A Study on Live Accident Detection and Instantaneous Ambulance Dispatch

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Abstract:
During the accident, people can lose their lives due to the delayed medical services and the ambulance stuck in traffic. It is important to provide immediate on-scene care. A study on detects the accident and immediately calls the ambulance. After the accident, some life cannot be saved due to the lack of information. The system becomes active once an accident occurs, initializing immediate care by contacting the ambulance on behalf of the individuals involved. Stores details of the individual. These details like annual blood group, health issues, and personal insurance policy, etc. are stored on the blocks of the e-SIM card. Once an accident is detected by the system, a predefined message is sent to the nearest hospital along with the person's details. Additionally, provides the location of the accident. In compliance with new governmental regulations to ensure citizen safety, car manufacturers have begun to implement e-call systems in vehicles. E-call is a new safety system in vehicles that uses GSM and GPS technology. A study of this technology signals the emergency services or the mobile phone of the driver of the vehicle accident location. But the major automotive manufacturers do not implement all vehicles yet. The vehicle accident rate in a developing country like India is very high compared to other countries. In a study of system, a study has been designed to develop an e-call system as an additional safety system in vehicles that are not equipped with e-call.

Keywords:
Ambulance, Accident Detection, GSM & GPS, Sensor, Dispatch, Accelerometer, Gyroscope

1. Introduction

Road traffic accidents have been on the rise over the last few decades across the world. There are a few popular systems to report an accident these days, ***such as SOS apps (Save our Souls) and accident detection and messaging systems***. Although SOS apps have simplified reporting an accident nowadays, the main difficulty is the kind of inputs expected while sending a message. This could sometimes lead to incorrect inputs, which would further delay the dispatch of emergency services. Moreover, it is an additional task in a panicked situation. Accident detection and messaging systems are usually installed in vehicles to detect any accident and send an SOS message to emergency services automatically. These studies of systems are usually costly and cannot be quite affordable across the world. We present a system to help report accidents with minimal human interference, which would aid in easy and faster ambulance dispatch. A study of this system helps detect accidents and dispatches an ambulance automatically as soon as an accident is detected [1].

Road accidents are a major safety concern globally. To put this into perspective, estimates suggest that more than 1.2 million individuals become casualties of accidents annually. It is a sad situation since most of these fatalities and severe injuries could have been avoided had medical attention reached in time [8].

Conventional emergency medical services rely solely on human eyewitnesses for reporting accidents and then dispatching the nearest ambulance. It is intuitive that such services are inefficient and cause severe delays in the arrival of medical attention, thereby greatly affecting the outcomes. Delays can be further aggravating when accidents occur on highways, late at night, and/or in remote areas. It is observed that with every passing minute of delay in medical attention, there is a 3% rise in mortality, a 6% rise in the need for lifelong support, and a 7% spike in the need for chronic care [5,8].

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Preventing road accidents is the best solution to the issue, but there are no complete solutions available today. Possible ways to lessen the impact of such accidents are to reduce the time required to detect an accident and rush an ambulance to the accident scene as quickly as possible. Noting this, many researchers have been conducted that aim to detect road traffic accidents. However, most of the existing accident detection systems are in-car services that passively collect sensor data, most notably accelerometer and gyroscope information, and then perform accident detection after an accident has occurred [5]. In this work, we study a system that is independent of cars altogether. Prompt detection allows instantaneous ambulance dispatch, which in turn has a salient effect on the reduction of post-accident casualties and on the deceleration of the cost due to such accidents.

2. Methodology

2.1 Sensor And Iot Based

2.1.1. Sensor Integration In Vehicles:

2.1.1.1.AccelerometerandGyroscope (detecting effect and speed):

An accelerometer and gyroscope work together to detect live accidents by constantly monitoring the movement and orientation of a vehicle. The accelerometer measures a sudden change in speed, while the gyroscope tracks the angular speed. In the event of an accident, the accelerometer detects a sudden decrease in velocity (Ex- a sudden restriction from 60 km/h within milliseconds), indicating a possible collision. In addition, gyroscope records unusual rotation or tilt, such as rollover or an extreme angle change [1]. If both sensors detect significant impact forces and unusual movements beyond predetermined threshold, the system confirms an accident and automatically triggers an emergency warning. This data is then sent to a connected microcontroller or cloud platform, which processes information and informs the nearest ambulance service with a real -time location of the vehicle. The integration of these sensors ensures high accuracy in detecting accidents, reducing false alarms from slight road bumps or sudden braking [2].

