

An Enhanced Alert System for Accidents Involving Electric Vehicles

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Abstract

This paper introduces the development of an integrated data-based Electric Vehicle Accident Alert System (EVAAS), which is powered by Machine Learning, the Internet of Things(IoT), and cloud computing for better road safety & emergency handling by electric vehicles. The ESP8266-based system processes real-time GPS data using a K-Nearest Neighbors (KNN) classification algorithm to determine the likelihood of accidents in particular regions. When a crash happens, the EVAAS system will automatically send an SOS alert with accurate positioning data to one's pasted emergency contacts. EVAAS features a modular, plug-and-play design with an intuitive web interface for device registration and cloud integrations. Every device has a unique identifier linked to it on registration, so setup is easy and if need be quickly deployed in cars. Information from accidents is recorded continuously, and accident locations that are found get included in the ML model to increase prediction accuracy over time (the system teaches itself). This involves the use of Google Firebase for cloud services to enable enterprise-grade scalable and consistent data management. By converging the powers of IoT, ML and cloud technologies, we deliver resilient technology that is adaptable to changing EV-specific safety requirements, offering a human-centred approach. This paper also presents the architecture of EVAAS; model developments, IoT, and cloud integration are the focus of this study. We will also show performance measurements, detailing how accurate/fast/and scalable the system is. We end by discussing potential future improvements and externalities of such systems to enhance road safety in the era of electric mobility.

Keywords – *Electric Vehicle Safety, Accident Alert System, Machine Learning, Internet of Things (IoT), GPS-based Prediction, Real-time Monitoring, Cloud Computing, Emergency Response Technology, KNN Classification Algorithm*

1. INTRODUCTION

An area of negligent technology growth within the 21st-century world, is road safety when it comes to electric vehicles (EVs). Despite stupendous advances in many fields of technology, the sad statistic on death tolls from road crashes hurries to remind us that we are far away from perfection. Our technology has a long way to go before we master the immediacy demanded to save lives after car accidents.

Electric vehicles have caused a complete turnaround in the automotive industry by promising low emissions and better fuel efficiency. Yet, at the same time, this fundamental shift has created safety and emergency response challenges. Moreover, there are new risks with EVs -- battery fires and the quite high-voltage electrical system in these cars which calls for some special treatment after a crash. Classic emergency response procedures, created for other vehicles than electric cars, cannot always be effective in regard to EV-specific incidents [1].

Given the lack of road infrastructure and alarm system in place, deaths due to fog has not been stopped from increasing till now in countries like India which are still termed as developing. Lack of signs, especially in far-flung areas can be dangerous as it may lead to surprise dangers when a driver approaches. Night driving is especially dangerous, since this lack of information can increase the risk for accidents. The repercussions are lethal: not only does the absence of a prompt response kill numerous lives as much has passed since accidents most likely initially impacted, but it also takes an additional toll on life expectancy due to prolonged or lost emergency responses [2].

The World Health Organization estimates that worldwide, 1.3 million people are killed each year in road traffic crashes. In addition, 20 to 50 million suffer non-fatal injuries that many times may result in long-term health-related consequences and sometimes become life-threatening if not treated possible. This directly points to a need for pioneering solutions that can reduce the time between an event and emergency response, especially considering the adoption of EV technology.

Prompted by these urgent problems, we propose an Electric Vehicle Accident Alert System (EVAAS). This new technology combines Machine Learning (ML), the Internet of Things (IoT), and cloud computing to further boost road safety performance as well as emergency response capabilities for electric vehicles. Alert systems for speeding vehicles are the inspiration; we did not just steal them; they were repurposed and developed into a completely new generation of safety solutions that address many of the unique problems presented by EVs.

It is based on three fundamental principles: prevention (proactive discovery and blocking of threats), detective (reactive responses to events) and response. As a preventive measure, we use an advanced ML algorithm that is always analysing your vehicle's GPS location. A system that checks this information against an up-to-date database of likely accident locations and warns drivers when they are approaching a dangerous area (damper). Such a proactive approach can help ensure drivers take extra care and possibly avoid potential accidents before they happen [3].

If the worst case should occur, in other words, an accident happens, then EVAAS goes into its detection and response mode. The sensors on the vehicle can detect abrupt changes in velocity, orientation or other proper use conditions associated with a collision. When the EVAAS senses an impending accident, it automatically enters its emergency protocol. This includes an SOS alert sent to pre-registered emergency contacts with a Google Maps link showing the exact location of the accident. Facilitating the rapid spread of life-saving information is key to cutting down response times, as doing so can mean a matter of minutes or even seconds in critical medical emergencies [4].

The system logs the location data each time an accident is detected and verified, this way it drives up more volumes for the ML model. This experience feeds into a system learning engine, helping it become more accurate over time in predicting and notifying users when they enter high-risk locations.

The implementation of EVAAS is designed after the user-friendly, plug-and-play way of system. We have a web portal where consumers can easily register their devices. REGISTER - Any device is registered with a unique identifier and associated to our cloud backend system that uses Google Firebase. This process enables fast and simple installs of the EVAAS in any EV, allowing for instant safeguarding without time-consuming configuration requirements.

