Development of Emergency Notification System for Passenger Lift using IoT

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Abstract: This work aims to develop a highly efficient and reliable notification system that promptly alerts the emergency response team in the event of a passenger elevator failure, addressing the need to improve the safety and well-being of individuals trapped in elevators. The main research objectives focus on minimizing response time for the responsible party and engaging relevant stakeholders through the utilization of advanced components such as ESP8266, GSM Module, Arduino, and Blynk software. The study incorporates these materials and follows standard procedures to ensure the system's functionality. Key findings indicate the system's effectiveness with average notification times of 5.91 seconds for email, 1.35 seconds for phone, and 9.03 seconds for SMS notifications, regardless of internet connectivity. The discussion emphasizes the successful reduction in response time and suggests future work could involve further system optimization and integration with additional emergency response mechanisms.

Keywords: Internet Of Things, Emergency System, Notification System, Blynk

1. Introduction

Elevators and lifts offer convenience but being trapped in them poses risks. Despite safety features, incidents of people getting stuck persist. Statistics indicate a significant number of such incidents, with 900 reported cases from January to June of 2017 [1], and a total of 1,917 cases throughout 2019, according to records from KPKT [2]. This work aims to address the issue by developing a notification system that immediately alerts the responsible party via notifications and emails when the emergency button is pressed or during power outages. The objectives include notifying the emergency response team, providing victim feedback, and establishing a seamless emergency system. Leveraging IoT, the system informs relevant parties, incorporates LCD and Blynk widgets, and enhances the emergency alert system's range and responsiveness. Several relevant works serve as references for our endeavor, including a theft-detection system [3], IoT-based heating control [4], and gas leakage detection [5]. Notably, the incorporation of smartphone controls in a smart home context [6,7] aligns with our goals.

2. Methodology

This section provides visual representations of the system's structure and operational processes, including a block diagram, flowchart for the main system, and a separate flowchart for the backup system.

2.1 Block Diagram

In most works, the key components typically include inputs, a control unit, and outputs. For this particular work, the input is a toggle push button, the control unit is the ESP8266, and the outputs consist of an LED, LCD display, and buzzer. Figure 1 illustrates the block diagram depicting the configuration of these components.
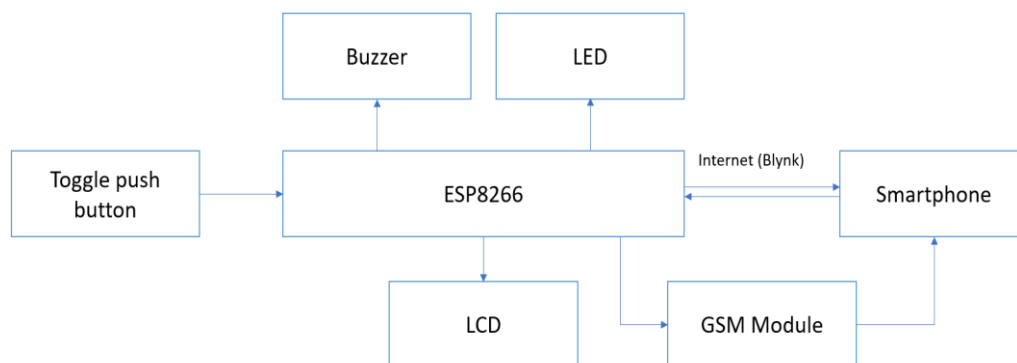

Figure 1: Block Diagram

The block diagram depicts a system's input and output flow, utilizing a toggle push button as the input device and an ESP8266 microcontroller for control. It includes various output devices like a buzzer, LED, and LCD. Additionally, the system integrates with a Blynk server and IoT system, enabling connectivity with a smartphone. The toggle push button serves as the initial input, transmitting a signal to the ESP8266 microcontroller for processing and controlling the output devices. The microcontroller processes the input signal and generates corresponding output signals to activate the buzzer, LED, and LCD. The system also establishes a connection to the GSM network, enabling SMS messaging capabilities. This enables the system to send text messages, particularly for emergency notifications, by utilizing a GSM module integrated with the NodeMCU. Overall, this block diagram showcases the input processing, output control, smartphone integration, and SMS messaging functionality of the system.

