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Electric Vehicle Accident Alert System

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Abstract
Electric Vehicle Accident Alert System is a Machine Learning Integrated, IoT based real-time alerting system, operating on ESP8266 microcontroller. Our designed system acts as an alerting system in its truest sense. It uses KNN classification algorithm to analyse the GPS location of the vehicle and generate a prediction indicating whether the vehicle is in an accident-prone area or not. And, if the accident occurs, the Electric Vehicle Accident Alert System sends a SOS alert message with a link to google maps (for directions), to the emergency contact saved in the system. The whole system is based on a plug n play concept, i.e., the system would be ready to use once powered up. To provide this agility and flexibility, we have designed a registration web portal for the device which registers the user and their device with a unique UID on the Cloud. After successful registration, the system becomes ready and can be simply fitted inside a vehicle to be used. Moreover,the ML algorithm saves those GPS coordinates in its dataset to further improve the accuracy of the prediction. The whole IoT stack integrated with ML algorithm, Web Portal and a Cloud server (implemented on Google Firebase), makes our project a self-improving, agile and a user-friendly system.

Keywords –IoT, KNN Classification Algorithm, Plug-N-Play, ESP8266, NMEA Sentences, AT Commands, Real-time Analysis

1.Introduction

In 21st century, where technology is leaping forward with new and new innovations and advancements; There is a side,still in the primitive stage of evolution, but its primitivity has cost countless loss of lives. Death due to unavailability of timely help after the events of a road accident is unfortunate and a point of shame;All the technological advancements done, yet the loss of precious human life can’t be prevented.

1.1. Motivation

In a country like India, a lot of remote locations don’t have much road signs to alert the driver of an accident-prone area ahead. And identifying such a road sign becomes more difficult during the night. This lack of knowledge has cost the loss of a lot of lives to road accidents [15]. A lot of these deaths could have been prevented if someone knew about the accident, and if someone could’ve been able to bring urgent medical help to the injured in time.

With this thought in our mind, we came across a system which could detect an over speeding vehicle and alert the driver to reduce the speed of the vehicle [6]. This system’s alerting concept laid the foundation for our project.

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1.2. Contributions

In a fast-moving world where everything is connected, then the thought of people losing lives due to road accidents at an isolated location is quite disturbing. WHO states, that approximately 1.3 billion people die each year of road traffic crashes [15].Also, between 20 to 50 million more people suffer non-fatal injuries, which have a potential to become fatal if medical help is not given in time.This is where the Electric Vehicle Accident Alert System comes into picture.

- Our system alerts the driver in real time if he is driving in an accident-prone area, so that he can keep his speed in check. This real time alerting system works on a ML algorithm that constantly analyzes the location of the vehicle and sends a prediction about whether the driver is near an accident-prone area or not.
- And if God forbid, the vehicle meets with an accident, our system will send a SOS message, with a link to google maps with directions to the site of accident, to the saved emergency contact in the system.
- Moreover, our system saves the location of the accident in its dataset to further improve it and help make the predictions more precise.
- This can act as an important tool to save lives and provide help during the golden hour of the first aid.

2. Related work

The work done in [6] proposes a system with which they can detect the speed of the user and alert them if they are over-speeding. They collect the data using a sensor and create an audio alert using a buzzer to notify the driver about exceeding the speed limit. Moreover, they have also proposed a complex mechanical system which would control the break drums of the vehicle to apply breaks duly whenever the driver exceeds the speed limit. This mechanism is susceptible to failure and such strict and automated control over braking system could actually cause road accidents.Authors of [12]-[14] have implemented and suggested similar systems which detect an accident using accelerometers, ultrasonic and vibration sensors, and send an SMS alert to the emergency services about the accident. *Patel et al.* [12] have a huge gapping hole in their design as they have not proposed of any component, like LCD screens or piezo buzzers, in their system which could provide any visual aur audio update regarding the status of the whole system. This could make the user doubt the functionality of the system. On the other hand, [13]-[14] have kept a scope for generating system status notifications, but their system is large and bulky. *J.M Bautista et al.* [14] did a survey which concluded that an accident alerting system would be a great help to both, the community and the first responders. And finally, it is strongly suggested in [12]-[14] that more work is required in this domain and the concept has potential to save lives. Taking forward the work stated above,duringour literature review, we cameacross a comparative study between various real-time location tracking techniques for mobile devices. [7]-[9] explained various NMEA sentences and there uses, which were used as building blocks for our project to track the vehicles in real time.

