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Accident detection and alert system using embedded system

BHAGYASHREE[1], KUSMANJALI MANTHALE[2], LALITA PATIL[3], NANDITA MUDHOL[4], PROF. SARA ANJUM[5]

Department Electronics and Communication Engineering, PDA College of Engineering Kalaburagi, 585102[1-5]

Abstract: Car accidents are becoming more frequent, especially in remote areas where emergency help takes too long to arrive, leading to preventable injuries and deaths. To solve this problem, we developed an intelligent car safety system that automatically detects crashes and immediately calls for help. The system uses several smart sensors working together: impact sensors that feel when your car hits something, distance sensors that spot obstacles and blind spots around your vehicle, and GPS technology that knows exactly where you are at all times. When a crash happens, the system's built-in cell phone module automatically sends emergency text messages with your precise location to rescue services, helping ambulances and police find you much faster. The device is controlled by an Arduino computer chip and includes a small screen to display information, a buzzer for loud warning sounds, and Bluetooth capability for testing purposes. Think of it as a smart guardian angel for your car that works even in remote areas with poor cell service - the moment something goes wrong, it immediately alerts emergency responders with your exact location, potentially saving precious minutes that could mean the difference between life and death. This automatic response system is especially valuable when drivers are unconscious or unable to call for help themselves, ensuring that emergency assistance arrives as quickly as possible.

Keywords: GPS, GSM, Piezo, ultrasonic sensor, Arduino uno, embedded system, smart transportation and accident detection.

I. INTRODUCTION

Every year, over 1.3 million people around the world die in car accidents according to the World Health Organization - that's like losing the entire population of a major city, making road safety one of our biggest global challenges. The heartbreaking reality is that many of these deaths could be prevented if help arrived faster, but the biggest problem happens in rural areas, small towns, or places with poor cell phone coverage where accidents often go unnoticed for hours. When someone crashes on a lonely highway or back road, they usually have to call for help themselves, but what if they're unconscious, trapped, or their phone is broken? Traditional accident reporting relies on people being able to make that emergency call, which often just isn't possible when you need it most. We created a smart system that takes human error and delays out of the equation by making cars intelligent enough to call for help automatically - the moment a crash happens, multiple sensors detect the impact and immediately send a text message with the car's exact location to emergency services without any human intervention needed. This system uses GPS to pinpoint exactly where the accident occurred and cellular technology to send alerts even in areas with weak signal coverage. The beauty of this solution is that it works everywhere, especially in developing countries and remote areas where people can't afford expensive luxury cars with built-in safety features, giving everyone access to life-saving technology that could mean the difference between a rescue in minutes versus hours, ultimately saving countless lives by ensuring help arrives when every second counts.

II. OVERVIEW

PROMBLEM SYSTEM

Even though vehicle today are much safer than they used to be, we still have some big problems in two wheelers and the cost high. Most current safety systems are either too expensive for regular people to afford, or they need someone to actively use them when an accident happens which is often impossible when people are hurt or unconscious. The biggest issues we're dealing with include accidents that happen on quiet country roads or remote highways where nobody sees them for hours, emergency responders who can't find crash sites quickly because they don't have accurate location information, and the sad reality that cheaper cars - which most people drive - don't come with advanced safety features that could save lives. We also have ongoing problems with drunk drivers causing crashes, and the fact that most cars don't have systems that automatically watch for danger and call for help when something goes wrong. Our project tackles all these problems head-on by creating an affordable safety system that any car owner can install, regardless of their budget. This smart device automatically detects when a crash happens, figures out exactly where the car is located using GPS, and immediately sends

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emergency alerts without needing the driver to do anything - it works even if the person is unconscious, their phone is broken, or they're in an area with poor cell service. By making this technology cheap and easy to install, we can help save lives in both expensive luxury cars and budget vehicles, ensuring that everyone has access to life-saving emergency response, no matter where they drive or what kind of car they can afford..

