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Development of Real Time SOS System for Vehicle

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Abstract-
The goal of this study is to develop and implement a new SOS system for vehicles, aiming to enhance emergency response effectiveness and vehicle safety. To achieve this, the system utilizes the GSM800L module for cellular connectivity, the NEO-6M GPS module for accurate geolocation, and the Arduino Nano as its main controller. Integration of these technologies enables real-time tracking and immediate emergency communication, crucial in the aftermath of a vehicle accident. The system automatically triggers an SOS signal when either an emergency button inside the vehicle is pressed or a collision is detected. This signal contains the vehicle's precise coordinates from the NEO-6M GPS module and is transmitted to predetermined emergency contacts and services using the GSM800L module. The Arduino Nano serves as the primary processing unit, offering a compact, cost-effective solution that minimizes spatial intrusion and is compatible with various vehicle models. By facilitating instantaneous connection with emergency services and enabling precise location monitoring, this technology significantly reduces reaction times, potentially saving lives and mitigating the severity of accident outcomes. Furthermore, this study underscores the system's scalability and adaptability to future advancements, such as integration with IoT platforms and vehicular telematics systems, paving the way for the next generation of automotive safety technologies.

Keywords*: Real-time tracking, emergency response, GSM800L, NEO-6M GPS, Arduino Nano, SOS system, and vehicle safety etc.*

I. Introduction

The integration of technology in automotive safety has paved the way for innovative solutions aimed at minimizing accidents and enhancing the overall safety of passengers. Among such advancements, the implementation of an SOS (Save Our Souls) system in vehicles stands out as a critical development. This system is designed to automatically send out an emergency alert in the event of an accident or any situation where the passengers are in distress and unable to seek help manually. Arduino Nano: The Arduino Nano serves as the brain of the SOS system. It's a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). Its compact size and flexibility make it an ideal choice for embedding into automotive systems. The Nano is responsible for processing the data received from the GPS module, controlling the GSM800L module to send out the distress message, and managing any additional logic or sensors integrated into the system.

GSM800L Module: The GSM800L module provides the system with cellular communication capabilities. It allows the Arduino Nano to send SMS messages or make calls to pre-defined phone numbers, which can include emergency services or contacts listed by the vehicle owner. As long as there is cellular coverage, this module can send alerts from almost anywhere thanks to its GSM network operation.

In order to confirm the system's dependability and reactivity under many circumstances, extensive testing scenarios were incorporated into its development. To assure timely GPS data capture and successful SOS message transmission, this required simulating car accidents and emergency scenarios. In order to comply with realistic deployment requirements, the system's power consumption, robustness, and simplicity of installation were also carefully evaluated. This SOS system's deployment promises to significantly improve vehicle safety protocols.

II. Problem Definition

Designing and implementing a Real-time SOS (Save Our Souls) System for Vehicles that ensures the swift and effective response to emergency situations and incidents occurring during vehicular travel. This system must address the following key challenges:

Immediate Response: Developing a mechanism that enables vehicle occupants to send distress signals to relevant authorities or emergency services in real-time when faced with accidents, medical emergencies, or safety threats.

Location Accuracy: Ensuring precise location tracking of the vehicle using GPS technology to allow emergency responders to reach the scene quickly and accurately.

Communication Reliability: Establishing a robust and reliable communication network between the vehicle and emergency services, considering various connectivity options such as cellular networks, satellite communication, or emerging technologies like 5G.

Alert Prioritization: Implementing a system for prioritizing emergency alerts based on severity and urgency to optimize resource allocation and response times.

User-Friendly Interface: Creating an intuitive and user-friendly interface within vehicles that allows passengers and

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drivers to trigger SOS alerts easily, even in high-stress situations.

Data Security and Privacy: Ensuring the security of personal and location data transmitted during emergencies while complying with relevant data privacy regulations.

Integration with Existing Infrastructure: Integrating the SOS system seamlessly with existing emergency response services, such as 911 centers, and ensuring interoperability with various vehicle makes and models.

Scalability: Designing a system that can scale to accommodate the increasing number of connected vehicles and the growing demand for emergency response services.

Cost-Effective Implementation: Developing a solution that strikes a balance between cost-effectiveness and delivering high-quality emergency response capabilities, making it accessible to a wide range of vehicle owners.

Maintenance and Updates: Establishing a plan for regular maintenance and updates to ensure the system's long-term reliability and effectiveness.