Bokaba et al. [10] have done a comparative study between various ML algorithms like logistic regression, k-nearest neighbor, random forest and AdaBoost for modelling road traffic accidents. Their research shows that random forest gives best results based on their dataset. *Charbuty et al.* [11] has explicitly explained the uses of Decision Tree Algorithm and how it can be used to classify various kinds of dataset.

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3. Proposed methodology

The Electric Vehicle Accident Alert System would primarily work as an alerting system in its truest sense. It would alert the driver to be cautious before the accident and alert the emergency contact of the driver after the accident.

The system's functions can be broadly categorized into three segments.

a) Registration and Bootstrapping

The system is designed on a plug and play concept, i.e., the system would just need to be plugged in the vehicle and it would come online and be ready for use. But before the driver can use the system, they would need to register on the EVAAS Registration portal. Until successful registration is done, the system won't start.

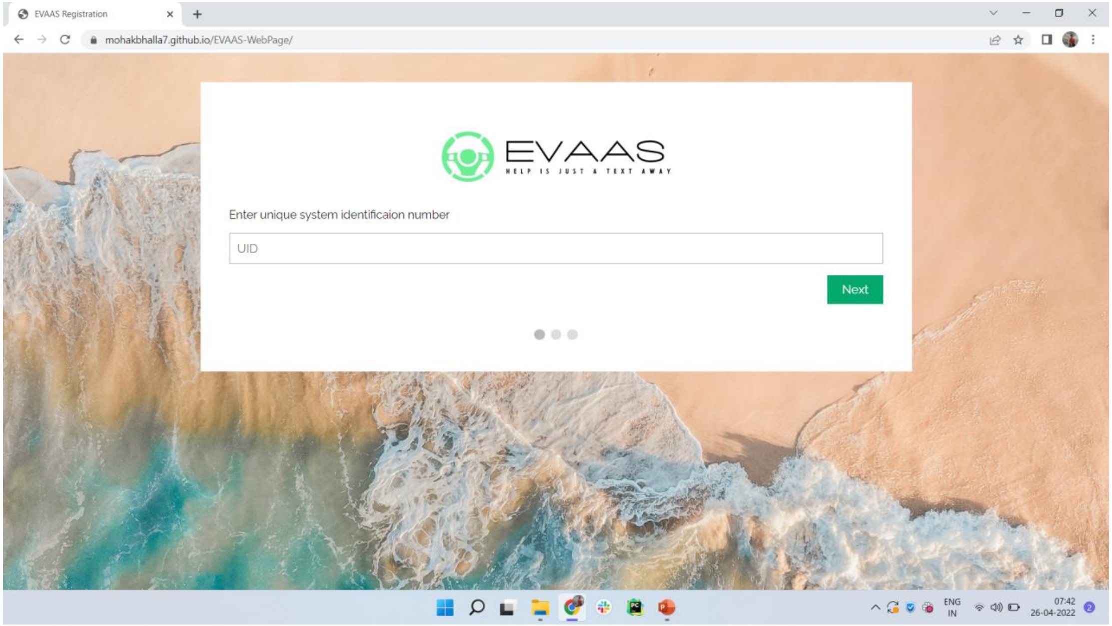

Fig. 1 - EVAAS Registration portal

The portal provides safety measures such as all the fields in the portal are mandatory and the user cannot proceed further without filling all the details. Also, the portal doesn't allow the user to re-register a previously registered system, preventing sensitive and private information from being overwritten or modified.

