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Wearable Current Leakage Detection by Using GPS and GSM Module

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Abstract: *Current leakage in electrical systems poses serious safety hazards, including electric shocks, equipment damage, and fire risks. This research presents a wearable device designed for real-time current leakage detection using GPS and GSM modules. The device continuously monitors electrical current and immediately alerts the user via GSM communication if leakage is detected, while providing the exact location using GPS. The wearable nature of the device ensures mobility, allowing users to receive alerts wherever they are. Experimental results indicate that the proposed system can effectively detect leakage currents and ensure rapid response, enhancing personal and workplace safety. The system is designed to be cost-effective, low-power, and reliable for continuous monitoring in various environments*

Keywords: *Current leakage*

I. INTRODUCTION

Electrical safety is a critical concern in residential, commercial, and industrial environments. Electrical accidents caused by current leakage can result in severe injuries, fatalities, and property damage. Traditional stationary current leakage detection devices, such as Residual Current Devices (RCDs) or ground fault circuit interrupters (GFCIs), provide safety but are limited in mobility and immediate notification capabilities.

Wearable technology offers an innovative solution, allowing real-time monitoring and mobile alerts for the user. The integration of sensors, GPS, and GSM modules into a wearable device enables continuous monitoring of electrical current and instant alerts in case of leakage. The system can notify the user and nearby monitoring personnel, providing a proactive approach to safety and emergency management. By adopting wearable current leakage detection systems, workplaces and households can significantly reduce the risk of electrical hazards.

II. LITERATURE REVIEW

Several studies have focused on current leakage detection methods and electrical safety. Traditional methods rely on stationary sensors and circuit protection devices. RCDs detect leakage currents by monitoring the difference between live and neutral wires and trip the circuit when the current exceeds a predefined limit. While effective, these devices cannot notify users on the go and are limited to fixed locations.

Recent advancements in wearable electronics have introduced mobile monitoring solutions. Wearable devices with current sensors allow real-time monitoring of electrical parameters. GSM modules are commonly used in remote alert systems, while GPS modules provide location tracking. Studies have shown that combining these technologies can provide location-based alerts, which is crucial for rapid intervention in electrical emergencies.

Other research highlights the importance of integrating low-power microcontrollers and energy-efficient sensors to ensure continuous operation without frequent battery replacement. Furthermore, wearable electrical safety devices can also collect historical data on electrical faults, contributing to predictive maintenance and risk assessment.

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III. PROPOSED METHODOLOGY

The proposed wearable device consists of three main components: a current sensor, a GPS module, and a GSM module, integrated through a microcontroller. The current sensor continuously monitors electrical current flowing through the circuit. When the current exceeds a safety threshold, indicating leakage, the system triggers an alert.

The GPS module captures the exact location of the wearer, while the GSM module sends a detailed SMS alert to the user and designated monitoring centers. This ensures that the user is immediately informed and appropriate safety measures can be taken. The wearable device operates in real-time and is designed to minimize false positives through threshold calibration and sensor filtering.

The methodology also includes power optimization techniques. The microcontroller manages power consumption by activating the GPS and GSM modules only when a leakage is detected. This approach extends battery life and ensures the device remains operational during long monitoring periods.

System Design and Implementation

Hardware Components

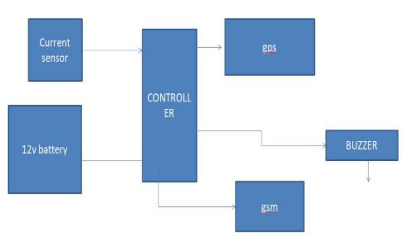
Current Sensor: Measures leakage current continuously with high sensitivity.
Microcontroller: Processes sensor data, applies filters, and controls communication modules.
GPS Module: Determines the wearer's precise geographic location.
GSM Module: Sends alert messages with location details to mobile phones or monitoring stations.
Wearable Interface: Lightweight and ergonomic design ensures comfort and ease of use.

Software Flow

System initialization and sensor calibration.
Continuous monitoring of electrical current.
Comparison of measured current against the predefined leakage threshold.
If leakage is detected:
Capture GPS coordinates.
Send an alert SMS via GSM module.
Log the event for historical analysis.
Return to continuous monitoring mode.

System Features

The system is designed with modularity in mind, allowing easy replacement of components and firmware updates. It also features LED indicators and audio alarms for immediate local awareness. Data logging allows for post-incident analysis, enabling users to identify frequently affected circuits and take preventive measures.



IV. RESULTS AND DISCUSSION

The proposed wearable device was tested in controlled environments simulating various current leakage scenarios. The device successfully detected leakage currents exceeding the set threshold and transmitted alerts accurately. GPS

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coordinates were precise, allowing rapid response and intervention. The GSM alerts were delivered within seconds, demonstrating the system's efficiency in real-time monitoring.

Advantages of the wearable system include mobility, real-time alerts, and precise location tracking. Additionally, the device's compact design allows for comfortable, continuous wear without hindering daily activities. Limitations observed during testing include dependence on GSM network coverage and potential delays in GPS signal acquisition in indoor environments. Future iterations can include alternative communication protocols, such as LoRa or NB-IoT, to improve coverage and reliability.

The system's data logging capabilities also provide valuable insights for preventive maintenance. By analyzing recorded events, users can identify patterns in electrical leakage and take proactive measures, further enhancing safety and reducing long-term risks.

V. CONCLUSION

This research presents a wearable current leakage detection system integrating GPS and GSM modules to provide mobile, real-time safety monitoring. The device effectively detects leakage currents, alerts users immediately, and provides precise location information for quick intervention. The system enhances personal and workplace safety by offering mobility, continuous monitoring, and reliable alert mechanisms.

Future work can focus on improving battery life, integrating additional environmental sensors, and implementing IoT connectivity for centralized monitoring and analytics. The wearable system has the potential to become a standard personal safety device for electrical workers and households, significantly reducing the risk of electrical hazards.

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