III. Literature Survey

- Mohamad Ali Assaad, March-2018. In this paper, we present the Cooperative Maneuvers Manager for Autonomous Vehicles (CMMAV), a SoS framework that contributes to the ITS by enabling autonomous vehicles to perform complex maneuvers on highways in a cooperative way. We used Systems of Systems Approach to Context-based Requirements Engineering (SoS-ACRE) to model the system.

- Reine Talj et.al. 2018. The paper first derives a dynamic model of a four-wheels tire side-slip which takes into account the nonlinear lateral force characteristic of the tires. In order to accommodate the use of SOS programming techniques, a polynomial approximation model of the tire slip dynamics is then derived.

- Pushpendra Kumar et.al. 2013, In the present work, a power consumption model is proposed for a SoS considering its hierarchical structure. The proposed algorithm is applied to a platoon of autonomous vehicles for power consumption estimation in the whole SoS of vehicles.

IV. Block Diagram

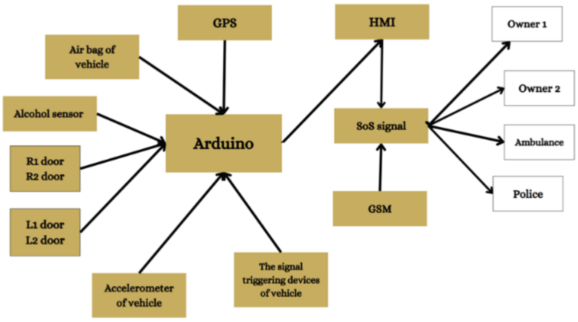

Fig.1.Block Diagram

V. Working

A real-time SOS (Save Our Souls) system for vehicles is a critical safety feature designed to provide rapid assistance to drivers and passengers in emergency situations. Here's a brief overview of how a real-time based SOS system for vehicles typically works:

Hardware Components:

Each vehicle is equipped with an SOS system that includes hardware such as GPS, cellular communication module, and sensors.

Emergency Detection:

The system continuously monitors various sensors within the vehicle, including accelerometers, airbag sensors, and crash detection sensors.

It can also be manually activated by the driver or passengers in case of an emergency, typically through a dedicated SOS button or voice command.

Emergency Signal Transmission:

When an emergency event is detected or the SOS button is pressed, the in-vehicle device immediately establishes a connection with a central monitoring center or emergency response service.

It transmits critical data, including the vehicle's GPS coordinates, vehicle identification, and details about the nature of the emergency (e.g., collision, medical issue).

Central Monitoring Center:

The central monitoring center receives the SOS signal and quickly assesses the situation based on the transmitted data.

Trained operators at the center can communicate directly with the vehicle's occupants through hands-free voice communication to gather more information and provide reassurance.

Emergency Dispatch:

If the situation warrants it, the monitoring center can dispatch emergency services, such as police, fire, or medical personnel, to the vehicle's location.

The precise GPS coordinates provided by the in-vehicle device help emergency responders reach the scene quickly.

User Notification:

In parallel with contacting emergency services, the system can also notify pre-designated contacts, such as family members or friends, about the emergency situation and the vehicle's location.

Two-Way Communication:

The SOS system allows for two-way communication between the occupants of the vehicle and the central monitoring center.

This communication can be crucial for providing first aid instructions, reassurance, and updates on the arrival of emergency responders.

Post-Emergency Support:

After the emergency is resolved, the system can provide post-event support, such as arranging for tow services, contacting insurance providers, or assisting with medical follow-up.

Data Logging and Reporting:

The system typically logs and reports all SOS events, including the nature of the emergency, response times, and outcomes, for documentation and analysis purposes.
Privacy and Security:
Robust privacy and security measures are implemented to ensure that only authorized parties have access to the SOS system and its data.

VI. Components Specification

- ***Arduino Nano***

The Arduino Nano, based on the ATmega328P microcontroller chip, is a compact and versatile microcontroller board highly favored within the Arduino family due to its affordable price and dependable performance. Powered by the Atmel ATmega328P microcontroller running at 16 MHz, the Arduino Nano offers a range of digital and analog I/O pins. These pins facilitate seamless interfacing with various actuators, sensors, and electronic components, making it suitable for a wide array of applications.

- ***GSM sim800L***

The SIM800L module, a compact GSM module, operates on frequencies including GSM 850MHz, EGSM 900MHz, DCS 1800MHz, and PCS 1900MHz. This module enables the addition of GSM/GPRS communication capabilities to projects through a straightforward UART (Serial) interface. Utilizing UART serial communication protocol, the SIM800L module communicates with microcontrollers like Arduino. Control and configuration of the module are facilitated through AT commands.