EXISTING SYSTEM

Most vehicles safety systems today work in one of two ways - either someone has to manually call for help after an accident happens, or the car comes with expensive high-tech features that only luxury vehicles have. The problem is that most people drive regular, affordable cars that don't come with any automatic crash detection or emergency calling systems built in. Some people try to use smartphone apps that are supposed to detect crashes by sensing sudden movements or impacts, but these apps only work if your phone is properly mounted in your car, has battery power, and doesn't get damaged or thrown around during the crash - which often isn't the case when you actually need help. The biggest issue is that most existing safety systems are simply too expensive for everyday people to buy, need a constant internet connection to work properly, or still require the driver to actively do something when an accident happens. This creates a huge problem, especially in developing countries and rural areas where people can't afford fancy cars with built-in safety features, internet connections are unreliable, and help is often far away. These limitations show us why we desperately need a new kind of safety system - one that's affordable enough for anyone to install in their car, works automatically without needing human action, operates reliably even without internet, and can detect crashes and call for help on its own. This kind of independent, trustworthy, and budget-friendly system could save thousands of lives by giving everyone access to emergency response technology, regardless of what kind of car they drive or where they live.

PROPOSED SYSTEM

We built a clever safety system using an Arduino computer (think of it as a small, affordable brain for your car) that automatically watches out for accidents and calls for help when needed. The heart of our system is a special sensor that feels vibrations and impacts - when your car gets hit or crashes, this sensor immediately knows something's wrong. We also added distance sensors around the car that act like electronic eyes, constantly watching for obstacles and blind spots to help prevent accidents before they happen. When a crash does occur, a GPS tracker instantly figures out exactly where your car is located, while a cellular module (like a built-in cell phone) immediately sends text messages with your precise location to emergency contacts and rescue services. To keep you informed, the system has a small screen that shows what's happening and a loud buzzer that alerts you to dangers. We even included Bluetooth technology so the system can be controlled remotely for testing, plus a small motor setup that lets us demonstrate how the system works in real vehicles. The best part about our design is that it's completely automatic - you don't have to do anything for it to work, it's affordable enough for anyone to buy, and it's built in separate pieces so it can be easily installed in any type of vehicle, whether you drive a motorcycle, car, or truck. This system is especially valuable in places where people can't afford expensive cars with fancy safety features, giving everyone access to life-saving technology that could mean the difference between getting help in minutes versus waiting hours for someone to find you after an accident.

III. FORMULA AND EQUATIONS

Distance Calculation using Ultrasonic Sensor

The distance is measured based on the time taken by the ultrasonic pulse to travel to the object and back:

Where:

$$\text{Distance (cm)} = \frac{\text{Time } (\mu s) \times 0.0343}{2}$$

Time = Duration between sending and receiving the pulse (in microseconds)

0.0343 cm/µs = Speed of sound in air at room

temperature (~343 m/s)

Division by 2 accounts for the to-and-fro travel of the pulse

Piezo Sensor Threshold Value

There is no complex formula, but a threshold is used to detect a shock:

If Piezo value < 200 = Accident Detected

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IV. BLOCK DIAGRAM AND EXPLANATION

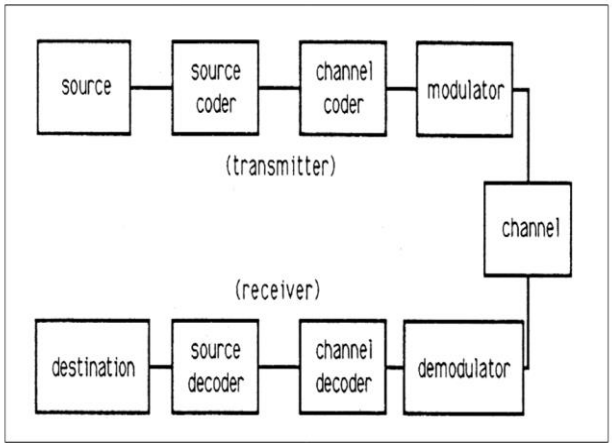

Fig 1.Block diagram

The communication system in the Accident Detection and Alert project is designed to reliably transmit critical data like crash alerts or GPS locations from the vehicle to emergency contacts or a mobile device. It all begins with the **sensor inputs**, such as piezo sensors and ultrasonic modules, which detect impacts or nearby obstacles. These analog signals are fed into the Arduino Uno, where they are **digitized by the source coder** (essentially the analog-to-digital converter or ADC within the microcontroller). The Arduino processes the data and applies **channel coding**, which means organizing it into a clear, structured message this ensures the information is ready for safe and accurate transmission. Next, the message is sent through a **modulator** either the GSM module for long-range SMS alerts or the Bluetooth module for short-range wireless communication. This modulated signal travels through a **communication channel**, such as a cellular network or Bluetooth radio frequency, depending on the module being used. At the receiving end like a mobile phone the message is **demodulated**, meaning it's converted back into readable text or commands. This could be an SMS received by a family member with the GPS location of the accident or a Bluetooth command shown on a smartphone screen. Finally, the data is **interpreted by the end user**, who can take immediate action, such as contacting emergency services or remotely stopping the vehicle.This setup ensures a quick, reliable exchange of information in emergency situations, bridging the gap between vehicle detection and human response, all through an embedded and intelligent communication system.