Example: If the car going at 60 km/h suddenly comes to a stop within the millisecond, the accelerometer detects a high negative acceleration, indicating a possible bump.

2.1.1.2. GPS Module (Location Tracking):

A GPS module plays an important role in detecting a live accident by continuously tracking the real -time space and movement of a vehicle. The module receives signs from several satellites to determine the exact latitude, longitude, and speed of the vehicle. During normal operations, GPS updates the situation at regular intervals, but when an accident occurs, detected by the accelerometer and gyroscope, the system records the final known location before immediate effect [4]. If the vehicle suddenly comes under stop or unexpectedly distracts from its way without any logical reason, GPS helps to confirm an accident. The system automatically sends the bring together of the accident to emergency services, allowing the ambulance to reach the proper accident site without any late. on the other hand, if the vehicle continues to move after detection of a vehicle [6]. By collecting GPS data with other sensor, the system give quick and accurate emergency response, reduces rescue time and increase chances for survival.

Example: After an accident is detected, the GPS module automatically sends latitude and longitude to the nearest ambulance service.

2.1.1.3. Vibrations:

The vibration and pressure sensors play an important role in detection of live accident by measuring the intensity of the effect during the collision. These sensors detect sudden minute activity in the vehicle's body, helping to difference between minor bumps and serious accidents. When an accident occurs, a high-effect collision causes strong vibrations, which exceeds a predetermined range, trigger an alert. In addition, pressure sensors measure various vehicle components, such as airbags or chassis to determine the severity of the accident. If the two sensors detect a high-effect force within the millisecond, the system confirms a serious accident. This data is then sent to the microcontroller, which processes information and if necessary, triggers an automatic emergency alert for nearby ambulance services [2]. By analysing a change in real -time vibration and pressure, the system detects an accurate accident, reducing the false alarm caused by small pits or sudden braking.

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Example: A small collision in traffic cannot produce enough vibration, but a collision on one head will have a sharp spike in sensor reading.

2.1.1.4. Temperature Sensor (Fire and overheating detection)

Temperature sensors play an important role in detecting live accidents by monitoring the heat levels in the vehicle for identification of potential fire hazards or overheating caused by accidents. Under normal conditions, these sensors track the temperature of the engine and the vehicle, ensuring they are in safe condition. However, at the time of an accident, a crash may lead to fuel leaks, short circuit in vehicle or engine develop a fault, which show the sudden increase in a heat. If the sensor detects an unusual point in the heat beyond the set range (e.g., above 200 ° C), it shows the risk of fire or heat. This information is immediately processed by the system, which then includes fire alert in an accident report sent to emergency services [6]. By integrating the temperature sensor with the accelerometer, gyroscope and vibration sensors, the system provides a more comprehensive evaluation of the severity of the accident, ensuring that the rescue teams are well prepared to handle the potential fire -related emergency conditions.

Example: If an accident engine temperature causes rising above 200 ° C, an additional fire warning is sent to emergency respondents.

2.1.1.5. Microcontroller (Esp32, Raspberry Pie, Or Arduino):

Microcontroller, such as ESP32, Raspberry Pie, or Arduino, serves as the central processing unit of the IOT-based accident detection system. It acts as a brain by collecting real -time data from various sensors, including accelerometer, gyroscope, GPS module, vibration sensor and temperature sensors. Once the data is obtained, the microcontroller processes and analyses to detect abnormal changes in vehicle speed, effect force or temperature, indicating an accident. If a potential collision is detected, the microcontroller triggers the required response, such as sending emergency alert and transmitting location data on the cloud. Additionally, it communicates through Wi-Fi, Bluetooth, GSM, or 5G module with outer networks, ensuring real-time data transmission to emergency services [4,6]. Due to its low power consumption, high efficiency and rapid processing capabilities, the microcontroller plays an important role in detecting an accurate accident and ensuring a sharp emergency response.