- ***GPS NEO 6M***

The NEO-6M GPS module is a widely adopted compact and budget-friendly Global Positioning System (GPS) receiver module. Here are some important details about the NEO-6M module: GPS Receiver: The NEO-6M module serves as a comprehensive GPS receiver, capable of receiving signals from GPS satellites to ascertain its position, velocity, and time. Chipset: Built upon the u-blox NEO-6M GPS chipset, it delivers precise positioning data while consuming minimal power.

- ***SW420***

The SW420 is a vibration sensor module extensively employed in electronics projects for detecting vibrations or shocks. Below are some crucial details about the SW420 vibration sensor module.
Detection Principle: The SW420 sensor module utilizes a sensitive spring-based mechanism to detect vibrations. Upon experiencing vibration or shock, the spring undergoes movement, leading to a change in resistance. This variation in resistance is subsequently converted into an electrical signal, which can be detected by a microcontroller.

VII. Results & Discussion

The proposed IoT SOS Service presents an innovative concept with significant potential benefits for society, catering to a broad audience. Our implementation involved developing a prototype with a user-friendly interface to demonstrate its functionality and potential scope. Each module's description was provided, highlighting the diverse functional requirements, such as obtaining the car's location and alerting relevant authorities in the event of a crash.

The interface, accessible through a website, offers users only essential and pertinent data. Illustrated by our graph snapshot, data from the accelerometer 3-axis sensor is transmitted through the GSM module to our cloud server, where it is visualized in a chart showcasing the car's acceleration over time.

While a basic prototype was developed to showcase the core idea of vehicle collision detection, further refinement is necessary to design a compact and easy-to-install product suitable for integration into cars. Additionally, exploring the utilization of other car sensors, such as contact sensors on all corners of the vehicle, could enhance collision detection accuracy while reducing manufacturing costs.

The integration of additional sensors like gas sensors to detect leaks or proximity sensors with cameras to anticipate accidents and potentially mitigate them before they occur would enhance the product's capabilities. This expansion could also extend to various industries, particularly logistics, where features like Geo-fencing could be leveraged to assign specific routes to delivery trucks, enabling owners to monitor deviations or accidents in real-time.

Fig.2. Project Model

VIII. Conclusion

The integration of Arduino Nano, GSM 800L, SW420, and GPS NEO-6M modules into a SOS system for vehicles offers a comprehensive solution to enhance vehicle safety and emergency response capabilities. Acting as the central processing unit, the Arduino Nano effectively coordinates communication among the various components. The GSM 800L module facilitates real-time communication with emergency services, transmitting precise location data acquired from the GPS NEO-6M module. Additionally, the SW420 vibration sensor provides an additional layer of security by detecting impacts or accidents and triggering the SOS alert when necessary. Collectively, these components form a reliable and efficient SOS system capable of swiftly notifying emergency services in critical situations, potentially saving lives on the road.

IX. Future Scope

Future advancements for an SOS system in vehicles utilizing Arduino Nano, GSM 800L, SW420 vibration sensor, and GPS NEO-6M module offer promising enhancements for vehicle safety and emergency response. These include:

Enhanced Emergency Detection Algorithms: Future iterations could employ advanced algorithms to accurately identify various emergency scenarios such as sudden acceleration/deceleration patterns, rollovers, or specific vehicle malfunctions.

Real-Time Monitoring and Analysis: Leveraging the GPS NEO-6M module, the system could monitor and analyze vehicle movements and conditions in real-time, enabling the identification of dangerous driving behaviors and preemptive responses to potential emergencies.

Smart IoT Integration: Integration with other IoT devices and sensors could expand the system's capabilities, such as gathering data from roadside sensors, weather stations, or traffic cameras to provide comprehensive situational awareness and adaptive responses.

AI-Powered Decision Support Systems: By integrating AI and machine learning, the system could analyze complex data in real-time, assess emergency severity, and recommend optimal response strategies.

User-Friendly Interfaces and Mobile Applications: Development of intuitive interfaces and mobile apps could enhance user interaction, incorporating features like voice commands, gesture recognition, and simplified displays for streamlined emergency response.

Integration with Autonomous Vehicles: Integration with autonomous driving systems could facilitate seamless coordination between the vehicle's autonomous functions and emergency response mechanisms, enhancing overall safety and efficiency.

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