Once the Registration is done, the system would initialize itself and begin Bootstrapping with the cloud server to get all the required details to start. Only after this, the system would be ready for use.

b) Real Time Location tracking and Alerting

The system constantly fetches the GPS coordinates of the vehicle using NMEA sentences. These coordinates are then published on the cloud. A ML server, running independently, reads the coordinates from the cloud and runs them through a ML algorithm. The algorithm decides whether the user is in an accident-prone area or not, and the ML server publishes that result back to the cloud. Now that result is read by the system and an alert message is displayed on the LCD screen accordingly. All of this happens in real time and it takes about 10 – 14 seconds for one complete cycle to finish.

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c) Accident detection and SOS Alert

The Accelerometer measures the coordinates of the vehicle’s orientation in 3D space and the system analyzes those coordinates. The system samples 100 measurements form the accelerometer and compares the current value with the average of these samples. The difference between the two is compared by the systemwith a threshold. If the threshold is exceeded, the system understands it as a sudden change in orientation of the vehicle and considers it as an accident.

On detecting an accident, the system sends a SOS alert message with a link to google maps (for directions), to the emergency contact saved in the system, through the GSM module using AT commands.

3.1. Working Implementation

a) Hardware

The GSM module, GPS module, Accelerometer, 16x2 LCD and 4x1 MUX are interfaced with ESP8266 microcontroller [1]-[5]. The pin connections with all the modules are listed in Table I and Table II and the circuit schematic can be seen in Fig. 4.

Table I. Pin connections with ESP8266

<table>
<tr><th>ESP8266</th><th colspan="2">Module Pins</th></tr>
<tr><td>D1</td><td>SCL</td><td rowspan="2">16x2A LCD</td></tr>
<tr><td>D2</td><td>SDA</td></tr>
<tr><td>D3</td><td>A (pin 10)</td><td rowspan="3">CD4052
4x1 MUX</td></tr>
<tr><td>D4</td><td>B (pin 9)</td></tr>
<tr><td>A0</td><td>X (pin 13)</td></tr>
<tr><td>D5</td><td>Tx</td><td rowspan="2">SIM900A
GSM module</td></tr>
<tr><td>D6</td><td>Rx</td></tr>
<tr><td>D7</td><td>Rx</td><td rowspan="2">SIM28ML
GPS module</td></tr>
<tr><td>D8</td><td>Tx</td></tr>
<tr><td>Vin</td><td colspan="2">5V DC Input</td></tr>
<tr><td>Gnd</td><td colspan="2">Common Ground</td></tr>
<tr><td>3V3</td><td>Vcc</td><td>CD4052
&
SIM28ML</td></tr>
</table>

Table II. Pin connections with ADXL335

ADXL335	Module Pins	
X	X0	CD4052 4x1 MUX
Y	X1	
Z	X2	
Vcc	3V3	ESP8266
Gnd	Common Ground	

The Vcc of LCD and GSM module are powered using an external DC power supply of 12V.

The firmware is designed in such a way, that it initializes the whole system in a step wise manner, connecting with all the necessary services and systems.

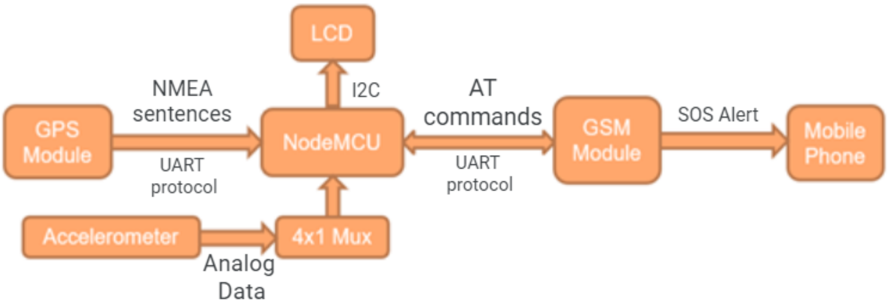

Fig. 2 – Firmware Dataflow diagram and with their communication protocols

The system is agile enough to keep on trying, until every component of the system is initialized and ready for operation.

b) Software

Every segment of the Electric Vehicle Accident Alert System communicates with each other using a Cloud interface (Google Firebase RTDB).

