. This review discusses various early warning systems for flood hazards, emphasizing the integration of IoT and real-time monitoring. It highlights the importance of timely alerts for disaster management, particularly in areas vulnerable to flooding. (Al Halbusi, H., Hammood, O. A., & Al Abri, S., 2021). Research from Mohammed Siddique, D. T. Ahmed, and Mohammad Shahid Husain (2023), this paper delves into the success factors of flood early warning systems, focusing on the relationship between technological advancement and the reduction of disaster impacts. It supports the use of IoT-based monitoring and predictive analytics to improve flood response and safety.

In case of a flash flood, the early feedback on the occurrence of the flood is necessary for alerting resident to take early action such as evacuate quickly to a safer. This article explores the integration of IoT-enabled devices for monitoring hazards such as gas emissions and flooding in underground parking spaces. It addresses the effectiveness of these systems in providing early warnings for environmental risks. Through the integration of IoT and wearable devices in the development of healthcare systems, a shift in handling patients' health is observed (Ashwini, A & Sangeetha, 2024). This paper assesses and compares the effectiveness of IoT-enabled flood detection systems that have been integrated into underground parking facilities to enhance flood response times. These systems provide real-time updates on water levels, enabling building management to take timely actions in the event of a flood, which is especially critical during flash floods. Wang, L., Bian, L., Leon, A. S., Yin, Z., & Hu, B. (2024).

RESEARCH METHOD

This applied research aims to cover the entire process, from initial planning and development to the testing of an application tailored to user needs. Additionally, it emphasizes the broader impact on community safety, ensuring the device adheres to safety standards while promoting sustainability. The integration of green technologies, such as solar power and energy-efficient systems, not only enhances safety but also reduces the environmental footprint of underground parking spaces,

supporting long-term sustainability goals. By providing innovative solutions to monitor and manage safety risks, this system contributes to both environmental and operational sustainability in urban infrastructure.

Block diagram

This project will be powered or using solar energy as an electrical power source, which aligns with the title "GREEN GUARDIAN" that incorporates green technology and will be stored in a battery. For the main microcontroller, we use two different microcontrollers, WEMOS-D1 and MAKER-UNO. Additionally, this project uses five different sensors, an IR sensor to detect vehicle movement in and out, a MQ2 sensor to detect gas presence, a DHT11/22 to detect ambient heat, and a rain sensor to detect water level. All the data collected by these sensors will pass through the microcontroller and will be sent to two different outputs, either the LED display located in the building or the Blynk application on the smartphones and computers of the building manager. The Blynk application would send warning notifications to the building manager if the data received from these sensors reaches an alert level.

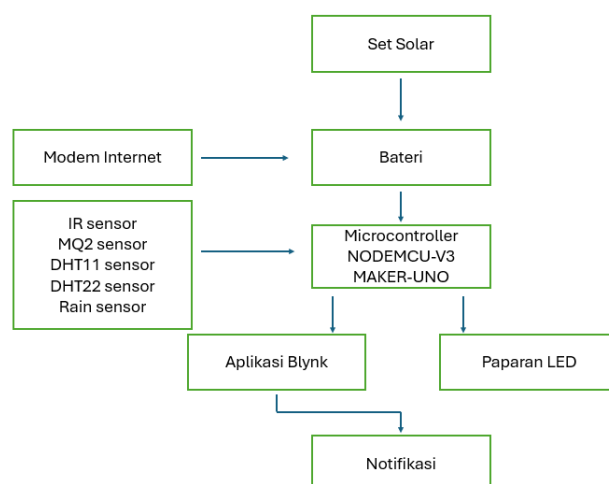


Figure 1. Block diagram

Model/Prototype

For this project prototype, acrylic boards were used as the walls of the prototype. The acrylic board was cut into several pieces and glued together to form the desired shape. The size of this prototype is 2ft x 2ft. After the outer walls were completed, the sensors as mentioned above were installed and incorporated into this prototype. The IR sensor is located at the entrance and exit of the vehicle passage, and an LED display has been placed at the front of the prototype to show the number of available parking spaces in the underground parking lot. Inside the prototype, we installed the MQ2 sensor and DHT11 sensor. For the rain sensor to detect water levels, we provided a special compartment in the prototype to hold water, to prevent leaks that could damage the electrical circuits in this prototype. Solar panel is connected to the electrical circuit to provide electric power to run this project prototype.