The architecture for our system is meant to be very scalable and fault tolerant. In addition to utilizing IoT technology to allow real-time data collection and transfer, we employ our cloud-based infrastructure so that the system can cope with thousands of concurrent users without any impact on its performance. Utilizing the ESP8266 microcontroller as a system-on-chip offers quite the balance between performance and low overhead, which is ideal for lasting operation within vehicle-based environments [5].

The potential consequences reach far beyond individual protection in the EVAAS. Our system can provide valuable insights to urban planners, road safety authorities and policymakers on accident-prone areas by

collecting data from these collected accidents. For example, this data-driven approach could be used to guide infrastructure investment in specific locations or even provide city planners and governments with the information they need for a more efficient traffic management strategy - effectively building smarter cities at no extra cost.

EVAAS are more critical than ever as we enter the era of electric and autonomous vehicles, the future experience will rely heavily on these types of systems for road safety. Our work not only meets an urgent need for better accident rescue in EVs, but also opens up perspectives towards future developments of vehicle safety technologies.

2. STATE-OF-THE-ART METHODOLOGIES

The implementation in [6] describes a system that checks the velocity of the user and notifications for over speeding. They collect the data with a sensor and then sound an audio alert using the buzzer to inform their driver that they have gone over the speed limit. Additionally, they have suggested a more elaborate mechanical apparatus that would regulate the brake drums of the vehicle in order to stop on time if and when a driver crosses over speed limit. This process can fail and such tight, solar-powered control of the braking system could actually contribute to causing a on road accidents. The systems have been implemented and suggested by the Authors of [7-8], which use accelerometers and ultrasonic sensors along with a vibration sensor for accident detection. Then, they send an SMS to emergency services about the detected incident. Patel et al. However, they have a very critical drawback: they failed to integrate any kind of LCD screens or piezo buzzers in their system that could be used for periodically checking the status (audio and visual) of the whole system. This will make the user question how good this forecasting system is. On the other hand, [9-10] left a space to implement system status notifications but their systems are voluminous and weighty. [13] Conducting a survey, they found the most beneficial feature would be an accident alerting system for first responders. And at the end, based on [14], there are strong suggestions that this field can still bring more motives and it is life-saving.

Continuing with the aforementioned preliminary work, we found a survey of real-time location tracking methods for mobile devices. This is what I tried from the NMEA sentences and their use-cases were derived, which we used in our project of real time vehicle tracking.[15] Adjusts coordinates for accurate placement on map, [16] removes potential interference from GPS Ageing when not getting new data & adjust to predefined positions if allowed by operators business logic or keep running with old location (repeating Bus Stop) - Depush mode {HIGH} configured(initiator)- Saves Records transmitted}. A study [17] has compared some ML algorithms such as logistic regression, k-nearest neighbour, random forest and AdaBoost since phase 1 for modelling road traffic accidents. Their dataset proves that random forest produces high accuracy crosses their case study. Next, [18] provides a good explanation of the purposeful application of the decision tree algorithm and how it could classify types of datasets.

It's no secret that electric vehicles (EVs) are a hot commodity when it comes to environmentally-friendly motoring and advancements in battery tech. But electric vehicles carry an added layer of difficulty when it comes to safety and crash response strategies. Several research studies have recommended the involvement of Machine Learning (ML), Internet of Things(IoT) and cloud computing technologies to improve road safety, emergency response system for EVs. One example is its introduction of a speed detection and warning system to monitor the driving behavior based on vehicle speeds, issuing sound warnings if the driver exceeds it [19]. While this is a safe system that prevents speeding, it works by using mechanical parts to control the braking system which means if not managed properly these components could fail and ultimately result in an accident.

Some studies [20-21] have targeted the application of accident detection with a fusion sensor for accelerometer, ultrasonic sensor and vibration sensors. Such systems are programmed to send out SMS alerts for emergency services in case of an accident. But the design suggested by Patel et al. Without elements such as LCD screens or piezo buzzers [22] that are necessary to offer live status updates for the user, it might lead users to believe in the dysfunctionality of a hi-tech system. Other systems [23-24] provide means of status updates generation too; however, their size and complexity make them cumbersome for daily usage.

Moreover, the survey conducted by [25] stresses stronger reasons for having efficient accident alert systems in place. Seven years ago, research pointed to the substantial advantages of such systems for both

communities and emergency responders [26]. The survey points to a wider literature suggesting further R&D might be critical, potentially contributing more life-saving innovations.

In the literature, a number of studies have compared different techniques that are beneficial in real-time location tracking for mobile devices [27] and these comparisons provided guidelines to develop systems to track vehicles which is discussed ahead. [28] provided some attempt in this field by comparing various ML strategies for the modeling of road traffic accidents, and they obtained that random forest algorithm performed well using their data. This is an essential result for the development of accurate and robust accident prediction models.

