IoT based E-vehicle monitoring system using sensors and imaging processing algorithm

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ABSTRACT

Human evolution has included the development of transportation systems. People are currently driving a significant number of fuel-powered automobiles. This resulted in an increase in the number of accidents as well as pollution in the environment. To address the disadvantages of gasoline-based vehicles, this study presents an IoT-based E-vehicle monitoring system (E-VMS) for early accident detection and to make the environment cleaner and greener by using alternative energy. E-VMS employs internet of things (IoT) technology to continuously monitor the vehicle as well as to access and control it remotely. The IoT devices installed in vehicles are built using an Arduino microcontroller and sensors to detect accidents quickly. When an accident occurs, the E-VMS recognizes it quickly and determines the severity of the incident. The machine will then promptly alert the authorities. The E-VMS is also familiar with the GPS system. This will allow the E-VMS to maintain track of the cars' location in real time. This information will be used to locate the car in the event of an accident or theft. The E-VMS system's results were promising in terms of accurately identifying accidents, determining the severity of the accident, and determining the position of the vehicle.

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1. INTRODUCTION

Transportation plays a critical role in getting goods to far-flung corners of the globe in a short amount of time. If transportation is not developed, the market in local regions will be limited, and manufacturing will be constrained to fulfill local requirements alone. As a result, each country's economy would stay underdeveloped. A car is one of our most valuable possessions. And everyone wants to keep it secure and avoid any potential damage. If you engage a vehicle transport service to send your automobile from one location to another, you can be assured that it will arrive safely. New cars come with a set of pre-installed hardware and software that, in most cases, cannot be upgraded after they leave the factory. Cars emit a significant amount of carbon dioxide into the environment, making us vulnerable to pollution and greenhouse gas emissions [1]–[5].

An E-Vehicle is a fantastic step forward in terms of positively assisting the environment in which we live. An electric vehicle has more batteries than a traditional gasoline vehicle. This is the same type of battery that's often used to start a combustion engine. The main difference is that there are more of them in electric cars, which are utilized to power the engine. People's experiences with E-vehicles are increasingly becoming more individualized, similar to what a Smartphone can deliver. Updateability/upgradability and ease of customization are required elements in vehicles and many commercial applications, such as household appliances [6]–[10]. Every car designer is aware of these difficulties, and attempts have been made to incorporate mobile device operating systems for both information and route planning at the same time. However, new study finds that mobile phone operating systems, especially the open software, commonly accessible Latest Android platform, can be used for more important tasks. In the automotive arena, for example, employing sensors for safe driving, interfacing for power flow regulation, and using applications to alter suspension and steering are all conceivable applications of mobile phone functionality [11]–[15]. Tablets or smart phones might be utilized as a module interface to take use of their connectivity capabilities to help with vehicle administration, customization, reconfigurability, and the other daily characteristics that digital objects provide.

Despite how far technology has progressed, the accident prevention and detection methods now in use were put in place decades ago and are all static features such as speed breakers and road signs. In this research, an IoT-based E-vehicle monitoring system (E-VMS) is proposed that uses IoT technology and a sensor-acquainted microcontroller to identify early accidents [16]–[20]. To determine the severity of the collision, E-VMS employs a machine learning-based picture categorization algorithm. The system is also equipped with a GPS and GSM module for locating the car and communicating via a cellular network. This planned work has been completed in various sections of this publication [21]–[26]. The architecture and physical model of the E-vehicle will be discussed in section 2. Section 3 collects data from E-Vehicle drivers and classifies their photographs. The implementation and outcomes will be carried out in section 4. Finally, the results will be presented and discussed.

2. PROPOSED WORK DESIGN AND ARCHITECTURE

The motors, controller, power supply, chargers, and drive train are the primary parts of an electrical vehicles system. For vehicle and motor control, a microprocessor-based controller is employed. To avoid catastrophic failures at this early stage of EV development, control difficulties should be kept to a minimum. The controller takes and manages electrical energy from battery and inverter when the automobile brakes are applied. The inverter then transmits a specified quantity of electrical energy to the motor when the controller is set. Electrical energy is converted into mechanical energy by an electric motor. The gearbox spins while the motor rotor turns, causing the wheels to revolve and the automobile to drive. The components of an E-vehicle are depicted in Figure 1. Computer-aided design (CAD) and computer-aided engineering (CAE) technologies were used to develop the automobile. Figure 2 shows the CAD model of the vehicle, whereas Figure 3 shows the real prototype.