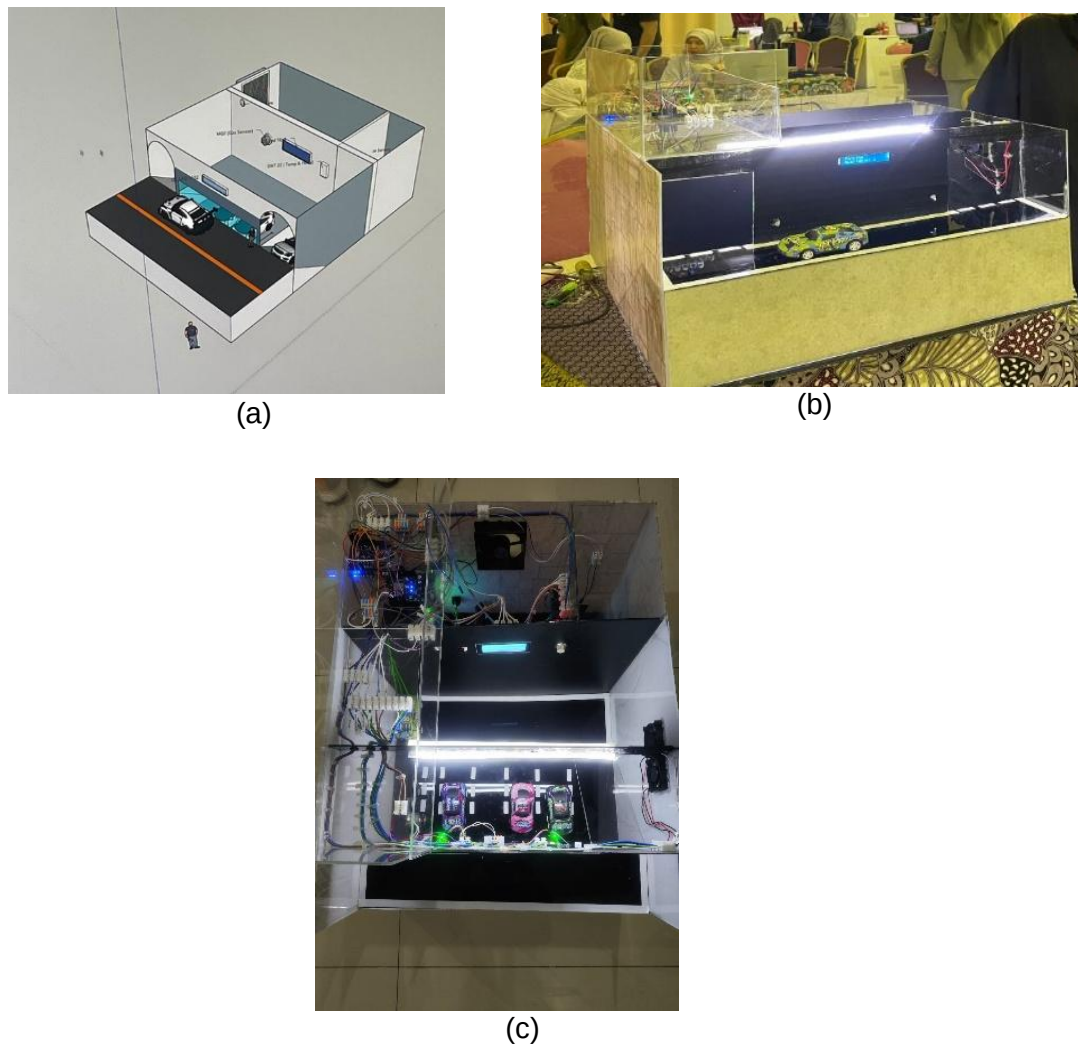


Figure 2. 3D Model (a); Prototype in lab scale (b); Top view of prototype (c)

RESULTS AND DISCUSSION

After the prototype was completed, tests were conducted to see if the application truly functions. Gas was released towards the MQ7 sensor and it was found that the sensor could detect the presence of high gas levels and immediately send a notification to the smartphone to provide a warning. The fan has also been automatically turned on to disperse the gas. Next, the IR sensor located at the entrance and exit of the pathway can detect in and out of vehicle and display the number of available parking space on the LED display. Additionally, other sensors such as the DHT11 temperature and humidity sensor and the rain sensor provide a great response as they can detect disasters and simultaneously send data to the Blynk application to alert the building manager. Based on the data we have gathered throughout the course of this project. This show that all the installed sensors are functioning well and can detect disasters accurately and precisely. Additionally, the BLYNK application also provides warning notifications as desired. The data that has been collected in the BLYNK application can also be stored as a reference by the building manager.

