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IoT-Based Smart Emergency Alert System with Live Location Tracking for Ambulance Response

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ABSTRACT: Road accidents remain one of the major causes of fatalities worldwide, not only due to the severity of collisions but also because of delays in emergency medical assistance. In many cases, victims are unable to report accidents manually, leading to critical loss of time before medical help arrives. To address this issue, this paper presents an IoT-Based Smart Emergency Alert System with Live Location Tracking for Ambulance Response, designed to automatically detect accidents and instantly notify emergency services without human intervention.

The proposed system uses an ESP8266 microcontroller integrated with an MPU6050 accelerometer and gyroscope to continuously monitor vehicle motion. Sudden impacts, abnormal tilts, or extreme acceleration patterns are analyzed to identify accident conditions. Once an accident is detected, the system immediately retrieves real-time GPS coordinates and transmits an emergency alert via GSM to predefined contacts and nearby ambulance services. Additionally, a Wi-Fi RSSI-based mechanism is employed to identify the nearest ambulance, ensuring faster response. On the ambulance side, received alerts and location details are displayed on an I2C LCD for quick navigation. Experimental results demonstrate reliable accident detection, accurate location tracking, and rapid alert delivery. The system significantly reduces emergency response time and enhances the effectiveness of rescue operations. Due to its low cost, scalability, and real-time performance, the proposed solution is suitable for deployment in private vehicles, public transport systems, and smart city emergency frameworks.

KEYWORDS: IoT, Accident Detection, GPS, GSM, ESP8266, Ambulance Response, RSSI.

I. INTRODUCTION

Road traffic accidents pose a serious threat to public safety, particularly in developing countries where traffic density is high and emergency response infrastructure is limited. Although vehicle safety technologies have improved, many accident-related deaths still occur due to delayed medical intervention rather than the accident itself. In several situations, victims may be unconscious or trapped, making it impossible to manually contact emergency services.

Conventional accident reporting systems depend heavily on witnesses or manual phone calls, which are time-consuming and prone to errors in communicating location details. This delay is especially critical on highways, rural roads, or isolated regions where immediate assistance is essential. Hence, there is a strong need for an automated system capable of detecting accidents instantly and sharing precise location information with emergency responders.

Recent advancements in Internet of Things (IoT), embedded systems, and wireless communication have enabled the development of intelligent safety solutions. By integrating sensors, microcontrollers, GPS, and GSM modules, real-time accident detection and alert systems can be achieved with minimal human involvement. This paper proposes an IoT-based smart emergency alert system that not only detects accidents but also identifies the nearest ambulance using RSSI-based proximity sensing, thereby minimizing response time and improving survival rates.

II. RELATED WORK

Usman Khalil, Adnan Nasir, S. M. Khan, T. Javid, S. A. Raza, and A. Siddiqui presented a work titled “Automatic Road Accident Detection Using Ultrasonic Sensor” in the IEEE 21st International Multi-Topic Conference (INMIC), 2018. The authors identified that inefficient ambulance routing and delayed emergency response significantly increase



the risk to accident victims. To overcome this issue, they proposed an automated accident detection system using ultrasonic sensors and a microcontroller to identify collisions. Once an accident is detected, alert messages are transmitted using GSM technology. The system demonstrated reliable collision detection under various conditions through MATLAB simulations and promptly alerted emergency services. However, the use of ultrasonic sensors limits detection range, and incorrect sensor placement may result in missed detections. The authors suggested real-world implementation and accuracy improvement as future work. [1].

Sasi Kumar, Soumyalatha, and Shruti G. Hegde proposed an “IoT Approach to Save Life Using GPS for the Traveller During Accident” in the IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI), 2017. The study focused on the delay in automated accident detection and alerting, which increases fatality risks. The proposed system uses IoT-based tilt, vibration, and distance sensors along with GPS for location tracking and automatic alert generation. The system successfully detects accidents and sends immediate alerts with precise location information while also storing accident data for future analysis. However, the system lacks intelligent decision-making to reduce false alarms. Future improvements include enhancing sensor accuracy and integrating smarter algorithms. [2].