[29] proposed to apply the Decision Tree Algorithm, which as they show can be quite good in classifying various datasets (useful for traffic and accident data analysis). These studies laid the basis for combining ML with IoT to boost the vehicle safety ecosystem

Using the above inputs, our research aims to create a comprehensive Intelligent In-vehicle Electric Vehicle Accident Alert System (EVAAS) on ML-IoT-cloud based solution -to provide an effective and scalable alternative improving road safety and emergency response system [30]. It uses an ESP8266 microcontroller to track real-time GPS data and predicts the probability of occurrence of accidents in that area using K-Nearest Neighbors (KNN) for classification. This preemptive capability is a game-changer in preventing accidents and gives another element to cars that can be proactive about keeping us safe.

In the event of a crash, EVAAS can automatically send an SOS with DOT approved location coordinates directly to pre-defined emergency contacts so help will be dispatched as quickly as possible [31]. A User-friendly web portal and simple device registration with cloud integration also in the core design ensure that this system is accessible even for a non-expert user. A unique ID is generated for each registered device to simplify setup and enable quick deployment in vehicles [32].

EVAAS is designed to learn with-time through collection of feedback data and its gradual addition into the ML model, making it more and more accurate. ISTIC_frgetTime Voter ProfilesSEG_Nature_GATE This adaptive learning is critical to being able to adapt the changing conditions on road and increasing overall system efficiency.

It also makes use of Google Firebase cloud services for scalable and reliable data management part in our implementation. When combined with IoT, ML and cloud technologies forms a complete solution for the specialized safety demands of electric vehicles. The performance evaluations of EVAAS show high accuracy results, rapid response time as well scalability which is convincing the solution applicable to deploy at large scale[33].

Future improvements can involve changes to state-of-the-art ML algorithms, an increase in sensor range for better accident detection or a real-time feedback mechanism, which will ultimately improve user interaction and system reliability. In addition, further investigation into how these systems could improve road safety in the electric mobility age on a larger scale may provide major gains for both public safety and transportation efficiency [34].

In short, ML + IoT + Cloud-Combination helps in better understanding EV accidents and makes it easier for us to initiate an immediate measure against the accident. EVAAS aims to alleviate this problem significantly by making use of the foundational research in the area as well as addressing problems with existing systems, and be a more dependable, scaleable, user-centric solution for accounting road crashes involving electric vehicles.

3. PROPOSED METHODOLOGY

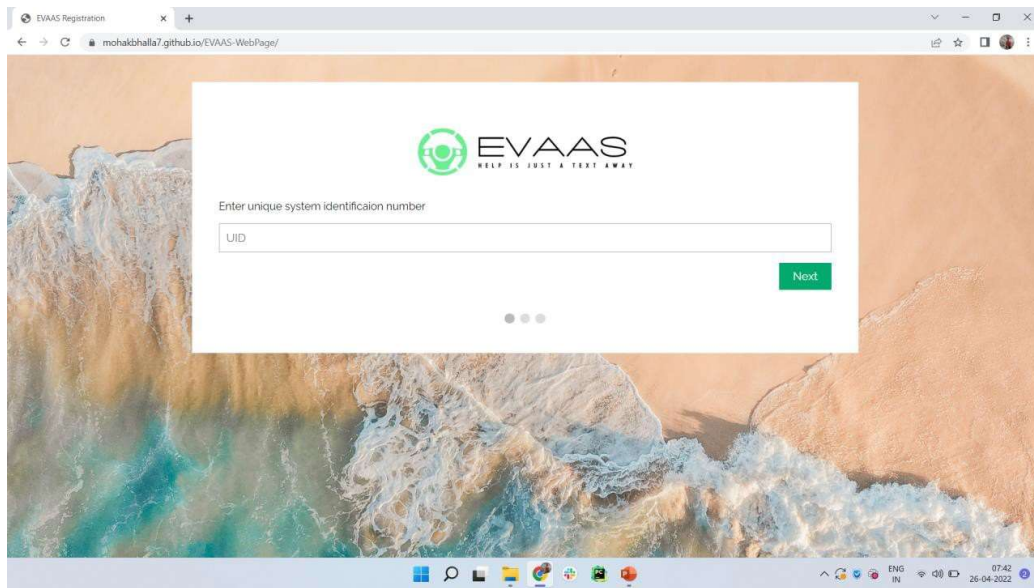


Figure 1: EVAAS Device Registration Web Portal Interface

EVAAS (Electric Vehicle Accident Alert System) is intended to be very efficient pre- and post -accident alerting system. Its key objective is to make traffic safer by warning the driver of impending dangers and even notifying one's emergency contacts if an accident occurs. The approach of the system is broken into three main components: registration and bootstrapping, real-time location tracking and alerting, accident detection algorithm & SOS alert.