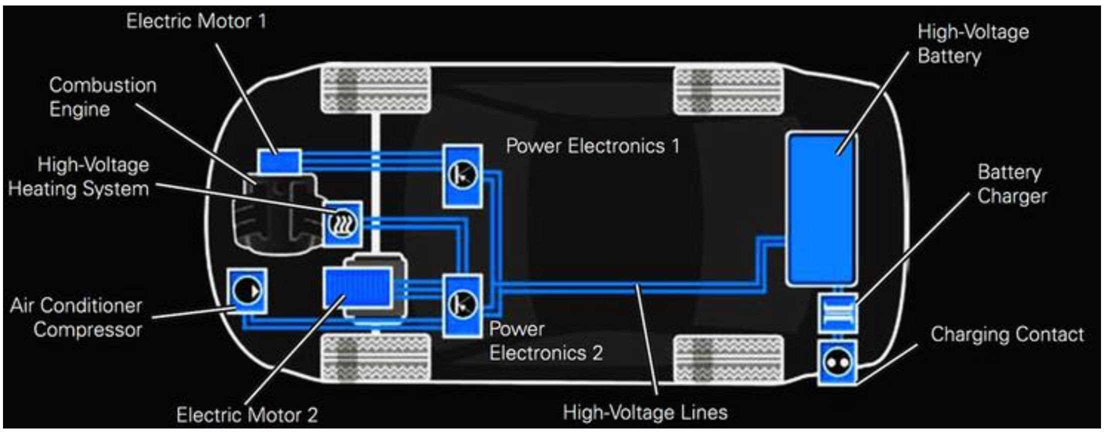


Figure 1. Components of E-vehicle

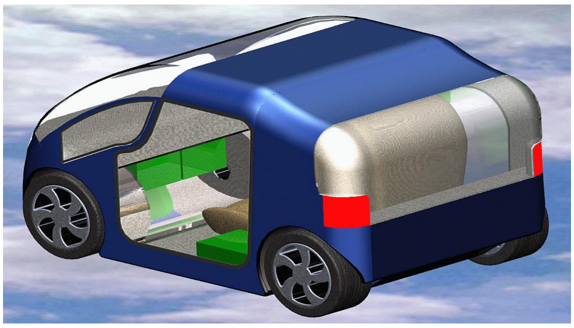


Figure 2. 3D model of proposed system

Figure 3. Physical prototype model of proposed system

For safety reasons, the monitoring and communication module must be activated after the effective delivery of E-Vehicle design. It is impossible to forecast all accidents with any available technology. As a result, we must at the very least be able to recognise mishaps as soon as feasible. Any human or animal that is harmed in an accident must receive medical attention as soon as possible. People who are wounded in accidents frequently do not seek early medical attention, either because they misjudge their injuries or because of the legal procedures involved in accidents. Even if a person appears to be in good health, it is always a good idea to have any injuries checked up.

The fundamental purpose of the E-VMS suggested in this research is to identify accidents quickly, evaluate the driver's condition, and notify authorities, all while using green energy. The E-VMS was not a simple system, but rather a framework for detecting serious incidents quickly. E-VMS also allows the user to remotely disable the vehicle in the event of theft. It also allows the user to track the whereabouts of the car from anywhere on the planet. The E-VMS comprises an Arduino controller, as well as several sensors, a GSM/GPRS module, and a GPS module, to accommodate all of this [3]. Figure 4 depicts the general design of the E-VMS [2]. The Internet of Things system consists of an Arduino board with various sensors, a webcam, a GSM/GPRS device, and a Gps receiver.

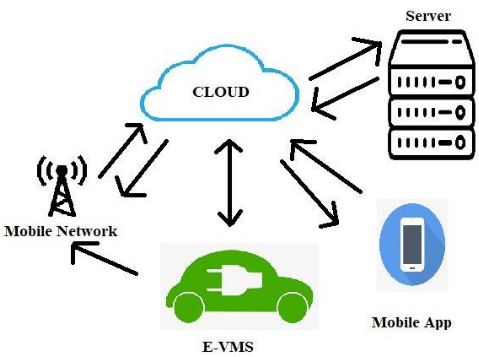
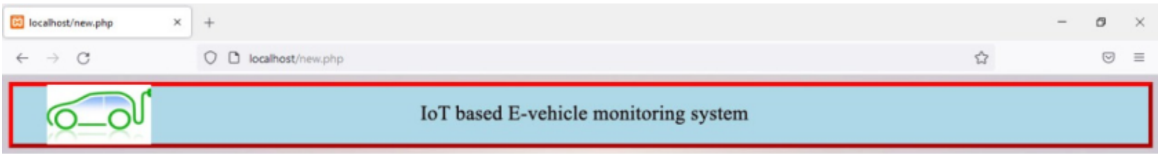


Figure 4. Architecture of E-VMS

Any change in acceleration in any direction may be detected, as can any tilt or rotation. Since a few decades, the impact sensor has been used in automobiles to detect collisions and activate airbags. These sensors are used by E-VMS to detect any mishaps. The accelerometer data are continually monitored, and will identify an accident if the acceleration or deceleration exceeds a threshold or the sensors is angled more than a particular degree.

