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REAL TIME VEHICLE TRACKING AND ACCIDENT ALERT SYSTEM USING DESIGNED GPS ANTENNA

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***Abstract*—**In this paper we propose a solution to reducing the likelihood of fatalities caused by overspeeding and improving safety measures to minimize deaths after an accident occurs. The system detects an overspeeding vehicle when it exceeds a set speed limit. In this system we designed GPS antenna which is micro strip patch antenna with a coaxial feed operating at GPS L1 frequency 1575 MHz. The antenna design and performance analysed using HFSS. Simulation results are expected to show improved gain, better directional radiation pattern and reduced multipath interference compared to conventional GPS antenna. This GPS antenna trace the location of vehicle in latitude and longitude. The attached accelerometer in vehicle senses the tilt of vehicle. When there is occurance of accident it sends the GPS location and message to the registered mobile number for accident alert and can be track the location of the vehicle.
Keywords: vehicle tracking, accident detection, GPS, GSM, Microstrip Patch Antenna, Arduino UNO, Accelerometer Sen-sor, Real-Time Monitoring, Emergency Alert System, Over-speed Detection.

I. INTRODUCTION

Nowadays the rate of accidents has increased rapidly. As the vehicles are increased more and due to traffic there is more chances of accidents. One of the main reason for causing accident is overspeed in the hurry of work. This cause effectively excess rate of accidents. Currently, speed guns are used to detect overspeeding by manually aiming them at moving vehicles, and the operator informs toll authorities if a violation is found. This process requires human effort and constant monitoring. To overcome this, the paper presents a tangible solution to reduce the possibility of deaths due to overspeeding. This system is designed to be installed in every vehicle, where it automatically monitors speed variations over a fixed period of time, eliminating the need for manual intervention and making the process more efficient. The main objective is to control the accidents by sending a message to the registered mobile, using wireless communications tech-niques.

Developed an automated vehicle speed detection system aimed at reducing the reliance on manual speed monitoring by traffic authorities. The proposed system uses GPS module which calculates speed based on changes in position over time using satellite data. It directly provides real-time monitoring of vehicle position using Arduino UNO. The system calculates speed, displays it on an LCD. Additionally, it wirelessly transmits speed data to the registered number through the GSM module. This approach emphasizes centralized mon-itoring and wireless data communication, contrasting with traditional handheld speed guns that require manual operation, thereby reducing manpower requirements and enhancing real-time monitoring capabilities. While innovative, this increases system complexity and is less suited for low-resource contexts.

II. LITERATURE SURVEY

Several researchers have developed systems for vehicle tracking and accident detection using GPS and GSM tech-nologies. These systems aim to reduce accident response time and improve road safety.

Ajith Kumar et al. [1] proposed an accident detection system using GPS and GSM modules along with an accelerometer sensor. The system detects sudden impacts and sends location details to

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emergency contacts via SMS. Their work highlights the importance of automatic alert systems in reducing fatali-ties.

ArunVarshan et al. [2] developed a vehicle tracking system that continuously monitors speed using GPS data. The system detects accidents based on sudden speed variations and trans-mits alerts using GSM technology. This approach emphasizes the role of speed monitoring in accident prevention.

Al-Balushi [3] introduced an automatic tracking and acci-dent detection system that sends a Google Maps link of the accident location. This improves the accuracy and usability of location tracking for emergency services.

Vincent Antony Raj [4] designed a system for automatic accident detection and vehicle localization using GPS and GSM. The study focuses on minimizing human intervention and ensuring faster communication during emergencies.

Dangat et al. [5] proposed a system using vibration sensors along with GSM and GPS modules to detect accidents and send immediate alerts. Their work demonstrates the effective-ness of integrating sensors with communication technologies.

Recent studies [6] highlight the importance of real-time tracking and quick response systems in reducing post-accident fatalities. These systems focus on improving accuracy, relia-bility, and response time.

III. OBJECTIVES

A. The system is designed to provide real-time vehicle track-ing by continuously monitoring and displaying the vehicle's current location using GPS technology.

B. The system aims to detect and alert when the vehicle ex-ceeds a predefined speed limit, ensuring safer driving through timely speed notifications.

C. The system is developed to identify accident occurrences and automatically send the vehicle's GPS location to a pre-defined emergency contact number for immediate assistance.