Dimitrios Zavantis, Ansar Yasar, and Lumbarda Hasim presented a study titled “Automatic Accident Detection Using IoT Compared to Traditional Systems” at the International Conference on Emerging Ubiquitous Systems and Pervasive Networks in 2016. The authors highlighted that traditional accident detection systems lack real-time data transmission, accurate location tracking, and automated alert mechanisms. Their IoT-based solution uses accelerometer sensors, GPS, and GSM modules to detect accidents and transmit location data to emergency services. The system demonstrated real-time accident detection and improved response time, enhancing victim assistance. However, performance may be affected by GPS or GSM signal loss, sensor inaccuracies, and network delays. The authors suggested direct ambulance communication to further improve system efficiency. [3].

P. Rajesh, K. Divya, and S. Harika proposed an “IoT-Based Accident Detection and Alert System Using GPS and GSM Modules” in the International Conference on Smart Computing and Communications (ICSCC), 2015. The study addressed the issue of delayed accident detection and manual alerting to hospitals or relatives, which often leads to increased fatalities. The proposed system uses an Arduino UNO along with vibration sensors, GPS, and GSM modules to detect vehicle collisions and send location-based SMS alerts. The system successfully transmitted alerts with coordinates within seconds of accident detection, reducing manual reporting time. However, vibration sensors may generate false alerts due to minor shocks or road irregularities. Future work includes improving detection accuracy using multiple sensor fusion techniques. [4].

K. Meghana et al. proposed an accident detection system using an accelerometer and GPS module interfaced with an Arduino controller. The system detects sudden changes in acceleration and sends alert messages containing location details via GSM. Although the system successfully identifies accidents, it relies on fixed threshold values, which may lead to false alerts during sudden braking or road bumps [5].

S. S. Pooja et al. developed a smart vehicle accident monitoring system using vibration sensors and GPS tracking. When an accident is detected, an alert message is sent to emergency contacts. However, the system lacks intelligent filtering techniques to differentiate between minor vibrations and severe accidents, which affects reliability in real-time scenarios [6].

R. Kumar et al. presented an IoT-based accident detection system using ESP8266 and cloud integration. Sensor data was transmitted to an online platform for monitoring and alert generation. While this approach improves remote accessibility, continuous internet dependency makes the system unsuitable for rural or low-network areas [7].

A. Prakash et al. proposed a GSM and GPS-based emergency alert system for vehicle safety. The system automatically sends the accident location to hospitals and police stations. However, it does not include any mechanism to identify or prioritize the nearest ambulance, which may increase response time during emergencies [8].

M. R. Patel et al. introduced an accident detection and ambulance alert system using accelerometer and gyroscope sensors. The system improves detection accuracy by combining multiple motion parameters. Still, the authors highlight challenges related to power consumption and real-time communication reliability [9].

The research papers studied highlight the importance of automated and intelligent systems for accident detection and emergency response. Most of the existing systems use IoT technologies, sensors such as accelerometers and vibration



sensors, along with GPS and GSM modules to detect accidents and transmit real-time location information. These approaches significantly reduce the dependency on manual reporting and help in faster emergency notification. However, common challenges identified from the literature include false accident detection, limited processing capability of controllers, unreliable communication due to network issues, and lack of nearest ambulance identification. From the study, it is observed that system performance can be improved by using sensor fusion techniques, optimizing communication methods, incorporating intelligent decision-making algorithms, and enabling direct ambulance coordination. Integrating real-time location tracking with smart ambulance selection can further reduce response time and improve the chances of saving lives.

III. PROPOSED METHODOLOGY

The proposed system consists of two main units: the Vehicle Subsystem and the Ambulance Subsystem. The vehicle unit continuously monitors motion parameters using an MPU6050 accelerometer and gyroscope connected to the ESP8266 microcontroller. Threshold-based algorithms analyze sudden acceleration changes, abnormal tilting, or impact forces to detect accidents accurately.