An overview of the operational early warning systems described above, , the development of this warning application has proven effective in not only preventing damage to property, such as vehicles, but also in providing a sense of relief and safety to underground parking users.

Furthermore, the findings of this project confirm that the system operates as intended and achieves its stated objectives. Hence, this application holds great potential for widespread adoption to enhance safety in underground parking areas.

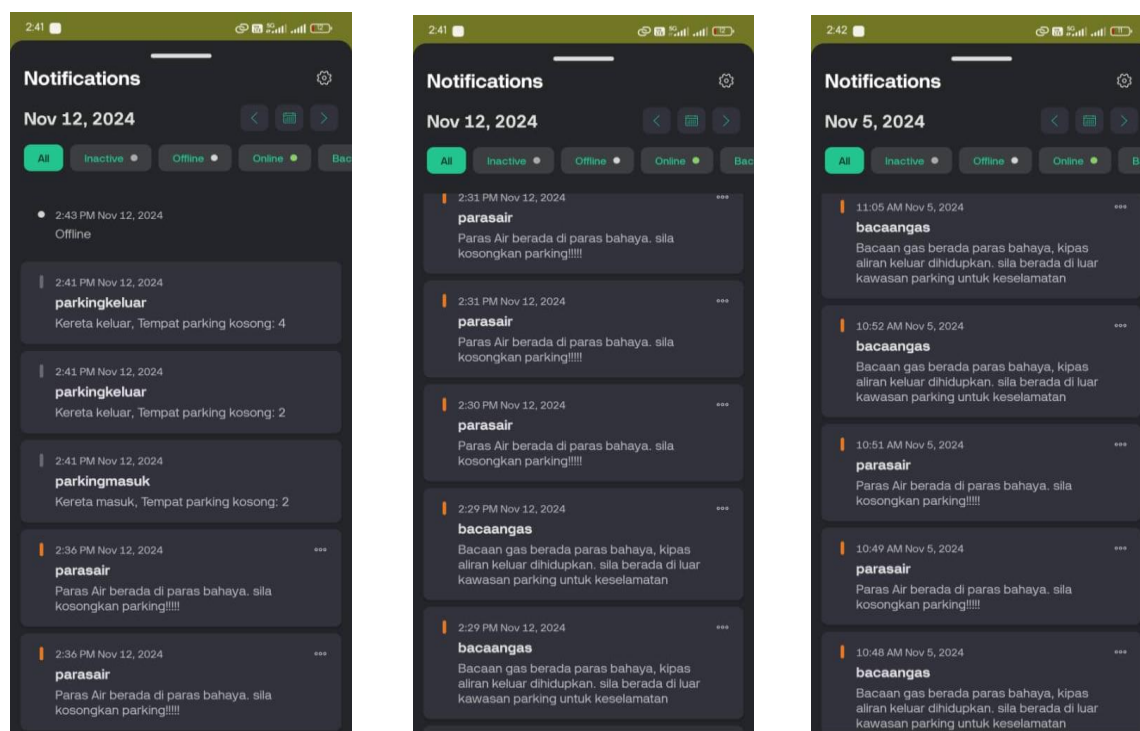


Figure 3. Notification display for building management

CONCLUSION

In conclusion, the "Green Guardian" system represents a significant step toward enhancing the safety and sustainability of underground parking spaces. By integrating advanced technologies such as solar power and IoT-enabled sensors, this system provides real-time notifications and early warnings, ensuring that both environmental hazards and safety risks are efficiently managed. The system's ability to monitor factors such as gas emissions, temperature fluctuations, and flooding events helps create a safer and more sustainable environment for users. Furthermore, the incorporation of green technology not only reduces the carbon footprint but also contributes to the broader goals of urban sustainability. As cities continue to face the challenges of urbanization, integrating such smart, eco-friendly solutions will be essential for improving the resilience of infrastructure while safeguarding public health and safety. Moving forward, further refinement and scalability of the system will enhance its impact, ultimately shaping the future of underground parking management in smart cities.

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