

NODEMCU - ENABLED SMART SHOE FOR WOMAN SAFETY

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Abstract : Women safety has become a major concern in today’s society, as incidents of harassment and unsafe situations can occur at any place and time, including workplaces and during travel. Although several safety solutions have been introduced, many of them are either complex, costly, or not easy to use in emergency situations. To overcome these limitations, this project proposes a simple, lightweight, and smart safety shoe designed specifically for women protection. The proposed system integrates a smart electric shock mechanism within the shoe to help defend the user during dangerous situations. A shock circuit is placed at the front of the shoe, which can deliver a low-current electric shock of about 10 mA, sufficient to startle the attacker and allow the victim to escape. The system is built using a NodeMCU controller along with essential components such as an electric shock circuit, pulse sensor, buzzer, and a USB boost converter. The pulse sensor continuously monitors the user’s heart rate, enabling the shoe to function as a basic health monitoring device. In emergency situations, the system can send alert notifications to predefined contacts and activate a buzzer to draw attention from nearby people. The USB boost converter allows the shoe to recharge small electronic devices when required. A key feature of the proposed system is its easy operation, as all functions can be activated using a single panic button. Overall, the smart shoe provides an effective, user-friendly, and multi-functional solution to enhance women safety in real-time situations.

Index Terms - Safety Shoe, Shock Circuit, Pulse Sensor, NodeMCU, USB Boost converter, Buzzer, GSM

1. INTRODUCTION

Women’s safety is an important issue in modern society, as incidents of harassment, assault, and other crimes against women continue to increase in many places such as public transport, workplaces, educational institutions, and isolated areas. In emergency situations, obtaining immediate help is often difficult, especially when the victim is unable to access a mobile phone or communicate with others. Although several mobile applications and wearable safety devices have been developed, many of these systems depend on smartphones, internet connectivity, or complex operating procedures. As a result, they may not provide effective assistance during critical situations when quick action is required. Therefore, there is a growing need for a simple, reliable, and easily accessible safety solution that can offer immediate protection and support.

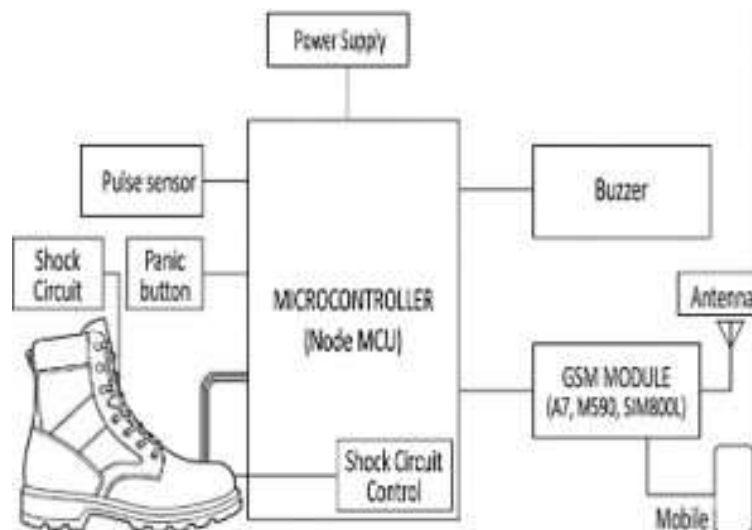


Fig 1: Smart Shoe Model

The proposed NodeMCU-Enabled Smart Safety Shoe is designed to address these challenges by providing a wearable safety device that integrates multiple protective features into a single system. The smart shoe includes a panic button, GSM-based alert communication, buzzer alert mechanism, shock circuit for self-defense, and pulse rate monitoring system. When the panic button is pressed, the system immediately sends alert messages to pre-registered contacts, activates a buzzer to attract nearby attention, and enables the shock mechanism to help the user defend against potential threats. These features work together to provide rapid assistance and improve the chances of escaping from dangerous situations.

The project combines embedded systems, wireless communication, and wearable technology to create a compact and user-friendly safety solution. The NodeMCU controller acts as the central processing unit and coordinates the operation of all connected components. The pulse sensor continuously monitors the user's heart rate and provides useful information regarding physical condition during stressful situations. The lightweight design of the shoe ensures comfort during daily use while maintaining the effectiveness of the safety features. By integrating emergency communication, public alerting, health monitoring, and self-defense into a single wearable device, the proposed system offers a practical, affordable, and efficient approach for enhancing women's safety and confidence in real-life situations.