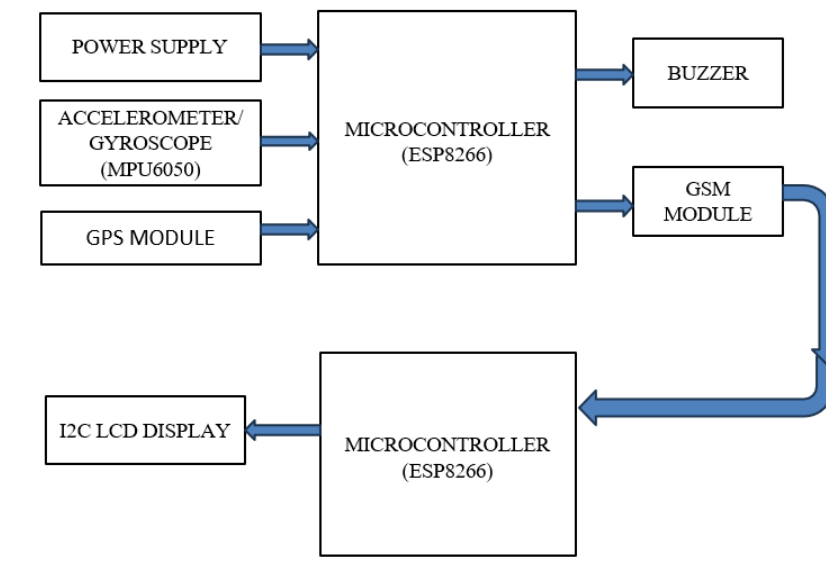


Fig .1: Block Diagram

Once an accident is confirmed, the system activates a buzzer for local alert and retrieves real-time latitude and longitude from the GPS module. These details are transmitted via the GSM module as an SMS alert to predefined emergency contacts and nearby ambulance services. Simultaneously, the ESP8266 performs Wi-Fi scanning and evaluates RSSI values to identify the nearest ambulance, ensuring priority notification.

The ambulance subsystem receives the alert and displays the accident information and GPS coordinates on an I2C LCD screen. This enables ambulance personnel to quickly locate the accident site and initiate immediate rescue operations. The overall architecture ensures fast detection, automated alerting, and efficient ambulance dispatch.

IV. HARDWARE DESCRIPTION

ESP8266 NodeMCU Microcontroller

The ESP8266 NodeMCU is a low-cost microcontroller widely used in Internet of Things (IoT) applications. It integrates a powerful processor with built-in Wi-Fi capability, making it suitable for real-time data communication. In the proposed system, the ESP8266 acts as the main control unit that collects data from various sensors, processes the information, and makes decisions based on predefined conditions. It continuously monitors sensor values to detect accident situations and controls the transmission of alerts through GSM and GPS modules. The NodeMCU also supports serial communication and multiple GPIO pins, which makes it easy to interface with sensors, displays, and



|| Volume 14, Issue 12, December 2025 ||

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communication modules. Due to its low power consumption, compact size, and wireless connectivity, the ESP8266 is well suited for smart emergency alert systems.



Fig .2: ESP8266 NodeMCU Microcontroller

I2C LCD Display Module

The I2C LCD display module is used to show important system information in a clear and readable format. It displays messages such as accident alerts, system status, and location-related details. The I2C interface reduces the number of connecting wires, making the circuit simpler and more reliable. In the proposed system, the LCD helps users and ambulance personnel quickly understand the alert information, ensuring faster response during emergencies.



Fig .3: LCD Display Module

LM2596 Buck Converter Module

The LM2596 Buck Converter Module is a voltage regulator used to step down higher voltage to a stable lower voltage suitable for electronic components. In the proposed system, it provides a consistent power supply to sensors, the ESP8266 microcontroller, and other modules, ensuring reliable operation. Its efficiency and compact design make it ideal for battery-powered IoT systems.



Fig .4: LM2596 Buck Converter Module



GSM800L Module

The GSM800L module is used for wireless communication to send SMS alerts in real-time. In the proposed system, it transmits accident notifications along with GPS coordinates to predefined emergency contacts and nearby ambulances. It communicates with the ESP8266 microcontroller via serial interface, enabling instant alerts even in areas without internet connectivity. Its small size and low power consumption make it suitable for portable IoT-based emergency systems.