First and foremost, the EVAAS is a plug-and-play system that is easy to implement. Once the system is plugged into a vehicle it powers up, however further registration from the user side of things will be needed at EVAAS Registration before they can make full use. It is essential to register driver and vehicle which links the system with a specific, authorized user. As you can see, the portal interface (Figure 1) requires all of the fields to be completed before a user may proceed any further. This step not only maintains the integrity of registration data but prevents registered systems from re-registration, also avoiding sensitive information overwrite writing.

After registration completes, the system initializes and initiates bootstrapping with the cloud server. This phase is when the EAAS pulls in all needed info from server and sets up for usage. This start-up is needed to have all the configurations and initial data in order for it to be operational when deployed on a vehicle. The real-time location tracking and alerting is the second segment of EVAAS methodology. NMEA sentences are post to the cloud, by taking coordinates of GPS continuously from system. Coordinates get fetched by an independent ML server which determines from the coordinates using a machine learning algorithm if and where the vehicle is in an accident-prone zone. This determination is communicated back to the cloud and subsequently read by the EVAAS, which responds with a conforming alert messaged displayed on an LCD integrated into vehicle. This whole process happens in real time and usually gets done within 10 to 14 seconds per cycle. Thanks to this fast processing, drivers are warned in time for potentially avoiding an accident.

If an accident occurs, the system goes to its third part: emergency situation finding as well as SOS alert. EVAAS features an accelerometer in order to gauge the current position of vehicle within three-dimensional space System is pooling these measures and so it takes every time one measure to do for the current reading compared with average of the previous 100 samples. The system will basically determine the vehicle is in an accident if the difference between this sample and average exceed a certain margin.

When an accident occurs, the EVAAS sends a message to emergency contacts that are stored in this system very soon (plus some other information). Inside that text is a link to Google Maps, which leads directly to

the location of the accident. An SOS alert is sent using an GSM module and through AT commands, which would assure a prompt and faultless communication with the emergency contacts. Crucial feature for very prompt intervention in emergency situations and even saving lives by enabling aid to get there faster. When they come together—registration and bootstrapping, real-time location tracking and alerting (and) accident detection along with SOS Alert creates a powerful solution to improving the safety of electric vehicle drivers. As such, the EVAAS combines cloud computing with machine learning as well as IoT technologies to provide a robust solution catered for electric vehicle accidents. Further, the real time nature of its system as well as a greatly efficient automated response mechanism with specific safety precautions detect if a driver is ever vigilant while behind the wheel and acts accordingly should anything be wrong. Inclusive installation - With its plug-and-play design, discerning users can install the VGS anywhere without requiring complicated setups. The required registration sequence is also designed to make sure these alerts are proper configured and tied with the right vehicle (and hence, driver), thus increased reliability/accuracy of this boon. Real-time processing of GPS data and accident-prone area prediction creates preemptive alarms for drivers to prevent accidents before they happen. Even when accidents are inevitable, the accelerometer-based detection as well as instant SOS alerts mean that the automated notifications get activated immediately so rescue operations turn out to be faster and easier. From interoperability to global usage, the EVAAS methodology creates a dependable and efficient collision alert device for electric vehicles that is both accessible yet incredibly advanced. It covers the full spectrum across prevention and response, which is valuable to road safety given its comprehensive nature in light of electric mobility. This design allows the system to be unobtrusively integrated and used effectively by a broad range of users, serving as an important aid during accidents while also lowering road accident rates involving electric vehicles.

4. WORKING IMPLEMENTATION

Table I: Pin connections of ESP8266 with various modules in the EVAAS system

Table I. Pin connections with ESP8266		
ESP8266	Module Pins	
D1	SCL	16x2A LCD
D2	SDA	
D3	A (pin 10)	CD4052
D4	B (pin 9)	4x1 MUX
A0	X (pin 13)	
D5	Tx	SIM900A
D6	Rx	GSM module
D7	Rx	SIM28ML
D8	Tx	GPS module
Vin	5V DC Input	
Gnd	Common Ground	
3V3	Vcc	CD4052 & SIM28ML

Table II: Pin connections between ADXL335 accelerometer and other modules

Table II. Pin connections with ADXL335

ADXL335	Module Pins	
X	X0	CD4052 4x1 MUX
Y	X1	
Z	X2	
V _{cc}	3V3	ESP8266
Gnd	Common Ground	