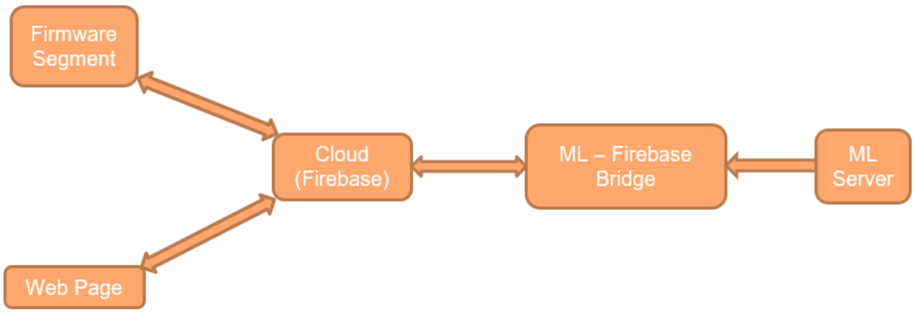

Fig. 3 – EVAAS Dataflow diagram

The firmware segment gets the details of the registered user from the cloud, during initialization, and posts the vehicle's GPS coordinates on the cloud while functioning normally.

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The ML server runs independently on a computer and is constantly communicating with the cloud with the help of a bridge script.The ML server returns a prediction on the bases of the received coordinates using a ML-algorithm based on K-Nearest Neighbor (KNN). KNN works by finding the distances between a query and all the examples in the data, selecting the specified number examples (K) closest to the query, then votes for the most frequent label (in the case of classification) or averages the labels (in the case of regression). Through our literature review, we tried various classification algorithms and finally chose KNN algorithm for our ML-model, because it yields maximum accuracy with respect to our dataset.This makes sure that our prediction is precise to the maximum point. The precision comparison between various classification algorithms tried can be seen in Table III.