Fig - 5: GSM800L Module

GPS Module

The NEO-6M GPS module provides accurate real-time location data, including latitude and longitude coordinates. In the proposed system, it helps track the exact position of the vehicle during an accident. This information is sent via the GSM module to emergency contacts and nearby ambulances, enabling faster response. The module is compact, easy to interface with the ESP8266, and supports continuous tracking for reliable location monitoring.

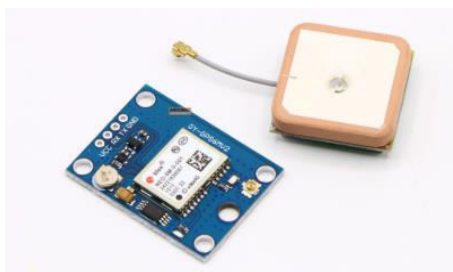


Fig - 6: GPS module

Li-Ion Batteries and Holders

Li-Ion batteries serve as the primary power source for the proposed system, providing a stable and rechargeable supply to the ESP8266, sensors, and communication modules. Battery holders securely mount the cells and ensure proper electrical connections. Using Li-Ion batteries allows the system to be portable, energy-efficient, and capable of continuous operation for extended periods, which is essential for reliable real-time accident detection and alerting.



Fig - 7 : Li-Ion Batteries and Holders



Jumper Wires

Jumper wires are used to connect different components of the system, such as sensors, modules, and the ESP8266 microcontroller, without soldering. They allow flexible and quick prototyping of the circuit. In the proposed system, jumper wires ensure reliable electrical connections, making it easy to assemble, modify, and troubleshoot the IoT-based emergency alert setup.



Fig .8: Jumper wires

V. SOFTWARE DESCRIPTION

Arduino IDE:

Arduino IDE is a software platform used for writing, compiling, and uploading programs to microcontrollers like the ESP8266 NodeMCU. In the proposed system, it is used to program the microcontroller to read sensor data, detect accidents, process GPS coordinates, and send SMS alerts via the GSM module. Arduino IDE provides a user-friendly interface, supports multiple libraries for sensors and communication modules, and allows easy debugging and real-time testing of the system.



Fig .9: Arduino IDE

VI. RESULTS

The developed prototype was tested under various motion conditions to evaluate the accuracy of accident detection and the reliability of alert generation. Sudden impacts, sharp deceleration, and abnormal tilting of the vehicle were successfully detected using the MPU6050 accelerometer and gyroscope sensor. The threshold-based detection logic minimized false triggers during normal driving conditions such as speed breakers and minor vibrations. Once an accident condition was confirmed, the system immediately activated the alert mechanism without requiring any manual intervention.

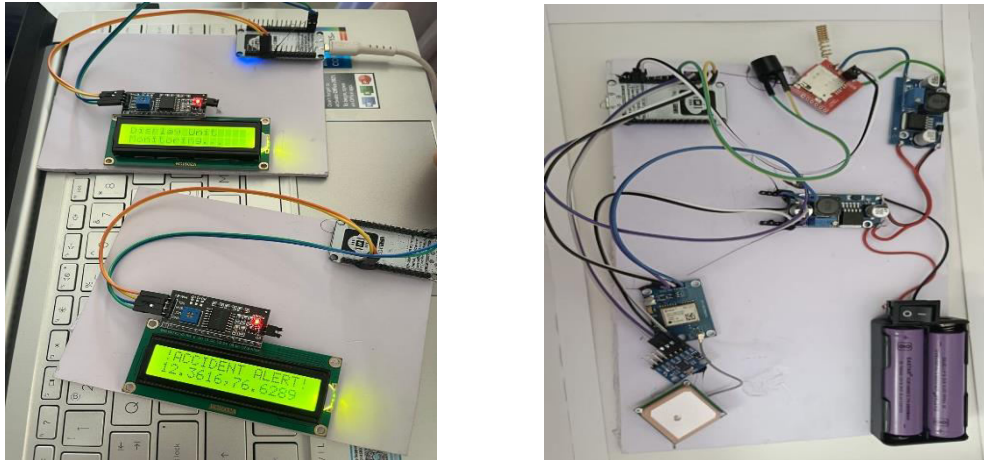


Fig .10: Vehicle Subsystem and Ambulance Subsystem of the Accident detection

After accident detection, the GPS module accurately retrieved the real-time latitude and longitude coordinates of the vehicle. These location details were transmitted through the GSM800L module as SMS alerts to predefined emergency contacts and ambulance units within a few seconds. The timely delivery of alerts demonstrates the effectiveness of GSM communication, even in situations where internet connectivity is unavailable. The integration of GPS and GSM ensured precise location tracking and fast dissemination of critical information, which is essential during emergency situations.