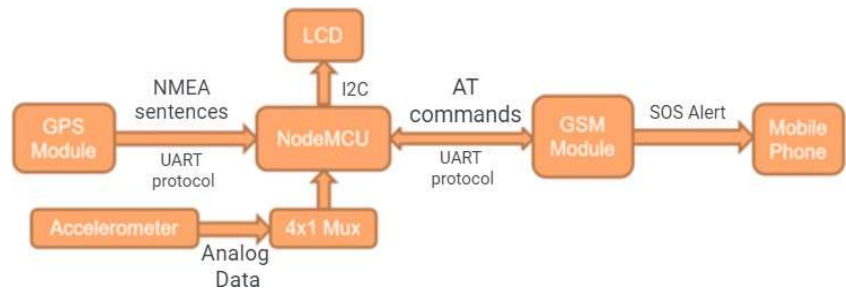


Figure 2: Block diagram of EVAAS system architecture and data flow

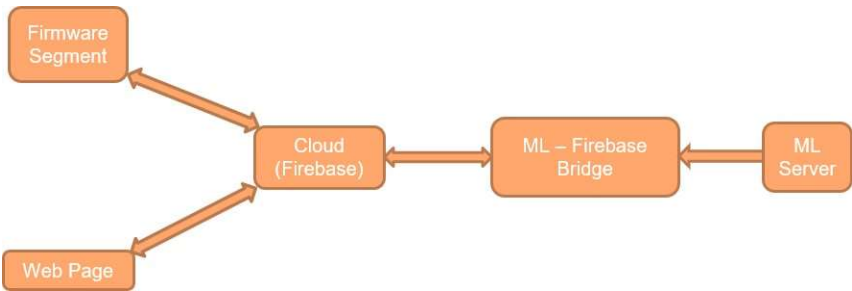


Fig. 3 – EVAAS Dataflow diagram

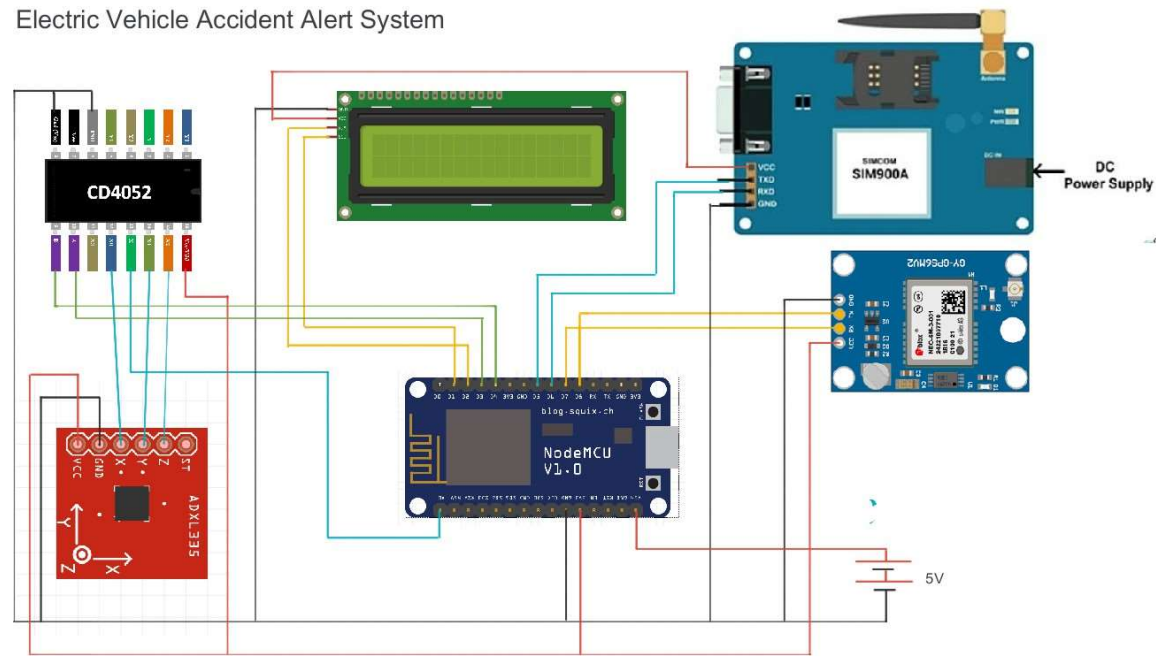


Fig. 4 – EVAAS Circuit Schematic

Table III. Precision Comparison between various classification algorithms

S.No.	Classification Algorithm	Prediction Precision w.r.t our dataset (%)
1.	Decision Tree Algorithm	98.975
2.	Logistic Regression Algorithm	79.254
3.	KNN Algorithm	99.331