When an accident occurs, the Arduino controller is also fitted with a camera to capture the driver's view. The photograph will then be transferred to a server, which will analyse it and use machine learning and image categorization to determine the severity of the accident. The Arduino controller will then extract the severity level and send an alarm to the authority with the level of severity and location. With the GPS module installed, the position of the accident may be determined [3]. Whenever the car is stolen, the owners may simply push a button on the online user interface to turn off the car's fuel system. The car's fuel relay switch is linked to an Arduino controller, allowing the operator to shut off the car remotely.

The E-VMS framework employs a server to give users with a user interface that allows them to view the vehicle's position as well as control it online. The web user interfaces are shown in Figures 5 and 6. Once a user logs in to the server, they may turn on/off the gasoline relay switch in the car and view the vehicle's current location in Google maps, as illustrated in Figure 5. The user may examine the history of the vehicle's prior locations, as illustrated in Figure 6. The accelerometer and the impact sensor are both included in the Arduino controller. Any rapid shift can be detected by the accelerometer sensor in E-VMS.



Vehicle number M-012
Chassis number: ZFRK1457QI

S.No	Date	Time	Latitude	Longitude
1	15.01.2022	12:10:33	27.2046° N	77.4977° E
2	16.01.2022	13:10:33	27.2046° N	77.4977° E
3	17.01.2022	14:10:33	27.2046° N	77.4977° E
4	18.01.2022	15:10:33	27.2046° N	77.4977° E
5	19.01.2022	16:10:33	27.2046° N	77.4977° E
6	20.01.2022	17:10:33	27.2046° N	77.4977° E
7	21.01.2022	18:10:33	27.2046° N	77.4977° E
8	22.01.2022	19:10:33	27.2046° N	77.4977° E
9	23.01.2022	20:10:33	27.2046° N	77.4977° E
10	24.01.2022	21:10:33	27.2046° N	77.4977° E
11	25.01.2022	22:10:33	27.2046° N	77.4977° E
12	26.01.2022	23:10:33	27.2046° N	77.4977° E
13	27.01.2022	00:10:33	27.2046° N	77.4977° E
14	28.01.2022	01:10:33	27.2046° N	77.4977° E
15	29.01.2022	02:10:33	27.2046° N	77.4977° E

Figure 5. E-vehicle monitoring system location history

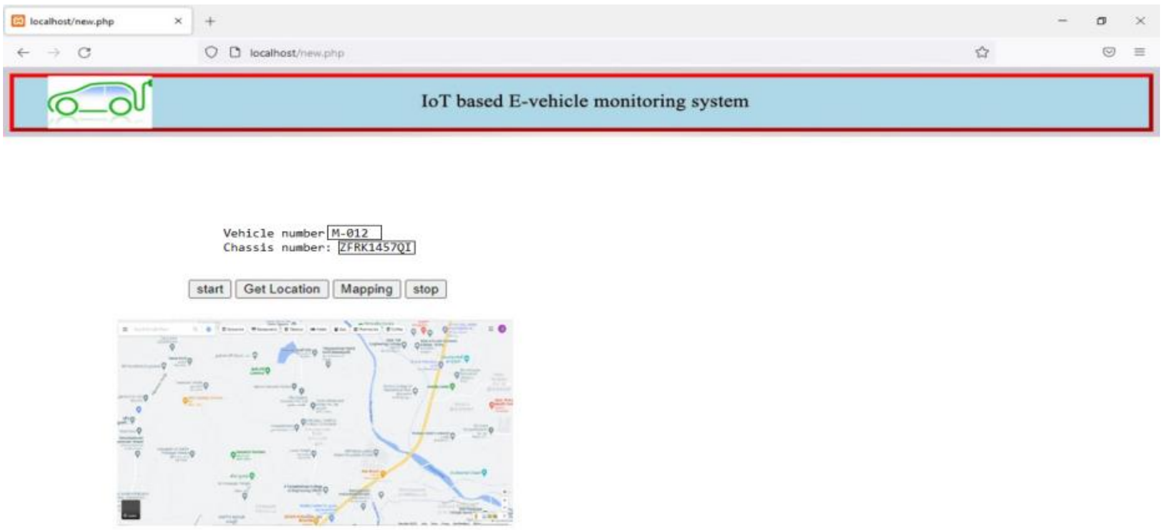


Figure 6. E-vehicle vehicle control system and location map

3. DETECTION AND CLASSIFICATION

Accidents are detected quickly by the E-VMS, which employs accelerometers and impact sensors. As previously stated, the E-VMS system includes an Arduino controller with an accelerometer sensor, a collision sensor, and a webcam for data collection from the vehicle. The microcontroller is attached to a relay switch to control gasoline supply and turn on/off the vehicle. The unit is also coupled to a GSM/GPRS module, which allows the controller to connect to the internet and cellular network [16]–[18]. The module includes a GPS module for determining the vehicle's geographic position.