2. NEED OF THE STUDY.

The need for this study arises from the increasing concern regarding women's safety in modern society. Women frequently face unsafe situations while traveling, working, or moving alone in public places. Although several safety applications and wearable devices are available, many of them depend on smartphones and internet connectivity, which may not always be accessible during emergencies. In critical situations, victims may not have sufficient time to unlock or operate a mobile device to seek help. Therefore, there is a need for a safety system that can provide immediate assistance, self-defense, and emergency communication through a simple and easily accessible mechanism.

The proposed Smart Safety Shoe is developed to address these challenges by integrating emergency alert communication, self-defense, public awareness, and health monitoring features into a single wearable device. The system enables women to quickly activate safety functions using a panic button, allowing them to seek help and protect themselves during dangerous situations. The study also focuses on providing a cost-effective, lightweight, and user-friendly solution that can be comfortably used in daily life. By combining GSM communication, pulse monitoring, buzzer alerts, and a shock mechanism, the proposed system contributes towards improving personal safety and enhancing confidence among women.

2.1 Population and Sample

The population of this study consists of wearable safety systems, women protection devices, and IoT-based emergency response technologies designed to enhance personal security. Various safety solutions such as mobile applications, smart bands, tracking devices, and wearable emergency systems are considered as part of the study population. These technologies have been analyzed to understand their features, limitations, and effectiveness in real-life situations.

The proposed NodeMCU-Enabled Smart Safety Shoe is selected as the sample system for implementation and evaluation. The study focuses on integrating components such as NodeMCU, GSM module, pulse sensor, buzzer, shock circuit, and power supply modules into a wearable shoe platform. The prototype is tested under different operating conditions to evaluate its emergency response capability, communication performance, pulse monitoring accuracy, and self-defense effectiveness. The performance of the system is analyzed based on reliability, response time, ease of operation, and overall user safety.

2.2 Data and Sources of Data

Both primary and secondary sources of data are used for this study. Primary data is obtained through the implementation and testing of the proposed smart safety shoe system. The pulse sensor readings, GSM alert transmission results, buzzer activation response, and shock circuit performance are observed and recorded during the testing process. These practical observations help in evaluating the efficiency and reliability of the proposed system under different operating conditions.

Secondary data is collected from research papers, journals, conference publications, technical articles, and online resources related to women's safety systems, wearable devices, IoT applications, GSM communication, embedded systems, and health monitoring technologies. The collected information is used to understand existing technologies, identify their limitations, and develop an improved solution. The combination of primary and secondary data helps in validating the effectiveness of the proposed smart safety shoe and supports the overall objectives of the study.

2.3 Theoretical framework

The theoretical framework of this study is based on the relationship between wearable safety technology and emergency response effectiveness. The dependent variable of the study is the overall safety performance of the proposed smart shoe system. This includes emergency communication, self-defense capability, health monitoring accuracy, public alert generation, and user convenience during critical situations.

The independent variables of the study include the performance of the GSM module, pulse sensor accuracy, shock circuit operation, buzzer alert mechanism, panic button response, and power management system. The NodeMCU controller processes the input signals from these components and coordinates their operation to ensure efficient functioning of the system. The integration of embedded systems, wireless communication, and wearable technology forms the foundation of the proposed model. The framework demonstrates how the combination of these technologies can improve women's safety by providing quick assistance, immediate response, and enhanced protection during emergency situations.

The independent variables include:

- Panic button response
- GSM communication performance
- Shock circuit activation
- Pulse sensor readings
- Buzzer alert performance
- NodeMCU processing efficiency
- Power supply stability
- User interaction and accessibility

The system uses embedded systems and wireless communication technologies to detect emergency situations and activate multiple safety features simultaneously. The NodeMCU controller processes user inputs and coordinates the operation of the GSM module, buzzer, pulse sensor, and shock circuit. The integration of these components helps improve emergency response, self-defense capability, and overall women's safety.