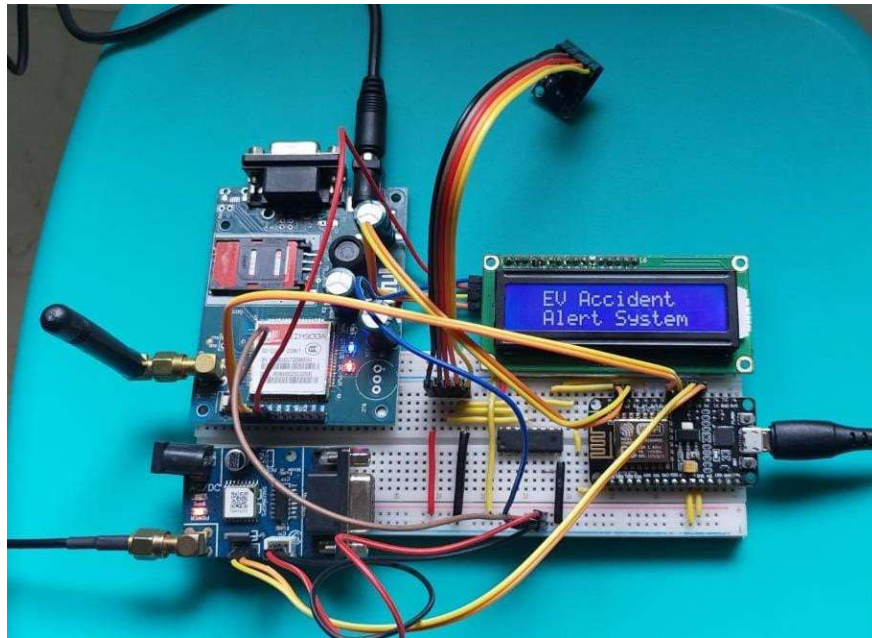


Fig. 5 - Electric Vehicle Accident Alert System

The system installation of the Electric Vehicle Accident Alert System (EVAAS) requires precise fitting hardware and software with each other subsequent to make it operate unobtrusively ultimately preventing electric vehicle crashes. This system consists of a GSM Module, GPS module, Accelerometer and 16*2 LCD & controlled by the ESP8266 Microcontroller. This section explains a detailed discussion on how the EVAAS works implementation wise along with hardware and software information.

4.1 Hardware Implementation

B) EVAAS Hardware Configuration The hardware setup of the EVAAS include necessary connection between different module and ESP8266 microcontroller which is shown as in Table I & II. The GSM module communicates using SMS for emergency alerts, the GPS fetches real-time coordinates of the vehicle and a accelerometer is used to record any sudden change in the orientation(vehicle rolling over which would indicate accident). The 16x2 LCD provides the user interface by showing smart-messages and system status, while the signals inputs are managed using a 4x1 MUX.

4.1.1 Pin Connections

The ESP8266 pin connections to different modules are important for controlling the system. A summary of these connections is given in Table I which makes a furnish all connections to microcontroller pin by their module. In this example, you can see that the Tx and Rx pins of GSM module are connected to D5 and D6 (D9 for RX) of ESP8266 so communication would be done via these microcontrollers. Likewise, the GPS module Tx pin is connected to D8 of ESP8266 for sending GPS data. In this case, I have connected the Vcc pins of both LCD and GSM module to an external DC power supply 12V which is a stable dedicated source running continuously.

The ADXL335 accelerometer will be used to measure the orientation of the vehicle, its connections are specified in Table II. This configuration allows the accelerometer to distinguish important orientation changes, which is needed for accident detection.

4.1.2 Initialization and Boot of the System; Firmware

Firmware that should be used to boot the whole system gradually(Initialized step by Step) This initialization process involves connecting to all required services and systems, making sure every part is alive. This is by design, as the system has been built to be immutable and fault tolerant - always trying again (and enable each component) in case of failure and that the system should never left ill-prepared when it really must perform.

4.2 Software Implementation

The EVAAS software is actually a large portion of the implementation as it uses Google Firebase RTDB to communicate with each edge in the system. By using a cloud interface, the local data exchange belongs to real-time between vehicle ML server and Cloud

4.2.1 Dataflow and ML Integration

The firmware segment of the system operates in a dataflow beginning with retrieving user registration details from cloud during its initialization. After it is activated, the system will then upload the location of the vehicle to a cloud-based network every 60 seconds. A computer independent is running on the ML server that reads these coordinates from our cloud and processes them using a machine learning algorithm called K-Nearest Neighbors (KNN). The ML server processes the coordinates and generates a response (we use this as an input to determine if we are driving in area prone of accidents).

Among the classification algorithms investigated as part of a comprehensive literature survey for this work, KNN algorithm was selected. KNN stores the dataset and computes the distance between Test data point & all other train examples then selects K minimum labels or modes (for regression) from top knn distances. KNN has the highest in terms of prediction accuracy (99.331%) as mentioned above with Decision Tree Algorithm and Logistic Regression Algorithm at 98.975% and 79.254%. This high accuracy guarantees that the alerts will have an unprecedented level of reliability following predictions created by the system.

4.2.2 Web Portal for Registration

A Web Portal is developed for user registration to make the system fully dynamic and self-functioning. This portal will register a user to the cloud, and from there onwards when it is booted up system collects all required data for that particular time over broadband. Its features are intuitive and practical, making it easy for users to complete the registration so they can finally get down installing everything. Do you use any car accessory?

4.3 Circuit Schematics and Data Flow Diagram

The two figures below show the schematic and data flow diagram of this EVAAS circuit: Figure 4. Circuit Schematic for Calculating EVAASE (b) Dataflow Diagram to Compute Effective Address) size as shown in Fig2-1 (indices i, j). Now some briefly overview the source code snippets that compose up this entire file (use regular expression). Figure 4: Circuit Schematic highlighting how the above hardware are connected together precisely (left) with a flow diagram showing data movement from vehicle, to cloud and back, depicting system operation workflow an example of extracted dataset.