2.1.2. Data Integration and Processing:

Data integration and processing phase is important to detect real -time accident, as it enables the system to analyse the vehicle movements and correct conflict. Microcontrollers, such as Arduino, Raspberry PI, or ESP32, serve as a central processing unit, collect data from various sensors, including continuous accelerometer, gyroscopes, GPS modules, vibration sensors and temperature sensors. These microcontrollers monitor major parameters such as real -time speed, acceleration, effect force and temperature changes. If the system detects a sudden change in velocity (such as sudden recession due to accident) or a strong impact for force beyond a predetermined range, it considers a possible accident. The sensor data collected to determine the severity of the conflict is analysed [4]. If the system confirms a high-effect accident, it triggers an emergency warning, sends seriousness details to the accident location and emergency services. By ensuring uninterrupted data acquisition and real -time processing, the system increases accuracy, reduces false alarms, and enables immediate accident reaction [2].

2.1.3. Accident detection algorithm:

Accident detection algorithm depends on a limit-based approach to correctly identify the conflicts and reduce false alarms. The system continuously monitors acceleration, vibration intensity and other sensor inputs to detect abnormal vehicle behaviour. If the acceleration falls too much (e.g., A sudden deceleration greater than 9.8 m/s^2 (which is approximately 1g) or more.) and with a strong vibration or effect force, the system confirms an accident and automatically an emergency alert Tiger to However, if only a minor impact is detected, such as a small bump or sudden braking, the system can motivate the driver to verify the driver through a mobile app that there is an

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accident before sending an alert. Or not [4]. To further improve the accuracy of detection, AI, and machine learning (ML) models can analyse historical accident data, which distinguish real accidents from false alarms. By continuously learning from new data, the AI-addicted system may make more accurate accident assessment, reducing unnecessary emergency remittances, ensuring rapid response to actual accidents [4].

2.1.4. Real-timcommunicationand warning system

Once an accident is confirmed, the system immediately triggers a real -time communication and alert process to ensure a sharp emergency response. The system automatically sends an alert to the exact accident location, severity level, and vehicle details in which several recipients, including nearest ambulance service, emergency connectivity (such as family and police), nearby hospitals and traffic control centres. This ensures that medical aid is sent immediately while officers can manage road traffic and prevent further dangers [5].

To facilitate sharp and reliable communication, the system uses GSM modules, 5G networks and cloud-based APIs. The GSM or 5G module enables the real -time broadcast of accident data on the mobile network, ensuring that the alert reaches emergency respondents without delay. Additionally, a cloud-based API processes and efficiently distribute information, allowing many emergency services to reach live accident data simultaneously. This strong communication framework reaction significantly reduces time, which increases the chances of survival and reduces the incidence of accidental confusion [6].

2.1.5. Immediate ambulance dispatch:

Once an accident is confirmed, the system automatically detects the ambulance available using GPS-based tracking. It immediately shares important accident data, including the exact location, severity level (light, medium, or severe) and the optimal route for the accident site. The system takes advantage of the Google Maps API or AI-based traffic routing algorithm to determine the fastest and minimal conjugged route, ensuring that medical aid reaches the accident scene as soon as possible.

To streamline the response process, a real -time dashboard or mobile application is provided for ambulance drivers and emergency respondents [6]. This interface displays live accident details, including location coordinates, severity analysis and patient's condition (if available). Additionally, the system can be integrated with smart traffic management systems, allowing traffic signals to prioritize ambulances for rapid movement. By ensuring a spontaneous and efficient remittance mechanism, this system significantly reduces emergency response time, improving the possibility of survival for accident victims.

