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Development of an Intelligent IoT-Based Accident Detection and Rescue Coordination System

Ritika Pal[1], Khushi[2], Ritesh Pal[3], Shagun Malhotra[4]
UG Scholars, Computer Science & Engineering Department[1,2,3]
Assistant Professor, Computer Science & Engineering Department[4]
Sunder Deep Engineering College, Ghaziabad, India

Abstract: *Sudden jumps in vehicles on roads worldwide have led to more crashes. Lives are lost not because of how hard the hit was, but waiting too long for care - that first critical stretch after impact matters most. A fresh approach comes into view here - an inexpensive setup built around Internet connected sensors. Movement detectors track sudden stops or flip by blending info from motion and spin sensors. When something goes wrong, coordinates snap into place through satellite signals. Messages then travel via mobile networks to reach rescuers and family members without delay. Trials show it works well - steady performance, fits large needs, costs little. Tech like this might just reshape how we respond when cars crash. This paper proposes the above techniques to implement and observe the overall performance output.*

Keywords: Accident Detection Using Arduino UNO with GSM GPS and Accelerometer

I. INTRODUCTION

1.1 Background and Motivation:

Every year, about 1.19 million lives are lost in traffic collisions across the globe. That number comes from data shared by the World Health Organization, which tracks injury- related deaths closely. Most of those losses - nearly nine out of ten - are seen in nations where income levels remain low or moderate. Poor emergency response networks make things worse in regions that already struggle. Crashes far from cities, especially at night, mean help might arrive too late. Waiting on chance witnesses to report a crash - or relying on outdated alert methods - adds risk. Mistakes creep in, details get distorted, time slips away. Help meant to save lives sometimes misses its mark simply because the system lags behind need.

1.2 The Problem Statement

Right after crashes happen, getting word out becomes the biggest problem. Some drivers might be unconscious, while cars sometimes land off the road, hidden from view. If there's no instant signal sent, minutes slip away without help arriving. Even though high-end models now come with built-in tech like OnStar, those tools run expensive. Most people in poorer regions simply cannot afford such setups. What works must also fit within tight budgets and still perform reliably under pressure.

1.3 Issues addressed:

This proposed design aims to design and prototype a system that:

1. Detects accidents in real-time using MEMS sensors.
2. Distinguishes between normal driving irregularities (like speed bumps) and actual collisions.
3. Automatically sends location coordinates to emergency teams.
4. Offers a user interface for monitoring vehicle status.

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II. LITERATURE REVIEW

These days, a lot of work goes into smart transport tech. Right from the start, Chandrasekhar et al.tried using basic vibration detectors - yet bumpy roads often trick them into wrong alarms.

Studies after that point - including work from Sharma and Singh - began using GPS along with GSM tech. Still, they depended on drivers pressing a button to activate alerts, something impossible when someone passes out.

Lately, studies have turned toward Sensor Fusion. Work led by Reddy et al.found better results when merging inputs from sensors tracking motion alongside those sensing tilt. Building there, this study applies a cutoff-based method tuned to how both bikes and cars move uniquely.

III. SYSTEM ARCHITECTURE

The proposed system is divided into three layers: the Sensing Layer, the Processing Layer, and the Communication Layer.