The actual implementation of the EVAAS is a showcase for how well hardware and software components can be brought together to sheer ship an accident alert system that meets all requirements in robustness, quality and reliability. Detailed pin connections ensure that every module is wired correctly, while both the functioning of Firmware and interface with Cloud ensures smooth communication and real-time data processing. Moreover, the reliability of these alerts is pretty high as the KNN algorithm tends to give accurate results for its accuracy. A self-service, web-based portal for user registration: it extends the flexibility and ease of use that make transitions fast to deploy and faster in operation. In conclusion, considering its all-encompassing service in providing technology into electric vehicles for improved safety; EVAAS is an exemplary solution.

5. RESULTS & DISCUSSIONS

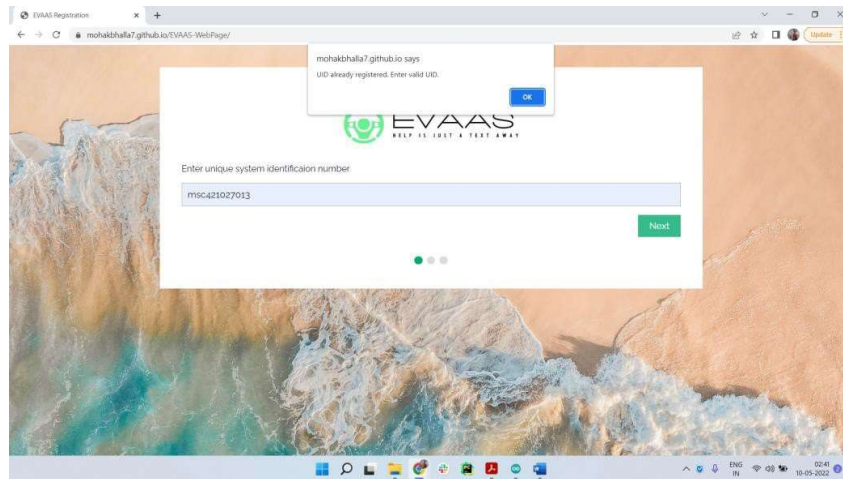


Fig. 6 – Web Portal displaying warning message



Fig. 7 – System displaying warning in when the vehicle enters an accident-prone area

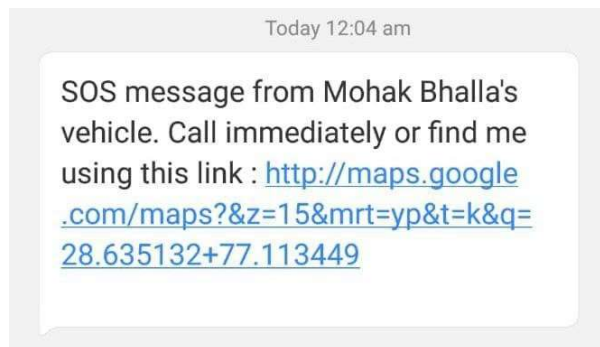


Fig. 8 – SOS Alert message

The results and discussions of the implementation of Electric Vehicle Accident Alert System (EVAAS) depicts various crucial aspects such as effectiveness registration portal, adaptability and CGAL enabled self-improving ML server, detection ability for accident based on accelerometer. Every part of the system is designed to be intuitive, work in a network environment with an absolute minimum dependency on

external Github API usage or third-party libraries ensuring powerful functionality and performant data delivery.

The registration portal is a key component of EVAAS, which provides the dynamically and user-friendly way happened through device related registrations. Where traditional systems might have had user-specific details hardcoded into the system, EVAAS can dynamically register new users and vehicles making it easy for change WITH OUT manual reconfiguration. Scalability is important - the ability to run well across many vehicles and user scenarios, which this flexibility allows us.

The registration portal has quite a few essential features on the security side as well. User safety risk practices that you need to know One such practice is being able to prevent private information of user from modification. When a device is registered by its owner, the system protects this data seamlessly from being changed or hijacked which maintains user-owned information integrity and confidentiality. Another feature of the registration form is that its dialogue boxes are compulsory and cannot be bypassed, meaning vital fields must be filled in prior to completing the sign-up process. It reduces the possibilities of print or wrong data entries, which in turn makes our system more robust and reliable.

Fig. 6 This is the warning message of web portal, this will be part of user experience as shown in next section This helps give users feedback on any problems or actions that must be taken during registration, which makes the interaction with the system simpler and more intuitive.

EVAAS has not just an ML server, as most algorithms and tools have - but one with a self-enhancing component that improves overall prediction accuracy over time. When a vehicle announces an accident, the server stores this location in its dataset. Continuous data collection helps the ML model keeps learning and updating their knowledge of traffic inflows to improve accuracy in defining accident-prone areas. The fact that ML server uses a dynamic customizable thread pool which is able to adapt and add new registered users automatically, without any user configuration, while keeping the system high performance often only becomes apparent when taking multiple loadspots into consideration. This ensures the system is still responsive and efficient as it scales to more users.

Figure 7 : A warning displayed on the system for high accident location detection of vehicle. The real time alerting system is the most important element in preventing any accident as it sends alerts to drivers at right time and hence help them with necessary actions.