2.1.6. Promotion of future:

To further increase the efficiency of the accident and increase the efficiency of emergency response, many advanced technologies can be integrated into the system. A major improvement is integration with the Smart City Infrastructure, where traffic lights can be controlled dynamically to prefer ambulances to reduce the delay due to the crowd. This will allow emergency vehicles to be moved through intersections without any interruption, ensuring rapid arrival time at accident sites.

Additionally, the machine learning (ML) model can be employed for future stating analysis, allowing the system to identify accident-affected areas based on historical data, road status and traffic patterns. This active approach helps to prevent accidents before warning drivers and authorities about high -risk areas.

Another significant growth is the use of blockchain technology for safe data transmission and storage. Since the accident report contains sensitive information, the blockchain ensures that the data remains tampering-proof and reliable, prevents any unauthorized amendments. This is especially beneficial for insurance claims, legal investigation, and medical records, ensuring accuracy and transparency in accident -related data. By incorporating these progresses, the system can be more intelligent, reliable, and efficient, further improvement of road safety and emergency reaction mechanisms [7].

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3. WORKING ON SENSOR INTEGRATION IN VEHICLES

3.1 WORKING:

Using IOT, it is designed to detect live accidents and immediate ambulance dispatch system to detect road accidents in real time and send help quickly. It uses sensors such as accelerometer and gyroscope to monitor the movement of the vehicle. If a vehicle suddenly slows down or stops (for example, from 60 km/h to 0 in a second) and unusually tilt, the system considers a possible accident [1]. Vibration and pressure sensors check how strong the effect is, it helps to tell whether the accident is severe or just a minor collision [2]. The temperature sensors detect fire or overheating, which may be caused by fuel leaks or engine damage after an accident [6].

A GPS module continuously tracks the location of the vehicle before, and after the accident. If the vehicle continues to move after an impact, the system verify whether the warning was a mistake. Each sensor has thresholds that must be met to assess if an accident has occurred or not. Each sensor has thresholds that must be met to assess if an accident has occurred or not [4]. A microcontroller (e.g., esp32, raspberry pie, or arduino) processes all sensor data to determine whether an accident has occurred. The system follows the method of detecting a rule-based accident-if there is a sudden stop, strong vibration, and abnormal inclination, it automatically sends an emergency warning. If the effect is minor, the system may ask the driver through a mobile app before informing emergency respondents [1].

Once an accident is confirmed, the system immediately warns emergency services. This accident location, severity level and vehicle details send the nearest ambulance, police, hospitals, and traffic control centres. This is done using mobile networks (GSM, 5G) and cloud-based systems to ensure rapid and reliable communication. A study of the system also finds a closest available ambulance and shares the accident location and severity. It calculates the fastest passage using Google Map or AI-based navigation to avoid traffic and delay [1].

Future reforms may include smart city integration, where the traffic lights automatically change the ambulance to give a clear way. AI can also help predict accident-affected areas by analysing previous data, allowing authorities to take preventive measures. Blockchain technology can be used to secure accident reports, causing them to tamper for legal and insurance purposes. By combining these techniques, the system ensures quick response time, reduces delays, and helps save more lives in road accidents [5].

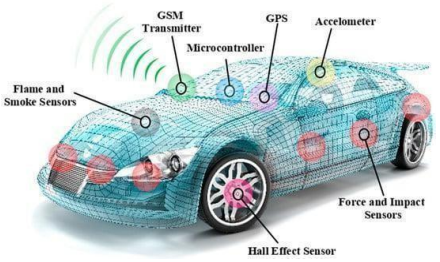

Fig.1. Components of Sensor Integration in Vehicles

Sources: https://www.mdpi.com/2071-1050/14/1/210

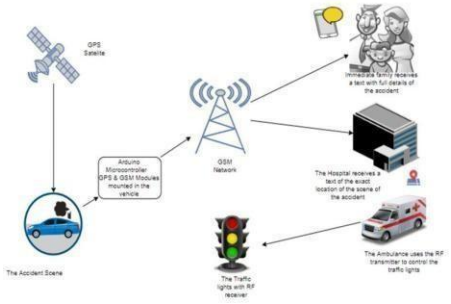

Fig.2. Diagrammatic Representation of Live Accident Detection and Instantaneous Ambulance Dispatch