IV. HARDWARE & SOFTWARE DESCRIPTION

A. Hardware Specifications

Component	Specifications
Microcontroller Board	Arduino Uno (ATmega328P), Operating Voltage: 5V, Input Voltage: 7–12V, 14 Digital Pins (6 PWM), 6 Analog Pins, Flash: 32 KB, Clock: 16 MHz, UART, I2C, SPI
GSM Module	SIM900, 3.4V–4.4V, Quad Band, UART, SMS/Call/GPRS
GPS Module	NEO-6M, 3–5V, Accuracy: ~2.5 m, UART TTL
LCD Display	16x2, 5V, Parallel Interface, HD44780
Power Supply	18650 Battery (3.7V, 2000–3000mAh), 9V Backup
Breadboard	400–830 tie points
Wires	Male-Male jumper wires
Power Interface	DC Jack, USB

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B. Software Specifications

Component	Specifications
Arduino IDE	Writing, compiling and upload-ing the code
Programming Language	Embedded C
Arduino Core	APIs for hardware interfacing
TinyGPS++	GPS data extraction (latitude, longitude)
GSM Communication	AT commands via UART
Proteus	Circuit simulation software
ANSYS HFSS	Antenna design and analysis
Operating System	Windows / Linux

V. METHODOLOGY

A. System Overview

The proposed system is designed to provide real-time vehicle tracking and accident alert functionality using GPS, GSM communication, an accelerometer sensor, and a designed rectangular patch antenna. The system continuously monitors vehicle movement and detects abnormal conditions such as sudden impacts or collisions.

The overall methodology consists of the following stages: Rectangular Patch Antenna Design Hardware Integration

Data Acquisition and Processing Accident Detection Mech-
anism Alert Transmission System

B. Rectangular Patch Antenna Design

A rectangular patch antenna is designed to operate at the GPS L1 frequency (1575 MHz) using electromagnetic simulation software.

The antenna is designed using ANSYS HFSS. A coaxial feed technique is used to excite the patch. Key design param-eters include: Patch length and width Substrate properties Feed position Performance Evaluation

The antenna performance is analyzed based on:

Return Loss (S) Voltage Standing Wave Ratio (VSWR) Gain Radiation Pattern Objective

The designed rectangular patch antenna aims to:

Enhance GPS signal reception Reduce multipath effects Provide stable and accurate positioning data

C. Hardware Architecture

The system hardware is centered around the Arduino Uno (ATmega328P) microcontroller.

Components and Interfacing GPS Module (NEO-6M): Pro-vides real-time latitude and longitude Connected via UART communication GSM Module (SIM900): Used for sending SMS alerts Controlled using AT commands via serial interface Accelerometer Sensor: Detects sudden motion, vibration, or tilt Used for accident detection LCD Display (16×2): Displays system status and location data Power Supply: 18650 Li-ion batteries provide primary power 9V battery used as backup

D. Software Implementation

The software is developed using the Arduino IDE with Embedded C.

Functional Modules GPS Data Processing The TinyGPS++ library is used to extract: Latitude Longitude Data is updated at regular intervals GSM Communication AT commands are used for: Sending SMS alerts Network communication Sensor Mon-itoring Accelerometer values are

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continuously read Threshold values are defined for abnormal conditions Display Interface LCD displays real-time vehicle status and coordinates

E. Accident Detection Algorithm

The system uses a sensor fusion approach combining ac-celerometer and GPS data.

Procedure Continuously read accelerometer values (X, Y, Z axes)

Compute total acceleration:

A=X2+Y2+Z2

Compare with predefined threshold value If threshold is exceeded: Detect as potential accident Optionally validate using GPS-based speed drop

F. Alert and Notification Mechanism

When an accident is detected:

GPS coordinates are obtained A predefined alert message is generated GSM module sends SMS to emergency contacts Alert Format Example

"Accident detected! Vehicle location: Latitude XX.XXXX, Longitude YY.YYYY"

G. Real-Time Tracking

The GPS module continuously tracks vehicle position Lo-cation data is: Displayed on LCD Optionally transmitted via GSM

H. System Workflow

System initialization GPS signal acquisition Continuous accelerometer monitoring Detection of abnormal motion Ac-cident confirmation Sending alert message with location Dis-playing status on LCD

I. Circuit Design and Validation

The system is designed and tested using Proteus simulation software Ensures: Correct connections Functional validation before implementation

J. Advantages of the Proposed System

Real-time accident detection Accurate tracking using de-signed rectangular patch antenna Quick emergency response through GSM alerts Low-cost and efficient implementation Scalable for real-world applications

VI. RESULTS AND DISCUSSION

The proposed vehicle tracking and accident detection sys-tem was implemented and evaluated to analyze its performance in terms of antenna characteristics, detection accuracy, and communication reliability.