The EVAAS hardware also includes an accelerometer, which identifies changes in the orientation of the vehicle. Axis-wise, the accelerometer reads analog outputs for orientation of vehicle. Why it's an accident is if a change of orientation on any axis (and there are about 100) was greater than 50 units, which is approximately equivalent to around 45 degrees. If it gets above this the system considers that a rapid change of direction and thinks you've crashed. When such a case is detected, the system sets off an SOS alert.

Figure 8: SOS alert message sent by the system in case of an accident If the driver does not respond to an alert, OnStar can use GPS technology to help local law enforcement locate them and deploy assistance. This mechanism works automatically, enabling a quick dispatch of assistance that could save lives and make post-crash outcomes less serious.

Attention in the results of these analyses is directly paid to each piece performing a unique role together ultimately making EVAAS effective. This is mainly to allow for slick, secure and user-friendly registration while making sure the system can be flexible and able to scale. A self-improving ML server increases prediction capabilities, a requirement for stopping an accident from happening or reacting in no time. The detection accuracy of the accelerometer allows the system to always recognize crashes and thus timely trigger alarms.

This study demonstrates that EVAAS is an effective and full-proof approach to improving electric vehicle safety. With flexible machine learning models, effective hardware detection, and user-friendly registration processes combined making the system reliable and robust. The dynamism and continuous enhancement of the system demonstrate its capacity to eliminate risks associated with accidents by tailoring responses in real-time while also enhancing emergency-response times, thereby serving as an indispensable support function within the safety-surround for EVs.

6. CONCLUSION

Electric Vehicle Accident Alert System (EVAAS) Option NRG has come up with interesting idea, although not as appealing and straight forward from consumer perspective but this can save countless precious lives by EVAAS. Given these capabilities should an ideal solution for fitting into electric vehicles (EVs), which have underlying traits well-suited to advanced systems such as this, the system is designed to be flexible yet strong enough via next-generation technology. EVAAS has an edge over its current counterparts in the applications on Internet of things (IoT) by adding a machine learning integrated IoT stack. This is where this integration comes in to play, providing more accurate and timely predictions that guarantee the shortest possible communication time for alert.

One of the key elements which make EVAAS prediction system unique is its agility. The system runs faster as it uses data in real time and high level ML algorithms to process accident prone scenarios dynamically, guiding the driver ahead of possible accidents. This rapid response feature can be the key to preventing accidents before they occur and limiting their effects when there is an accident. Rapid real-time analytics capabilities mean the system can send out emergency alerts almost immediately, providing an early warning which could save vital minutes for emergency contacts and first responders in order to prevent fatalities.

Another important piece included with EVAAS is the registration portal as a fuss free and user friendly way to complete device registrations. This characteristic helps for every active phone, that this is registered and accounted intended to keep system running integrity wise. The portal does more than just help you set up your pilot, it keeps an eye on the hardware and manages updates making sure that all devices are operational and in correct configuration. This is a necessary layer of administrative control in order for the system to be scalable and long-term usable.

While there are no perfect solutions, technology affords opportunities to enhance EVAAS. For example, you can replace current GSM module (SIM900A) working on 2G network with the one that supports a new LTE Quor band. This not only boosts the speed and quality of talking but also improves network availability especially where 2G might be phased out. For example, the current GPS module (SIM28ML) could be swapped out with a more powerful model that is able to provide faster satellite connection times. With more rapid GPS connectivity, the system can begin to track and send location data with almost no lag, making it an excellent tool in life-threatening applications where milliseconds count.

7. FUTURE SCOPE

Future Scope Further scope of improvement and expansion are essential with the Electric Vehicle Accident Alert System (EVAAS) as there is a sea of opportunities. The future of EVAAS This is where we can continue to see growth and evolution for this technology as it progresses.

But maybe most hopeful for helping integration in future development projects into domains like sophisticated communication technologies. Right now, the system currently uses a 2G GSM module (designed for accessing GPRS data networks) but replacing that with a newer generation 4G or even still-in-the-works 5Gs could dramatically increase throughput and reliability. This would (and) speed up the sending process of alerts and data in as well, which is also meant to cut down response times when an accident does occur. With all its 5G chanting it would get low-latency communication... which is kind of the foundation for real time application like EVAAS

The GPS module could see a few upgrades besides communication. The next-generation of EVAAS could be augmented to utilising multi-frequency (e. g., GPS, GLON and possible the oncoming European Galileo satellite system) GNSS receiver systems which provide a more precise estimation of location fix in shorter time based using signals from multiple inter-operable satellite constellation systems; This would be especially helpful in an urban environment where satellite signals are often blocked.

Powered by And perhaps an even more future oriented option would be to develop greater refinement using advanced sensors. Swapping the existing accelerometer with a gyroscope or an Inertial Measurement Unit (IMU) would give better insight into what the car is doing and where it's facing. It would allow the system to detect crashes more accurately and thus diminish false alarms, making alerts seem more reliable.

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