2.2 Flowchart

The overall system consists of two components: the primary system and the backup system. The primary system is designed to operate optimally and deliver flawless performance, relying on the "Emergency Notification System for Passenger Lift Using IoT" to establish an internet connection. It provides all the intended features seamlessly. On the other hand, the backup system serves as an alternative solution when the internet connection is unavailable. Maintaining a reliable connection is crucial for this system, but circumstances like natural disasters can disrupt internet connectivity. Although the backup system may exhibit limitations under such conditions, it still aims to achieve the objectives. Figure 2 shows the flow chart of the primary system while Figure 3 shows the flowchart of backup system.
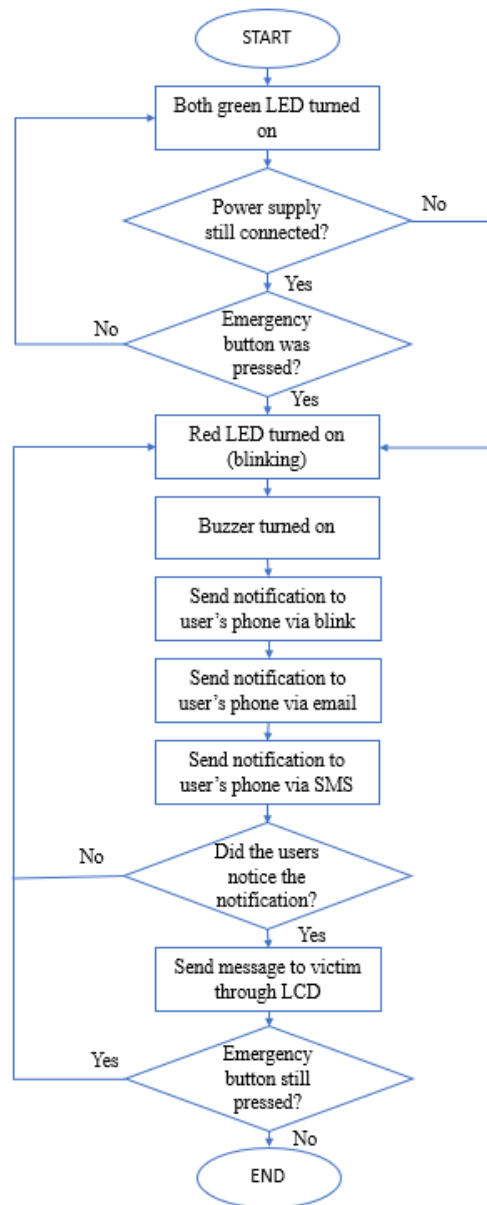
Figure 2: Flow chart of the primary system

The flowchart for the primary system depicts the operation of an emergency notification system in an elevator. It initiates by activating the green LEDs to signify readiness. Subsequently, the system verifies the connection status of the power supply and proceeds accordingly. If the power supply is disconnected, it advances to the next stage. On the other hand, if the emergency button is pressed, the system triggers emergency indicators, such as the blinking red LED and the sounding buzzer. Notifications are then dispatched to the user's phone via the Blynk app, SMS, and email. The system verifies the receipt of notifications by the user and communicates with the victim through the LCD display. It continuously monitors the state of the emergency button, adjusting the LED accordingly. The flowchart emphasizes the system's user-friendly design, intuitive functionality, and utilization of multiple indicators for effective communication during emergency situations.
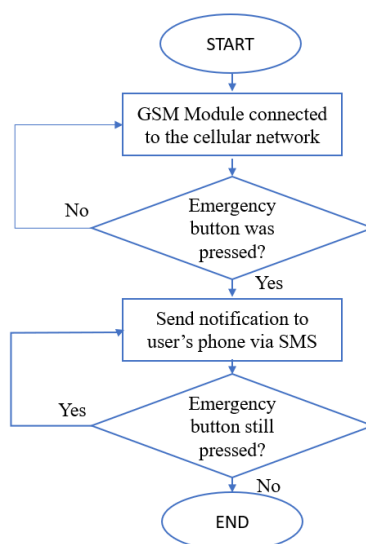
Figure 3: Flow chart of backup system

The backup system flowchart portrays an additional component for the Emergency Notification System in a Passenger Lift utilizing IoT. It prioritizes reliability and redundancy by incorporating a GSM module to establish a connection with the cellular network. When the emergency button is pressed, the system promptly dispatches an SMS notification containing critical information to the user's phone. This backup system ensures uninterrupted communication between the elevator and the user, facilitating the prompt delivery of essential notifications during emergencies. Even in the absence of internet connectivity, the backup system exhibits reliable performance, enabling the timely and dependable transmission of crucial information to users.

3. Results and Discussion

The focus of this chapter is to provide an overview of the final design for the Emergency Notification System for Passenger Lift using IoT, highlighting the key features and functionalities implemented.