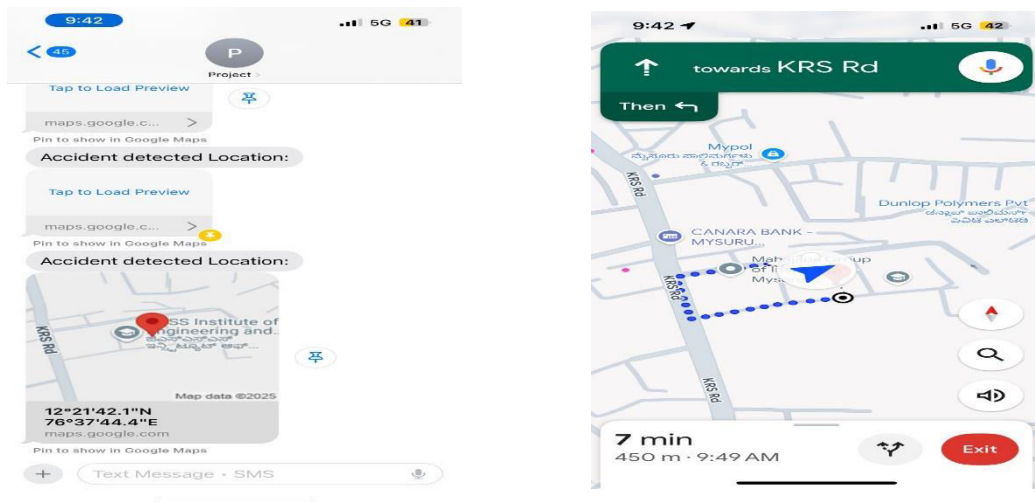


Fig .11: The results of the location after Accident detection

Additionally, the RSSI-based ambulance detection mechanism was tested to identify the nearest ambulance among multiple available Wi-Fi signals. The system successfully selected the ambulance with the strongest signal strength, ensuring quicker notification and reduced response time. On the ambulance side, alert messages and accident location details were clearly displayed on the I2C LCD display, allowing ambulance personnel to plan the fastest route to the accident site. Overall, the test results confirm that the proposed system improves emergency response efficiency, reduces communication delays, and enhances coordination between accident victims and emergency services.



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VII. CONCLUSION

This paper presented the design and implementation of an IoT-Based Smart Emergency Alert System with Live Location Tracking for Ambulance Response, aimed at reducing emergency response time during road accidents. The proposed system effectively automates accident detection using sensor-based motion analysis and immediately initiates alert generation without requiring human intervention. By integrating the ESP8266 microcontroller with MPU6050 sensors, GPS for precise location tracking, GSM for reliable communication, and RSSI-based ambulance identification, the system ensures that emergency alerts are delivered quickly and accurately to the nearest available ambulance and predefined contacts. The experimental results demonstrate reliable detection performance, fast alert transmission, and clear information display for emergency responders. Due to its low cost, compact design, scalability, and dependable operation, the system is well suited for real-world deployment in private vehicles, public transportation systems, and smart city safety infrastructures. Overall, the proposed solution shows strong potential to minimize accident-related fatalities, enhance emergency coordination, and contribute to improved road safety and intelligent transportation systems.

VIII. FUTURE WORK

The proposed IoT-based smart emergency alert system can be further enhanced in several ways to improve its functionality and reliability. One major improvement is the integration of cloud platforms for centralized data storage and monitoring, which would allow authorities to analyze accident patterns, track emergency response performance, and maintain historical records for future planning. Machine learning algorithms can be implemented to classify accident severity based on sensor data, enabling more accurate decision-making and prioritization of emergency services. Additionally, linking the system with smart traffic signal control can help automatically clear routes for ambulances, reducing travel time to the accident location. Future versions of the system can also include mobile applications for real-time monitoring, voice alerts, and hospital coordination. AI-based analytics and advanced sensor fusion techniques can further reduce false alarms, enhance detection accuracy, and support predictive emergency response planning, making the system more intelligent and suitable for large-scale smart city applications.