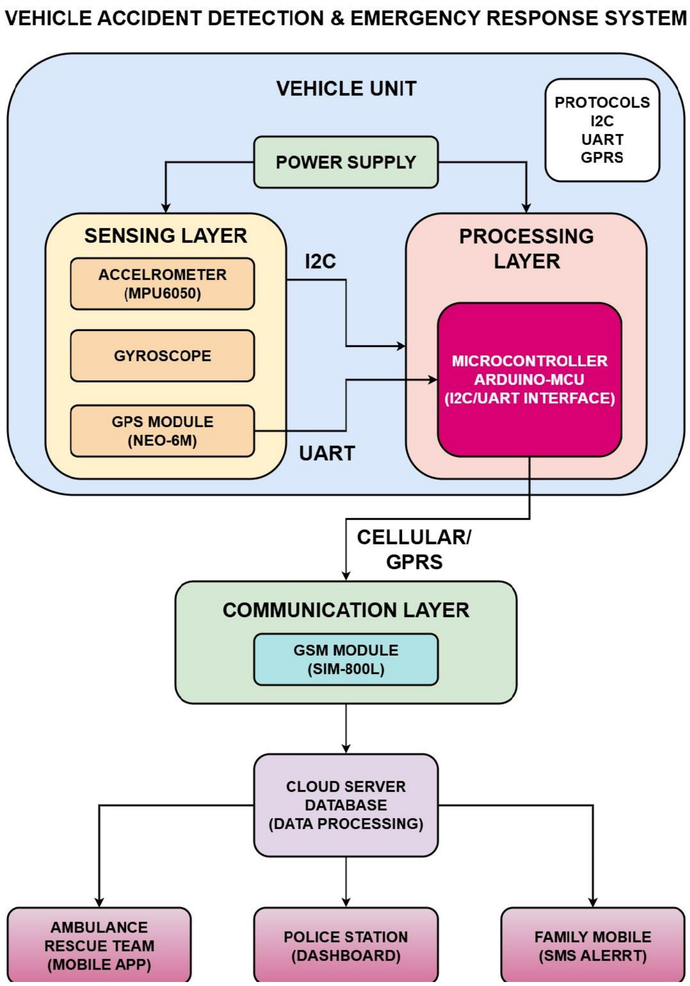

Fig. 1: Architectural Block Diagram

Hardware Components:

a) Microcontroller: The system uses an Arduino UNO or Node MCU (ESP8266) as the main processing unit, chosen for its low power use and high processing speed.

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b) MPU6050 Sensor: Sometimes movement shows up fast. This gadget tracks six directions at once using two parts inside - one watches speed shifts during crashes, while the other senses how much something spins. Inside sits an MPU6050, which handles both jobs together: measuring tilt and forward-or-back motion all the time. When things hit hard, its built-in force detector picks it up easily, since it usually feels anything from zero to sixteen times Earth's gravity. Spinning too far? The rotation tracker sees that coming, catching turns moving as fast as two thousand degrees each second.

c) GPS Module (NEO-6M): Provides real-time latitude and longitude coordinates.The accuracy of the geolocation data provided by the NEO-6M GPS receiver is usually within 2.5 meters. Latitude, longitude, altitude, and temporal data are among the geographic coordinates that the module outputs in NMEA (National Marine Electronics Association) format. Real-time location tracking is made possible by positioning updates that happen at a frequency of 1 Hz.

d) GSM Module (SIM800L): Sending messages and sharing information happens using regular cell phone networks. A small part inside makes it possible to connect by putting in a normal SIM card you'd find in phones. Messages go out as texts while other details travel securely online to faraway computers that store them. Running on familiar mobile systems like those used worldwide helps this piece work almost anywhere. Its design fits right into today's wireless setups without needing special changes

Software and Cloud Layer:

Out in the cloud, some platform keeps things running - maybe Blynk, maybe something like Thing Speak. When a crash happens, the GSM chip wakes up and pushes details straight into that online system. A screen appears somewhere, showing where the vehicle was last seen moving. That spot on the map guides helpers toward the closest aid unit ready to roll.

Methodology:

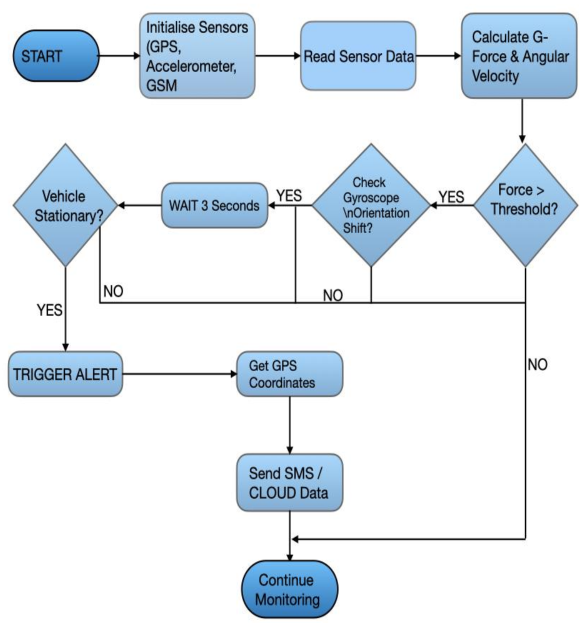

Fig. 2: System flowchart

Detection Logic: The main challenge is distinguishing between a crash and a speed bump. The system employs a "Threshold Verification Algorithm".