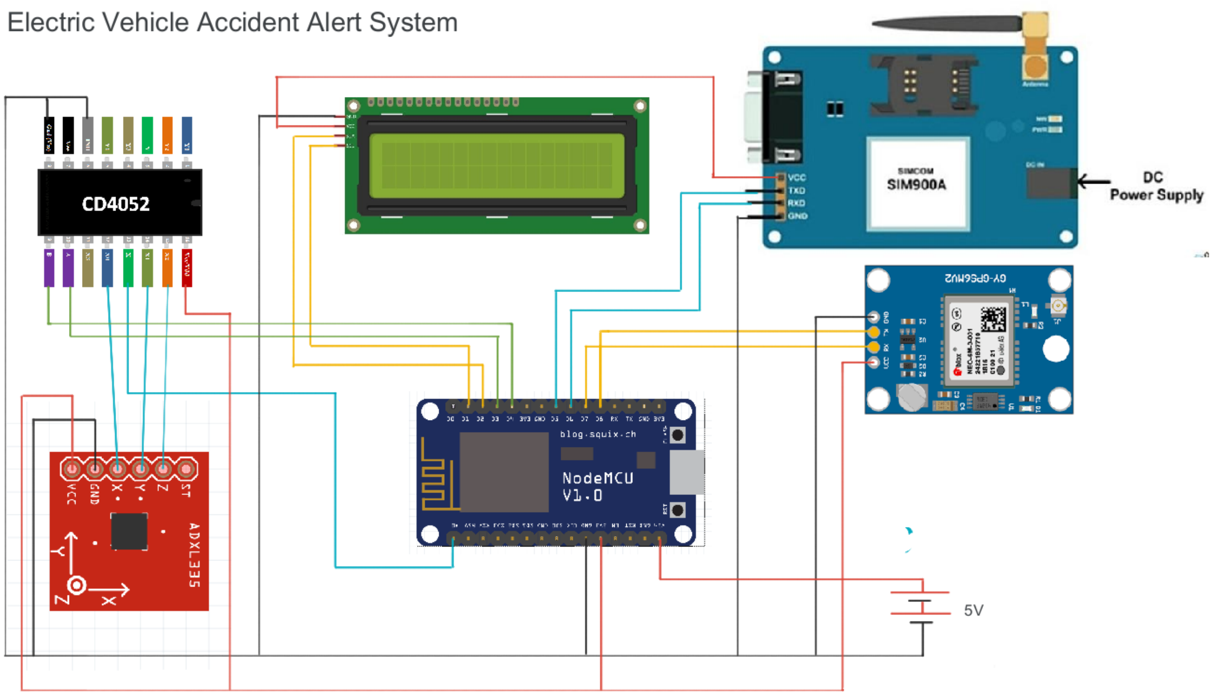

Fig. 4 – EVAAS Circuit Schematic

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

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To make the system fully flexible and self-functioning, we have designed a Web Portal that would register theuser on the cloud. Once the registration is done successfully, the system would be able to bootstrap with the cloud and get all the required user data from the cloud automatically.

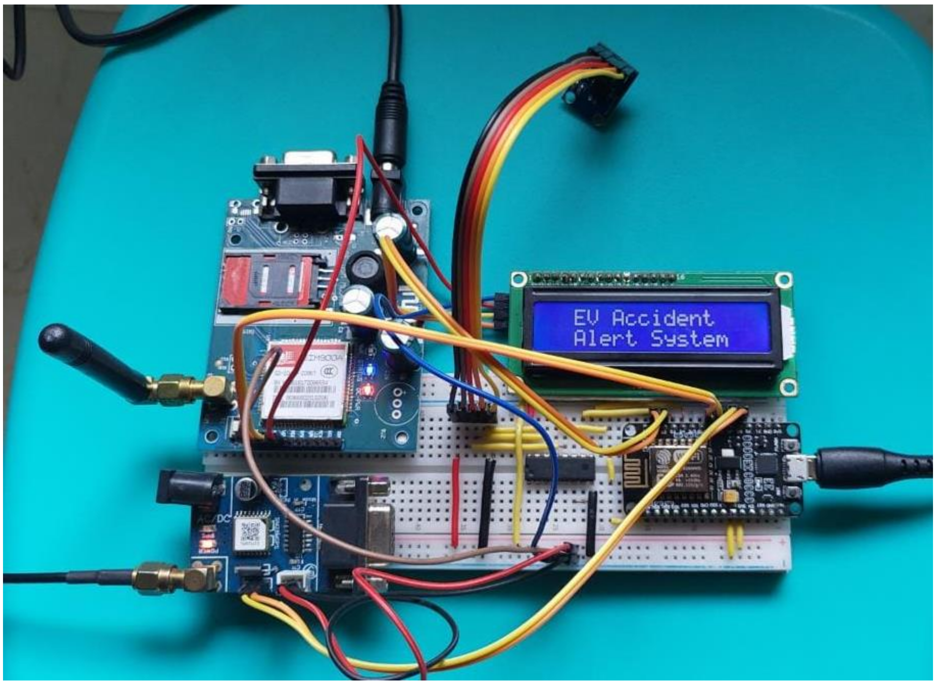

Fig. 5 - Electric Vehicle Accident Alert System

4. Results &Discussions

The registration portal offers a platform to register our device, making it dynamic and user friendly, as no user specific detail is hard coded in the system. Along with being flexible and agile, it also provides security features like prevention from modifying private user information, andunskippable mandatory dialogue boxes in the registration form.