Sources: https://www.researchgate.net/profile/Omowunmi-Longe/publication/356243165/figure/fig1/AS:1105716207206400@1640634695153/Overview-of-the-automatic-vehicle-accident-detection-and-rescue-system.jpg

3.2 FLOWCHART

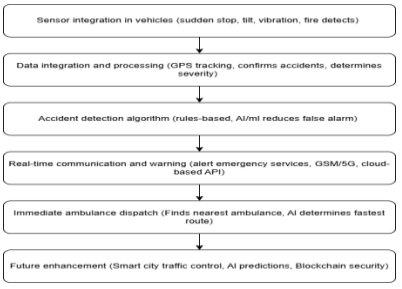

Fig.3. Sensor Based Live Accident Detection and Instantaneous Ambulance Dispatch

4. Precaution to Minimizing Accident

4.1. Solution-I:

4.1.1. Alcohol detection mechanism: To detect liquor levels in the driver, various sensors can be integrated into the vehicle. Breathalyzer sensor (MQ-3, MQ-135) analyse alcohol content in the breath, while the transdermal sensors measure ethanol through sweat

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for continuous monitoring. Additionally, steering wheel grip sensors detect alcohol through sweat or change in body temperature. These technologies help prevent impaired driving, increasing road safety.

4.1.2. Shock-based stimulation mechanism: If the detected alcohol level is higher than the range, a mild electrochecus stimulation can be applied using electrocutions stimulation (ECS). Steering wheels or seat belts embedded in small tens (transcutaneous electrical nerve stimulation) units may give low-voltage shocks. They are harmless, but help to stimulate the nervous system, increase vigilance, and potentially reduce intoxication effects.

4.1.3. Safety Control System: If alcohol is detected, the system first issues warnings on the dashboard with an alarm. If the driver still tries to start the car, a mild electric shock is triggered. If they remain, the system engine inactivates ignition and sends an alert to emergency contacts, ensures safety, and prevents drunk driving.

4.2. Solution-II:

4.2.1. Seat belt sensor integration system: The seat belt sensor uses a pressure sensor in the integration system, to find out if someone is sitting and the seat belt buckle sensor to check if the belt has been accelerated. This ensures that the vehicle can monitor the use of belt before allowing the engine to start.

4.2.2. Engine Start Ban System: The engine start restriction system prevents safety by preventing the engine from starting if the seat is occupied, but the seat belt has not been intensified. In such cases, a warning message and an alarm is triggered to alert the driver, encouraging them to buck before driving.

4.2.3. Emergency situations: In emergency situations, the system offers a manual overed option, allowing the driver to bypass the seat belt ban. This can be done by pressing a special button, which ensures flexibility in important cases such as medical emergency conditions.

5. Conclusion

A Study of IOT-competent accident detection and an ambulance dispatch system addresses important issues of delayed emergency response after road accidents. By integrating real-time sensors, GPS tracking, AI-based routing and cloud communication, the system study ensures immediate detection and response, reduces the number of casualties, and improves survival rates. The inclusion of several sensors, including accelerometer, gyroscopes, and temperature sensors, reduces the accuracy of detection of accidents by reducing false alarms.

In addition, the system's ability to autonomically alert emergency services, shares important accident data, and find the fastest ambulance route significantly reduces the response time. Advanced technologies such as AI, machine learning, blockchain and smart city integration further improve credibility, security, and efficiency. Dynamic traffic signal control for future enhancement, such as ambulances and future accident analysis, can make emergency response systems even more effective.

By ensuring rapid and automatic emergency intervention, this system can save countless lives, reduce long-term injuries, and increase road safety. Its deployment in vehicles without the underlying e-call system will democratizes access to important emergency services, especially in developing countries where the road accident rate is dangerously higher.

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