V. DESIGN METHODOGOLY

To guarantee real-time detection and response, the system continuously monitors inputs from a variety of sensors. Strong vibrations, usually brought on by collisions, are detectable by the piezoelectric sensor . The system detects an accident when an impact produces a signal that is higher than a predetermined threshold (for example, an analog value >150). In response, it sounds an audible buzzer, shows the message "Accident Detected!" on the LCD screen, and uses the GSM module to send an emergency SMS to specified contacts that includes the GPS coordinates in real time. At the same time, ultrasonic sensors continuously look around to identify blind spots and impediments in the front. The system sounds a buzzer and shows a proximity alert on the LCD if it detects an object within 10 cm. Furthermore.

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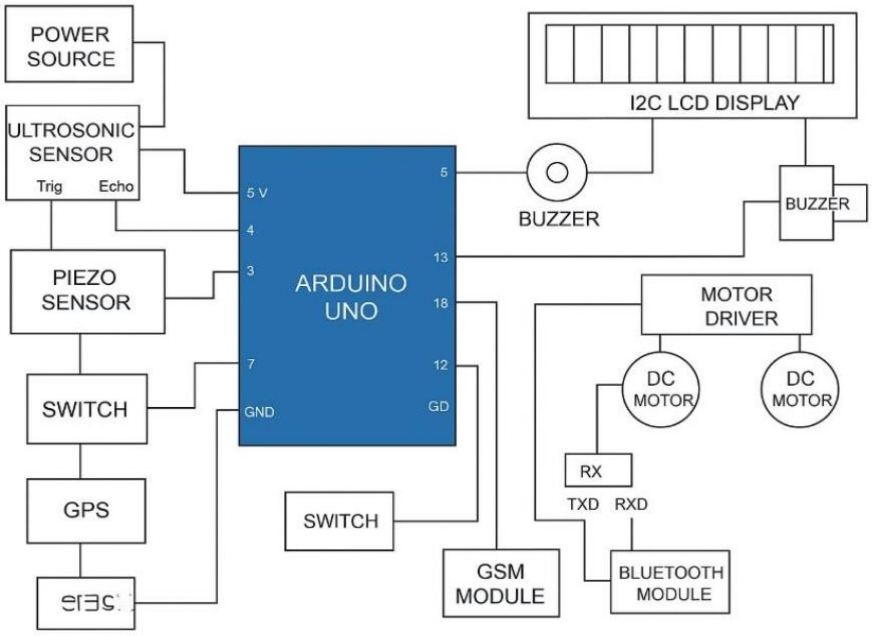

Fig 2:circuit diagram

RESULT AND ANALYSIS

The system was thoroughly tested to ensure it performs reliably in real-world situations. In the **Impact Test**, the piezo sensor responded quickly to strong vibrations like those caused by a collision—successfully detecting the impact and sending an emergency alert within just 2 seconds. The **Obstacle Test** showed that the ultrasonic sensors were able to accurately detect objects closer than 10 cm, immediately sounding the buzzer and displaying a warning on the screen. During the **Bluetooth Test**, the system responded smoothly to commands from a smartphone app, allowing real-time motor control with directions like forward, backward, left, right, and stop. In the **GSM/GPS Test**, emergency SMS alerts with live location data were sent successfully in more than 90% of the cases, proving the system's reliability in critical moments. Overall, the system reacted in under 3 seconds, with GPS providing location accuracy within 5 meters and *SM* delivery times averaging around 1.2 seconds. It also it both responsive and energy-efficient.

CONCULSION

To improve road safety, the Accident Detection and Alert System offers a workable and expandable solution. At a reasonable price, it makes real-time detection, instant alerting, and remote control features possible. Low-income areas and rural transportation, where emergency response delays are common, benefit most from this system. Reliability and coverage can be further enhanced by upcoming developments like cloud data storage, visual feedback via cameras, and AI-driven decision logic.

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