3. RESEARCH METHODOLOGY

The research methodology describes the systematic procedure followed for the design, development, implementation, and evaluation of the proposed NodeMCU-Enabled Smart Safety Shoe for Women Safety. The methodology includes problem identification, system design, hardware integration, software development, communication setup, testing, and performance evaluation. The primary objective of the methodology is to develop a reliable wearable safety device that can provide immediate assistance during emergency situations. The system combines embedded technology, wireless communication, self-defense mechanisms, and health monitoring features into a single platform. Each stage of development is carefully planned and tested to ensure proper functionality and effectiveness of the proposed safety system.

3.1. Problem Identification

Women often face unsafe situations in public places, workplaces, educational institutions, and while travelling alone. Existing safety solutions mainly depend on smartphones and mobile applications, which may not always be accessible during emergencies. In many situations, victims may not have sufficient time to unlock their phones, access an application, or contact someone for help. Furthermore, most existing systems focus only on sending alerts and do not provide any immediate self-defense mechanism. These limitations highlight the need for a wearable safety device that can provide instant communication, public awareness, health monitoring, and self-defense capabilities. The proposed smart safety shoe is developed to overcome these challenges and provide a practical solution for enhancing women's safety.

3.2. System Design

The proposed NodeMCU-Enabled Smart Safety Shoe is designed as an intelligent wearable safety device that provides immediate assistance and protection during emergency situations. The system integrates various hardware components such as a NodeMCU controller, GSM module, panic button, pulse sensor, buzzer, shock circuit, voltage regulator, and power supply into a single compact platform. The primary objective of the design is to create a lightweight, portable, and user-friendly safety solution that can be comfortably used in everyday life without causing inconvenience to the user. The overall architecture is developed in such a way that all components work together efficiently to provide quick response and reliable operation during critical situations.

The NodeMCU controller acts as the central processing unit of the system and is responsible for managing all connected modules. The panic button serves as the main input device and is strategically positioned on the side of the shoe to allow easy access during emergencies. When the user presses the panic button, the signal is immediately received by the NodeMCU, which initiates a series of predefined actions. The controller simultaneously activates the GSM module, buzzer, shock circuit, and pulse monitoring functions. This coordinated operation ensures that the user receives maximum protection and assistance within a very short period of time.

The GSM module is incorporated into the design to provide wireless communication with pre-registered emergency contacts. Once activated, the module sends alert messages informing family members, guardians, or authorized persons about the emergency situation. Unlike internet-based systems, the GSM module operates using cellular communication, making it more reliable in locations where internet connectivity may not be available. This feature significantly improves the effectiveness of the system by ensuring that emergency information reaches the concerned individuals without delay.

The buzzer functions as a public alert mechanism and plays an important role in attracting the attention of nearby people. When activated, it produces a loud sound that can alert individuals in the surrounding area and increase the chances of receiving immediate assistance. Along with the buzzer, the system incorporates a shock circuit positioned at the front portion of the shoe. The shock circuit acts as a self-defense mechanism capable of delivering a low-current electric shock that can temporarily startle an attacker. This provides valuable time for the user to escape from danger and seek help.

The entire system is powered using a rechargeable battery and regulated power supply circuit to ensure stable operation of all electronic components. The integration of emergency communication, self-defense, public alerting, and health monitoring into a single wearable platform makes the proposed Smart Safety Shoe an effective and practical solution for enhancing women's safety in real-world environments.

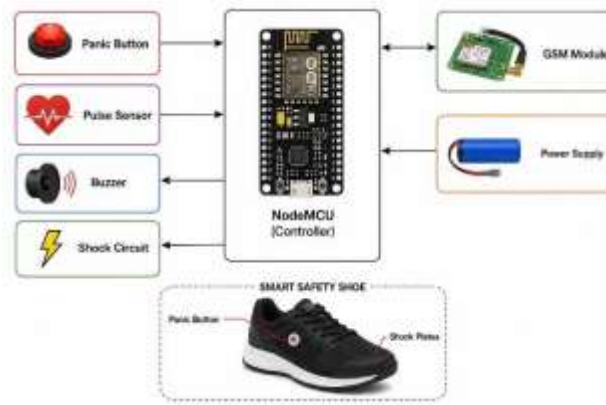


Fig 2: System Design

3.3. Hardware Implementation

The hardware implementation involves the integration of all selected electronic components into the safety shoe. The NodeMCU controller is connected with the GSM module, pulse sensor, buzzer, shock circuit, and power supply unit. Proper circuit connections are established to ensure reliable communication among all modules. The panic button is strategically positioned on the side of the shoe to allow easy access during emergency situations.