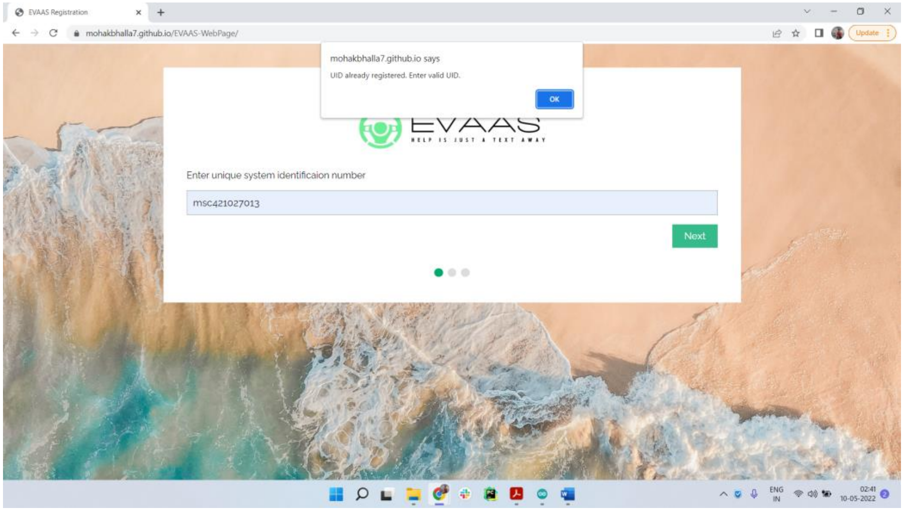

Fig. 6 – Web Portal displaying warning message

The ML server is designed in a self-improving way, such that every time a vehicle reports an

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accident, the server stores that location in its dataset, hence improving the prediction accuracy. Also, the server is dynamic and automatically increases its thread pool to adjust new registered users while the server is running.

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

The accelerometer fitted in the hardware detects the change in orientation of the vehicle. Its analog value changes when its orientation is changed in any axis. So, for our system, if the change in orientation on any axis is greater than 50units – which is around 45 deg. – the system counts it as an accident and gets triggered, which eventually sends a SOS alert.

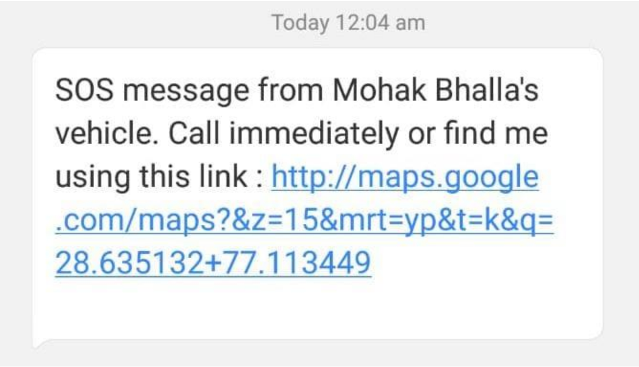

Fig. 8 – SOS Alert message

5. Conclusion &Future Work

The Electric Vehicle Accident Alert System holds potential to bring a breakthrough in saving lives of road accident victims. It is a dynamic and robust system that can be easily deployed in an electric vehicle as it has the mostfavorable environment for a system such as this. The ML integrated IoT stack gives our system an edge on all the other similar existing setups. The agility of our system's prediction ensures that the alert is communicated in time with minimum delay time. The registration portal is the icing on the cake. It makes sure that every active device deployed is registered and accounted for in our stack.

With tremendous improvements in the way the world communicates, the present module components in the system can be replaced to the better and superior models. Like the GSM module SIM900A works on 2G; It can be replaced with a 4G counterpart of the module. The GPS module SIM28ML can be upgraded such that it takes less time to connect to nearest orbiting satellites. The Accelerometer can be replaced with a Gyroscope to get better and more accurate readings of the vehicle's orientation in 3D space. This overall component upgrade can significantly improve the

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performance of our system.

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