3.1 Primary and backup system

This work incorporates two input devices, namely a toggle push button and a virtual button, to control the emergency system in the elevator. The system's optimized performance relies on five specific conditions, which are activated by the status of both the toggle push button physically present in the passenger lift and the virtual button in the BLYNK software. In the control room, a buzzer, red LED, and green LED 2 are installed to provide standard alerts for the responsible party. Inside the passenger lift, a green LED, LCD, and toggle push button are installed. Table 1 outlines the button state that has the ability to alter the system's condition and functionality.

Table 1: Button states and system condition

Internet Availability	Toggle push button	Virtual button	Type of condition
YES	LOW	LOW	Initial condition
YES	HIGH	LOW	Emergency Condition
YES	HIGH	HIGH	Rescue Condition
YES	LOW	HIGH	Error Condition
NO	HIGH	-	Backup system

The system operates under 5 distinct conditions, each designed to fulfill a specific purpose and ensure optimized performance. In the initial standby mode, the system indicates its preparedness for

emergencies, keeping users informed and ready to respond if needed. When an emergency condition is detected, the system swiftly alerts users, enabling them to promptly address critical situations. This timely notification mechanism ensures that users are well-informed and can take appropriate action. In the rescue condition, responsible parties actively acknowledge the emergency alert and initiate immediate actions by leveraging their mobile phones, ensuring a swift and coordinated response. On the other hand, the error condition serves as a failsafe to prevent false outputs resulting from accidental presses. If a user mistakenly presses the digital button without activating the emergency button, the system recognizes this error condition and avoids generating incorrect alerts or unintended actions.

To provide a more detailed overview, Table 2 shows a comprehensive summary of the outputs generated by each component in the system's distinct conditions. This table helps visualize the specific behaviour and responses of the system in different scenarios. Additionally, Table 3 shows the notification system employed within each of the four conditions, indicating how users are notified through various channels such as phone, email, and SMS. These tables provide valuable insights into the system's functioning and the seamless integration of notification mechanisms in emergency situations.

Table 2: Button states and hardware output

Type of condition	Green LED 1	LCD	Green LED 2	Buzzer	Red Led (Blinking)
Initial condition	ON	OFF	ON	OFF	OFF
Emergency Condition	ON	ON	ON	ON	ON
Rescue Condition	ON	ON	ON	ON	ON
Error Condition	ON	OFF	BLINKING	OFF	OFF
Backup System	OFF	OFF	OFF	OFF	OFF

Table 3: Button states and Notification output

Type of condition	Phone Notification	Email Notification	SMS Notification
Initial condition	OFF	OFF	OFF
Emergency Condition	ON	ON	ON
Rescue Condition	OFF	OFF	OFF
Error Condition	OFF	OFF	OFF
Backup system	OFF	OFF	ON

Table 2 provides an overview of the button states and hardware outputs corresponding to each system condition. In the initial condition, where the internet availability is confirmed and the toggle push button and virtual button are both in a low state, the system indicates readiness with the Green LED 1 turned on. The LCD remains off, and the Green LED 2 is also on. The Buzzer is inactive, and the Red LED does not blink.

During the emergency and rescue conditions, where the internet is available and the toggle push button is set to high while the virtual button varies, the system responds with the Green LED 1, LCD, Green LED 2, and Buzzer all turned on to provide visual and auditory alerts. The Red LED blinks to draw attention to the emergency.

In the error condition, where the internet is available, but the toggle push button is low and the virtual button is high, the system indicates an error with the Green LED 1 remaining on, the LCD off, the Green LED 2 blinking, and the Buzzer off. The Red LED does not blink.

Table 3 focuses on the notification outputs associated with each system condition. In the initial condition, emergency notifications through phone, email, and SMS are all disabled. In the emergency

condition, all three notification channels are active to promptly inform relevant parties. In the rescue condition, notifications are turned off to avoid unnecessary alerts. In the error condition, as well as in the backup system, all notifications are disabled.

The state of the internet connection, indicated in Table 1, influences the system's behaviour and availability to send notifications. When the internet is available, the system operates under normal conditions. However, in the absence of an internet connection, the backup system takes over, and notifications are limited to SMS only. Figure 4 shows the example of email notification, Figure 5 shows the example of SMS notification and Figure 6 shows the example of Phone notification, respectively.
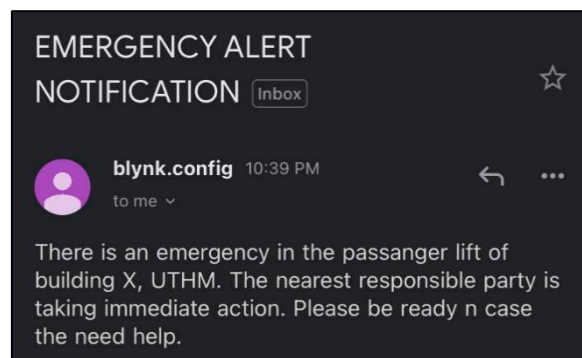