An accelerometer or gyroscope sensor is an electromechanical device that calculates accelerating force due to mass movement relative to electrodes. In the suggested model, a 3-axis accelerometer was employed for this purpose. This sensor operates at a very low voltage of 3.6V. Any acceleration up to +16g can be detected by the sensor. In the E-VMS system, an impact sensor was employed to detect any hit or collision. It runs on a low voltage of 3-12 volts. In the event of a collision, it outputs a low signal; otherwise, it outputs a high signal. The Arduino camera has a resolution of 16MP and is used to snap images of the car driver. [19], [20] When an accident occurs, the controller activates the camera and captures an image, which is then sent to the server. A machine learning technique was used to classify the images [12]. The algorithm is depicted in Figure 7.

Figures 8 and 9 illustrate two sets of photos that were fed into the classification model to investigate and analyse it. The photographs in one group are of aware individuals, whereas the images in the other set are of unconscious people. An image classification model was created using these two sets of training photos. When an accident occurs and a picture from the car is obtained, it will be classed as conscious or unconscious. As illustrated in Figure 7, the photos are transformed into Haar-like characteristics before being fed to the E-SVM classifier model. This label will be sent to the controller, who will inform the authorities via the GSM module.

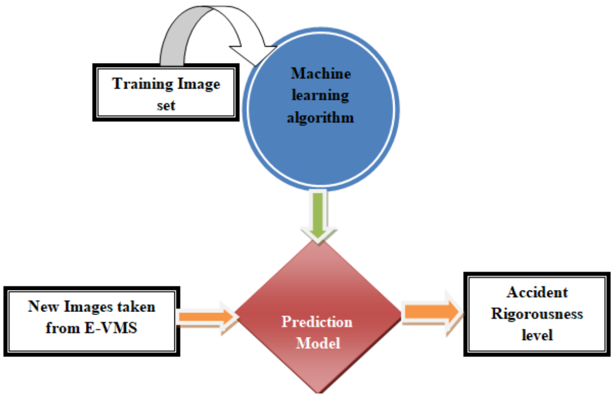


Figure 7. Accident rigorousness recognition Model using Machine Learning

Figure 8. Image set for conscious person

Figure 9. Image set for unconscious person

4. RESULTS AND DISCUSSION

Open source software was used to create all of the E-VMS software components. The image classification model was created using Python and OpenCV on a Linux server. The web application was created using Apache, MySQL, and PHP on the same Linux platform. The Internet of Things gadget is powered by an Arduino controller with an accelerometer and an impact sensor. GSM/GPRS and GPS modules were also linked to the controller. Also it comes with a camera mounted directly on the board. The E-VMS system was installed and tested in a tiny automobile. The system's outcomes appear to be encouraging. The image analysis model has been trained with two pairs of pictures, as shown in Figure 8 and Figure 9. As stated in the preceding section, the image classification classifier was tested with 2 sets of images, as shown in Figure 8 and Figure 9. HTML and PHP are used to create the website, which is hosted on a Linux server.

When an accident occurs, the E-VMS detects it and sends a message to the registered mobile numbers, such as the police, hospital, and family members, as illustrated in Figure 10. Whenever the car is stolen, the user may log in to the server and view the vehicle's position history, as seen in Figure 4, as well as control, i.e. turn off the car's fuel source, by pressing the button just on user experience, as shown in Figure 6 and Figure 7.

Figure 10. SMS alert when E-vehicle gets accident

5. CONCLUSION

Accidents will be identified promptly with severity levels utilizing the E-VMS and will be reported to the authorities without waiting. Urgent medical care will help to limit the incidence of fatalities and serious injuries in car accidents. This might also assist traffic officials in diverting traffic, saving time and money.

The frequency of car thefts will progressively decrease since this will assist the user in locating and controlling stolen automobiles . Providing security to public and private cars is the most important issue in today's environment. As a result, when a car is lost or concealed, a vehicle tracking system is suggested to determine the vehicle's precise location. The position is tracked using GPS technology, and the information is sent to the user using GSM. To ensure security, a tracking system and an anti-theft system have been designed. It is mostly used in fleet management, transportation systems, military applications, school buses, and public transit vehicles, among other things.

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