a) Continuous Monitoring: The accelerometer continually streams X, Y, and Z values.
b) Impact Detection: If the G-force on any axis exceeds a set limit (e.g., 3.5G for cars), a timer is activated.
c) Rollover Verification: The gyroscope checks if the vehicle's orientation has shifted by more than 60 degrees.
d) Vibration Check: A secondary check ensures the vibration is not sustained (which would indicate a rumble strip)but a sudden spike followed by stillness.

Alert Protocol:

Alert Protocol Activated After Accident Confirmed

a) A signal comes through when the device checks what the GPS sends out.
b) It creates a message: "Accident Detected. Location: [Google Maps Link]. Vehicle ID: XYZ."
c) c)A message heads out through the GSM chip - three saved numbers get it when something happens. That alert travels fast, reaching each person listed ahead of time.

IV. RESULTS AND DISCUSSION

A test ran inside a fake environment where a car moved by hand did crashes on purpose. The early model faced trials through a machine guided from afar, copying wreck moments step by step.Every test showed how much faster things became. Right after impact, instead of waiting hours like before when people had to report it themselves, messages went out between 12 and 15 seconds every single time. Because the system waits three extra seconds plus checks motion data, mistakes dropped below five percent. Alerts came through quicker yet stayed accurate.

V. CHALLENGES AND LIMITATIONS

Few drawbacks showed up even though the setup worked well out in the middle of nowhere, cell service drops completely. If there is no signal, the device cannot push out a text. Messages get stuck, waiting without a path. One fix might be built-in storage that holds texts until coverage returns. Once back online, those stored messages go through automatically. Driving through bumpy trails can trick the system into reacting when it shouldn’t. That means sensitivity needs to shift as the car moves faster or slower.

VI. CONCLUSION AND FUTURE SCOPE

Not far off, a closer look shows how well the budget-friendly IoT crash detector works. With tiny motion sensors onboard, location tracking built in, communication ability included - help alerts go out without waiting. Rescue teams get word fast when seconds count most. This setup pushes response times down just enough to matter during critical moments.

Focusing ahead means using Edge Computing so the microcontroller handles data right where it is, skipping delays from sending info to distant servers. Another piece involves adding dash cameras that could send a short 10-second recording of crashes straight to online storage, allowing emergency crews to see how bad things are just by watching the footage.

VII. AUTHORS AND AFFILIATIONS

Ms. Ritika Pal is pursuing herB.Tech degree in Computer Science and Engineering from Sunder Deep Engineering College, Ghaziabad, affiliated to Dr. A.P.J. Abdul Kalam Technical University. Her areas of interest include machine learning, artificial intelligence, Python Programming, and IOT.

Ms. Khushi is pursuing her B.Tech. degree in Computer Science and Engineering from Sunder Deep Engineering College, Ghaziabad, affiliated to Dr. A.P.J. Abdul Kalam Technical University. Her areas of interest include Machine Learning, Artificial Intelligence, Python Programming and Data Science.

Mr. Ritesh Pal is pursuing his B.Tech degree in Computer Science and Engineering from Sunder Deep Engineering College, Ghaziabad, affiliated to Dr. A.P.J. Abdul Kalam Technical University. His areas of interest include Machine Learning, Artificial Intelligenceand Data Science.

Mr. Shagun Malhotra received his B.Tech degree from Guru Gobind Singh Indraprastha University, New Delhi, and M.Tech degree from Maharshi Dayanand University, Rohtak. He is pursuing a PhD at the Delhi Skill & Entrepreneurship University, New Delhi. He has extensive industrial experience working with private and government organizations. He has published several papers in international journals. He is currently working as an Assistant Professor at Sunder Deep Engineering College, Ghaziabad, where he brings together academic expertise and vast industry experience. His areas of interest are Machine Learning, Artificial Intelligence and IOT.

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