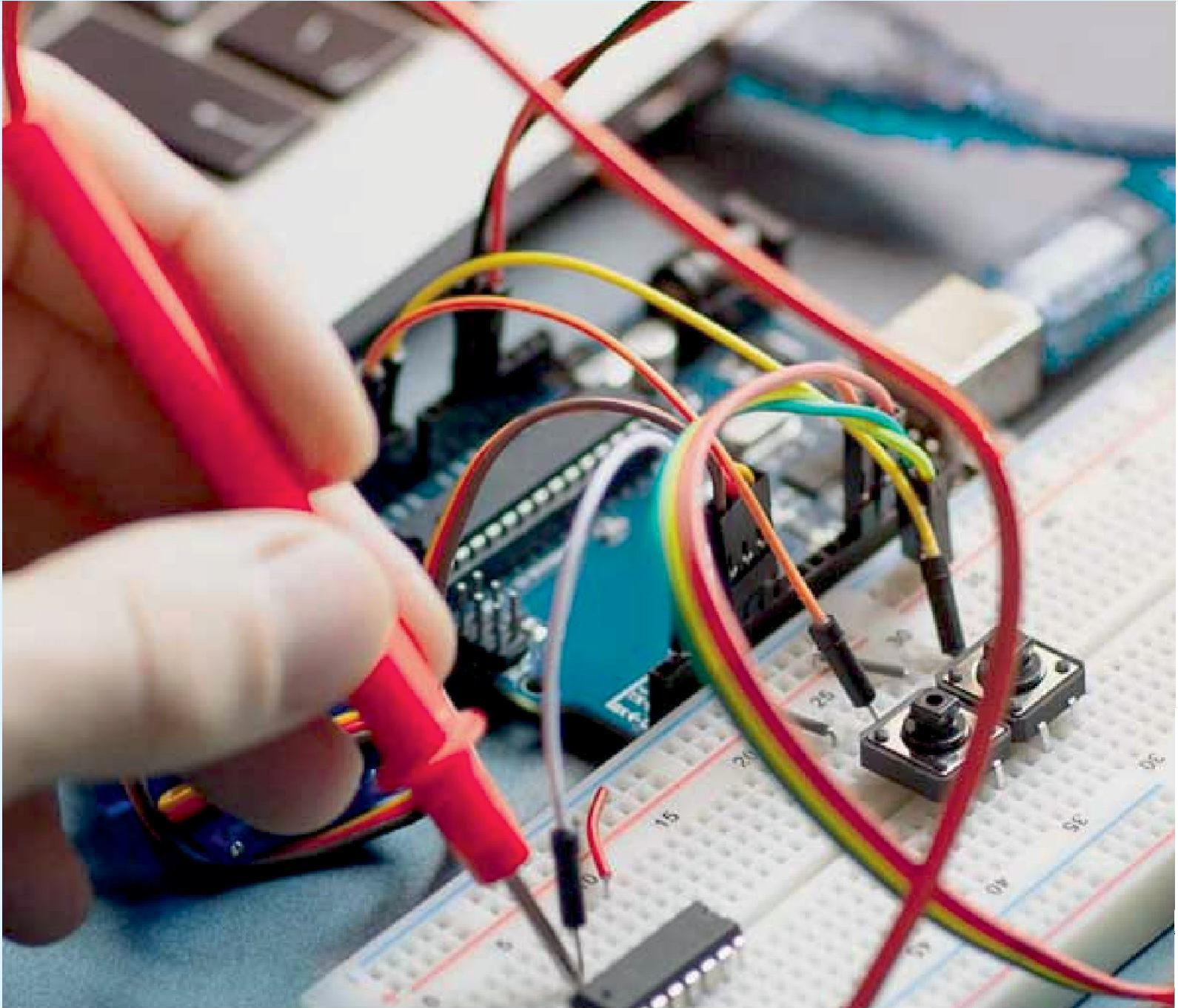
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