Special attention is given to component placement to maintain comfort and usability. The shock circuit is installed at the front portion of the shoe, while the remaining electronic components are securely embedded inside the shoe structure. The design ensures that the device remains lightweight and does not interfere with normal footwear usage. The hardware arrangement is carefully tested to guarantee durability, safety, and effective performance.

3.4. Data Collection

Data collection is carried out using the pulse sensor and system monitoring modules. The pulse sensor continuously measures the user's heart rate and provides real-time physiological information. During testing, different operating conditions are considered to evaluate the accuracy and reliability of the sensor readings. The collected pulse data helps assess the user's physical condition during stressful and emergency situations.

Additional data is collected regarding GSM communication performance, panic button response time, buzzer activation, and shock circuit operation. These observations help in evaluating the effectiveness of the proposed system. The collected information is recorded and analyzed to ensure that all safety functions perform efficiently under different conditions.



Fig 3: Data collection

3.5. Data Processing and Communication

The NodeMCU controller processes all incoming data from the pulse sensor and user inputs from the panic button. Once an emergency signal is detected, the controller executes predefined instructions and coordinates the operation of all connected components. The pulse data is processed and monitored continuously, while emergency actions are initiated whenever required. Communication is achieved through the GSM module, which transmits alert messages to pre-registered contacts. This communication process does not depend on internet connectivity, making the system more reliable during emergencies. The buzzer and shock circuit are also activated simultaneously to provide immediate assistance and self-defense.

3.6. Alert Message Transmission and Monitoring

The alert message transmission and monitoring process is one of the most important functions of the proposed Smart Safety Shoe system. The system is designed to provide immediate communication during emergency situations by sending alert messages to pre-registered contacts. When the user presses the panic button, the NodeMCU controller receives the input signal and activates the GSM module. The GSM module then transmits an emergency alert message to the stored contact numbers, informing them that the user is facing a critical situation and may require immediate assistance.

The transmission of alert messages is performed automatically without requiring any additional action from the user. This feature is particularly useful during emergencies where the user may not have enough time to make a phone call or access a mobile application. The GSM-based communication system ensures reliable message delivery through the cellular network and does not depend on internet connectivity. During testing, the alert messages were successfully delivered to the registered contacts, demonstrating the effectiveness of the communication mechanism.

Along with alert message transmission, the system continuously monitors the user's pulse rate through the pulse sensor. The collected pulse data can be observed to understand the physical condition of the user during stressful situations. Simultaneously, the buzzer is activated to attract the attention of nearby people, while the shock circuit provides a self-defense mechanism. The integration of communication, monitoring, and safety features ensures that the system can provide rapid assistance and improve the overall effectiveness of emergency response during critical situations.



Fig 4: Emergency Alert Message

3.7. Testing and Performance Evaluation

The developed Smart Safety Shoe system was tested under different operating conditions to evaluate its performance and reliability. Testing was carried out on each module individually as well as on the integrated system to ensure proper functioning of all components. The panic button response, GSM message transmission, buzzer activation, pulse sensor readings, and shock circuit operation were verified during the testing process. The response time of the system was observed to be satisfactory, as all modules were activated immediately after pressing the panic button. The testing process also ensured that the communication between the NodeMCU controller and connected devices was stable and accurate.

The GSM module successfully transmitted emergency alert messages to pre-registered contact numbers without significant delay. The buzzer generated a clear and audible sound that could attract the attention of nearby people during emergency situations. The pulse sensor was tested under normal and stressful conditions, and the readings were found to be consistent and reliable. The shock circuit functioned effectively as a self-defense mechanism and responded properly when activated. Based on the testing results, the system demonstrated reliable performance and was able to achieve the intended objectives of providing safety, communication, and emergency support for women.