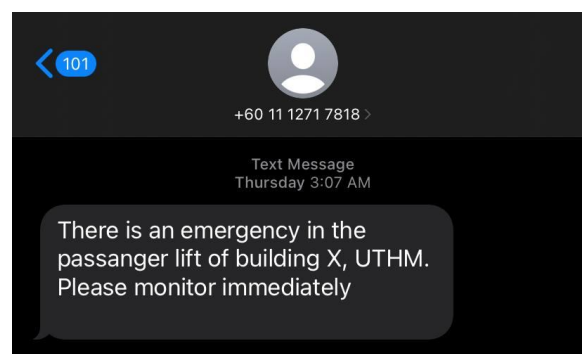**Figure 4: Example of Email Notification**

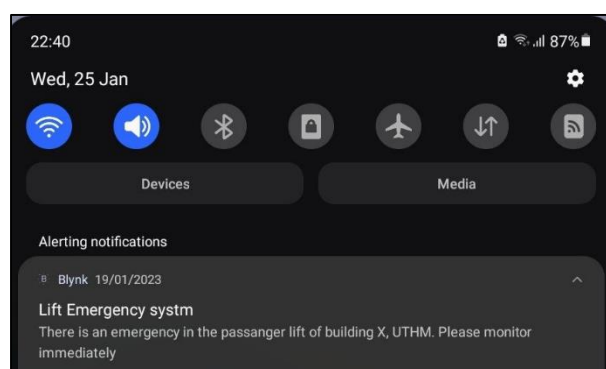**Figure 5: Example of SMS Notification**

Figure 6: Example of Phone Notification

3.2 Automation system

The implemented automation system addresses power supply problems in passenger lifts, providing an efficient solution. Once the passenger lift is connected to a backup power supply and internet connectivity is restored, the system automatically initiates the specified condition. When the condition is met, a series of actions take place to ensure the safety of individuals. The red LED rapidly blinks,

serving as an emergency signal, while the green LEDs illuminate to indicate the activation of a safety mechanism. Simultaneously, the buzzer emits a tone, drawing attention to the emergency situation. To provide clear instructions and notifications, an LCD display is activated, displaying a message urging calmness and notifying individuals that security has been alerted.

Additionally, an email is sent to a designated address, conveying detailed information about the power supply issue and urging immediate action. Furthermore, a notification is promptly dispatched via the Blynk platform, informing relevant parties about the power supply problem and the potential presence of someone trapped in the lift. Once the responsible party verifies that the passenger lift is ready for use, the system ceases the execution of this condition.

3.3 Analysis

The primary objective of this work is to enhance the reach of the emergency alert system, allowing it to cover a larger area. Additionally, the work aims to reduce the response time for the responsible party to promptly address situations where individuals are stuck in a passenger lift. Table 4 shows the Time taken to all notification systems received by the user.

Table 4: Time taken to all notification systems received by the user

Type of notification	Test 1	Test 2	Test 3	Test 4	Test 5
Email	5.88	5.90	5.98	5.88	5.92
Phone	1.16	1.36	1.16	1.60	1.47
SMS (internet)	8.70	8.43	10.14	9.03	8.87
SMS (Without Internet)	10.39	8.26	9.01	8.38	9.21

Table 4 provides an overview of the time taken for different notification systems to reach the user in various test scenarios. The average time for each type of notification is as follows: for email notifications, the average time is approximately 5.91 seconds across multiple tests. Phone notifications have an average time of around 1.35 seconds, indicating a quick delivery of alerts. SMS notifications, both with and without internet connectivity, have average times of approximately 8.83 seconds and 8.85 seconds, respectively. These results demonstrate that all notification systems achieve efficient delivery within a short timeframe. Notably, the efficiency of the system is unaffected by whether SMS notifications are sent with or without internet access. The findings suggest that the work has successfully achieved its objective of optimizing the emergency alert system's reach and reducing response time, ensuring effective and timely communication in emergency situations involving individuals trapped in a passenger lift.

4. Conclusion

Despite existing safety measures, elevator emergencies continue to pose risks to individuals. This work proposes an IoT-based emergency notification system to improve elevator safety. The flowchart outlines the process of detecting emergencies, activating alerts, and notifying responsible parties through various channels. In cases without internet connectivity, a backup system utilizing a GSM module and SMS notifications ensures continuous communication. By promptly alerting operators, this solution enhances response times and facilitates necessary actions during emergencies. Implementing this work mitigates risks, reduces stress, and promotes overall elevator safety for users.

Acknowledgement

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