Antenna Performance Analysis

The rectangular patch antenna designed for the GPS L1 frequency (1575 MHz) was simulated using ANSYS HFSS. The antenna exhibited a return loss (S) of 18.6 dB at 1575 MHz, indicating effective impedance matching. The VSWR was measured to be 1.28, which is within the acceptable range for efficient operation.

The antenna achieved a gain of approximately 3.2 dBi, suitable for GPS signal reception. The radiation pattern was found to be stable and directional, minimizing multipath interference.

These results confirm that the proposed antenna design en-hances GPS signal quality and improves positioning accuracy compared to standard antennas.

A. System Integration and Functional Performance

All hardware components were successfully integrated with the Arduino Uno microcontroller. The GPS module (NEO-6M) provided location updates with an average accuracy of ±3–5 meters under open-sky conditions. The GSM module (SIM900) demonstrated reliable communication, with SMS delivery times ranging between 5–10 seconds.

The accelerometer sensor continuously monitored motion parameters and transmitted real-time data to the microcon-troller. The LCD interface displayed system status and coor-dinates without noticeable delay.

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B. Accident Detection Evaluation

The accident detection algorithm was tested under various simulated conditions involving sudden impacts and abrupt stops. A threshold acceleration value of 2.5g was selected based on experimental tuning.

The system achieved a detection accuracy of approximately

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These results indicate that the sensor fusion approach effec-tively enhances accident detection performance.

C. Alert Transmission Performance

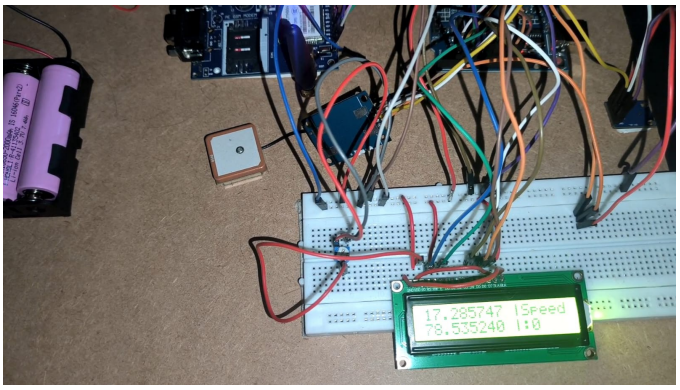
Upon detecting an accident, the system generated an alert message containing GPS coordinates and transmitted it via the GSM network. The success rate of message delivery was observed to be above 95

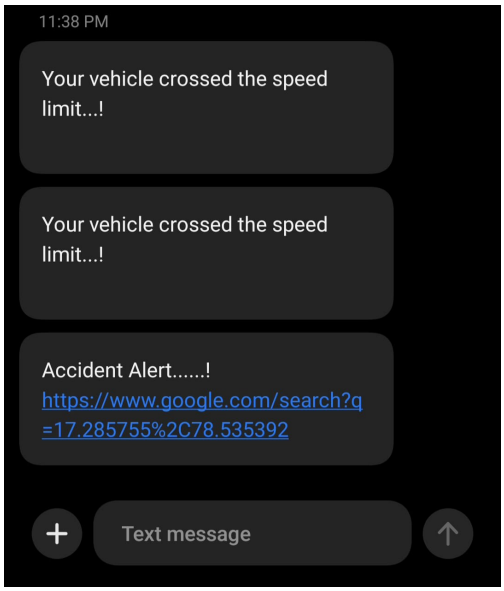
However, delays or failures were observed in low-signal regions, highlighting the dependency on GSM network avail-ability.

D. Real-Time Tracking Analysis

The system demonstrated continuous real-time tracking capability with periodic location updates every 1 second. The integration of the designed antenna ensured consistent GPS signal acquisition, even in moderately obstructed environ-ments.

The tracking data was accurately displayed on the LCD and could be transmitted when required, confirming the system's reliability for real-time applications.





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E. Discussion

The overall system performance validates the effectiveness of the proposed design in achieving real-time vehicle tracking and accident detection. The custom rectangular patch antenna significantly improves GPS reception, while the combination of accelerometer and GPS data enhances detection accuracy.

Despite these advantages, the system has certain limitations, including dependence on GSM network coverage and reduced GPS performance in obstructed environments such as tunnels or urban canyons.

Future enhancements may include the use of IoT-based communication technologies and advanced data analysis tech-niques to further improve system robustness and scalability.

VII. CONCLUSION

The system successfully integrates GPS, GSM, and sensor technology to provide a reliable vehicle tracking and accident alert solution. The inclusion of a microstrip patch antenna im-proves accuracy and efficiency. This system can significantly reduce fatalities by ensuring timely medical assistance.

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