3.8. Conclusion of Methodology

The research methodology successfully integrates embedded systems, wireless communication, wearable technology, and safety mechanisms into a single platform. The systematic approach followed during system design, hardware implementation, software

development, data processing, and testing ensured the successful development of the Smart Safety Shoe. The methodology provided a structured framework for evaluating the effectiveness of the proposed system and identifying areas for improvement. The developed system demonstrated efficient operation and reliable performance during testing. The integration of the GSM module, pulse sensor, buzzer, shock circuit, and NodeMCU controller enabled the system to perform multiple safety functions simultaneously. The methodology confirmed that the proposed design is practical, cost-effective, and suitable for real-world applications. The results obtained through implementation validate the effectiveness of the proposed approach in enhancing women's safety through wearable technology.

4. RESULTS AND DISCUSSION

The proposed NodeMCU-Enabled Smart Safety Shoe was successfully designed, implemented, and tested to evaluate its effectiveness in providing safety and emergency assistance. The system integrates multiple features including GSM-based alert communication, buzzer notification, pulse monitoring, and a shock-based self-defense mechanism. During testing, the system responded immediately whenever the panic button was pressed. The NodeMCU controller successfully coordinated the operation of all connected components, demonstrating proper synchronization between hardware and software modules.

The GSM module effectively transmitted emergency messages to the pre-registered contacts, ensuring that information regarding the emergency situation could be communicated without delay. The buzzer generated a loud sound capable of attracting the attention of people nearby, thereby increasing the possibility of receiving immediate assistance. The shock circuit operated as intended and provided a defensive response that could help the user escape from dangerous situations. The pulse sensor continuously monitored the user's heart rate and produced stable readings under different operating conditions. The monitoring feature can be useful in assessing the physical condition of the user during stressful situations.

The overall system was found to be lightweight, compact, and easy to operate. The placement of the panic button on the side of the shoe allows quick activation during emergencies without requiring complex actions from the user. Compared with many existing safety solutions that depend entirely on smartphones, the proposed system offers a more practical and direct approach to emergency response. However, certain limitations were observed, such as dependence on GSM network availability and battery capacity. Despite these limitations, the results indicate that the proposed Smart Safety Shoe provides an effective, affordable, and reliable solution for enhancing women's safety in real-life situations.

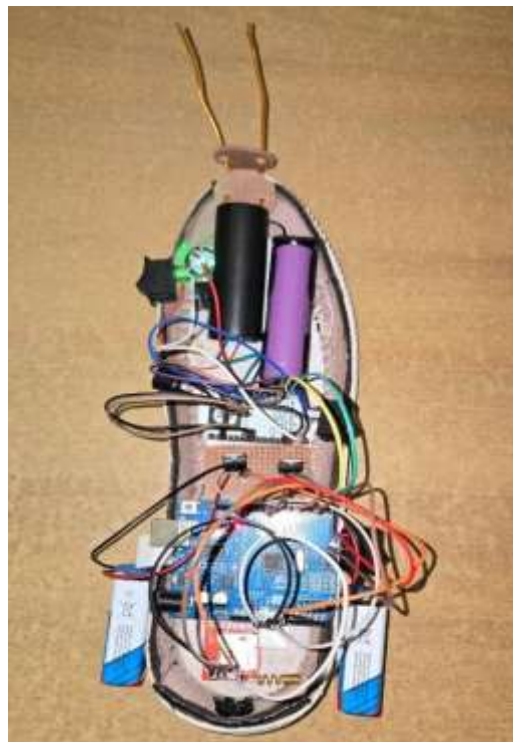


Fig 5: Women Safety Shoe

5. FUTURE SCOPE

The proposed Smart Safety Shoe can be further improved by integrating advanced technologies and additional safety features. One possible enhancement is the inclusion of a GPS module for real-time location tracking. This feature would allow emergency contacts and authorities to identify the exact location of the user during critical situations, thereby improving rescue and response time. The system can also be enhanced by incorporating a camera module capable of capturing images or video evidence during emergencies. Future versions of the system may include voice recognition and voice activation features that allow hands-free operation. Such functionality would enable users to activate the system through voice commands when physical access to the panic button is difficult. Additionally, improvements in battery technology and power management can increase operating time and overall system reliability. The integration of mobile applications and cloud-based monitoring systems can further enhance communication and data management capabilities.

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