Smart Detection of Vehicle Accidents using Object Identification Sensors with Artificial Intelligent Systems

P. Amrith, E. Umamaheswari, R.U. Anitha, Devi Mani, D M Ajay

Abstract: ***According to Government of India, around 1,46,000 people [20] lost their lives in five hundred thousand of accidents, where 7% of lives could have been saved if they would have got medical attention before-hand [21]. This can be achieved by intimating the accident to the nearby emergency unit in minimal time by using artificial intelligence based on the severity of accidents. In existing methods, the accidents are detected using On-based unit, and transmitted to the control unit using nearby antennas, where the severity of the accidents are classified using data-mining. Then the fetched data is compared with existing accident dataset which it is retrieved from previous accidents, the analysed results are then transmitted to the nearby emergency unit [1], [2]. This will lead to ambiguous prediction of data because if the data doesn't exist in the database, intensity of accident must be analysed manually in which it leads to increase in time complexity for transmitting the data to the nearby emergency unit due to intermediate infrastructure. To overcome these drawbacks, in this proposed system the accidents are detected using sensors and the severity of accident will be calculated using machine learning algorithms like k-means clustering and Support vector machine (SVM) classification under reinforcement learning with help of force and impact obtain while vehicle crashes, then the values are transmitted to the nearby emergency unit using Breadth-first-search in the form of A* Search algorithm.***

Index Terms*: Vehicle Accident Detection, Smart Sensors, Support Vector Machine (SVM), K-means, Reinforcement Learning, Breadth-First-Search (BFS)*

I. INTRODUCTION

In present days, driving a vehicle is insecure (especially Two-wheeler) [2], [3] reasons being path-holes, rash driving, reckless driving. According to Government of India, around 1,46,000 people have
lost their lives in accident, and in that around 7% of the victims had been died due to tarrying in admitting the victim to the nearest hospitals [20]. To reduce these types of causalities, many projects have been published. The existing works which are published in various journals can only prevent the accidents, but in few journals proposes methods of reporting accidents to the nearby emergency unit using Automated systems. In this proposed work, sensors detect the accidents and classification of data is achieved using machine learning algorithms to find the severity of accident. After finding the severity it transmits the predicted severity to nearby emergency units. Sensors are used to detect the severity of accidents, hit of a vehicle.

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Here SVM and K-means under reinforcement algorithm is used for prediction the intensity of accident in which the real-time data are fetch as an unlabelled data using Raspberry pi and will be send to IBM IoT-Watson with help of Bluemix and node-red through network [22]. In IoT-Watson, Machine learning algorithm is implemented to prediction the severity. First the data set will be cluster into two-variant cluster data using k-means clustering algorithm and prediction will be done by classifying the data-point with clustered data using Support Vector Machine (SVM) classification algorithm [4].The classified data is also called as predicted data. Capacity sensor is used to detect whether the person is inside the vehicle or not with in-build facilities. The vibration sensor is used to detect the force and impact of the accident. The ultrasonic sensor is used to identify the object with which held in collision. The load-cell sensor is used to identify the mass or weight of the person who drives or transport through the vehicle. The retrieving of data from sensor is done with the help of Raspberry pi. The in-build accelerator is used to find whether vehicles are in motion or not. The load cell and load sensor are used to detect the mass or weight of the car. In this work, the sensor data is transmitted through Wi-Fi using mobile network. In some cases, if the network doesn't exist or if the victim doesn't have mobile phone, then Ad-hoc network is used to transmit the data as given in [14], [23]. Ad-hoc network is a type of wireless network which does not rely on a pre-existing infrastructure. This Wi-Fi or Ad-hoc network acts as a medium to transfer data. This also transmits the location of Accidents. Camera is fixed in both rear and back side of vehicle which captures the image of hitting object which helps to solve hit and run cases. This work will be implemented in all type of vehicle including two-wheeler. The predicted data will be sending to nearby emergency unit as an SOS message using BFS algorithm in the form of A* search algorithm.

According to the survey of published paper's, accidents are detected with the help of data mining as given in and severity of accident is measured. It means that the accident will be detected with the help of sensor and transmits through on-based unit (OBU) i.e. vehicular network through Antenna's which is placed near to accident spot and will be received by the control unit [5]. Real-time fetched data are compared with the accident dataset which is already stored in the database with help of previous accident data's using sequential pattern data mining and then the severity of accident will be confirmed.

This will lead to long process of prediction and if the database doesn't contain previous data similar to recent data then the user's review will be considered. The main drawback of this work: Suppose if the data is unavailable in existing database, then the manual comparison of data takes place with the help of users. Since the data is compared with the previous accident data, in some cases this will lead to reporting of accidents unnecessarily In another project, the object detecting sensors are spatially distributed along the road to find the speed of the vehicle as given in [6]. These data are transfer to the neighbour sensor, if the two vehicles slow down at same rate which decides that accident takes place. The data are transmitted to control unit using wireless sensor network. This has a drawback that the cost of installation will be high and there is the chance of detecting false incident and this method won't be able to helpful to find the severity of accident. The accidents are also detected, and severity of accident is predicted using driver drowsiness which is also used to find accident based on behaviour of the driver as given in [3]. This work indicates that state of driver while driving. In case if the driver was in normal state but the accident occurs in which it has more probability to occur, in that case this proposed work will fail. This also has a drawback in that the accident will be predicted only based on drowsiness but not for other victims.

II. PROPOSED SYSTEM

In the proposed system, the accident is detected using proximity sensor, capacity and vibration sensor. When accident takes place, sensor detects the object in which sensors are placed in all four sides of the vehicle. In two-wheel vehicles, the sensors are placed in central body of vehicle to detect the accident easily. When the sensor detects the accident, then the signals are received by processor (raspberry pi) will be transmitted to IBM IoT Watson with help of IBM Bluemix, via node-red for analysing the retrieved data and measuring the severity of accident. The cloud environment is used in this proposed system for the following advantages: scalability, reliability, more processing speed, almost unlimited storage as given in [7], [8]. Here data is transmitted to Bluemix through wi-fi or ad-hoc network with the help of node-red as given in [9], [10]. In this proposed system, severities of accidents are measured by using force and impact of clash between two vehicle or vehicle-object [24],[25]. This force and impact are detected using vibration sensors. Severities of accidents are also measured using capacitive sensor and movement of wheels, where the sensor is used to detect whether persons are placed inside the vehicle or not. Severity of accident is processed in IoT Watson. Machine learning method in which the accident dataset is clustered and classified to find the severity of accident as given in [11], [12] with the help of reinforcement learning algorithm given in [26], [27] and then data will be transmitted to nearby emergency unit using breadth-first search algorithm in the form of A* search algorithmas given in [28] [29] along with location details of accident, as referred in [13]. In this proposed system camera is installed in both front and rear side of vehicle to capture the image of the hitting object to solve crime accidents like hit and run when sensors detect.

A. Detection of Accident

In this module, accidents are detected using sensors. Four Sensors are used to detect the accident they are capacitive sensor, vibration sensor, Load Sensor and ultrasonic sensor. The capacitive sensor is a type of sensor which is used to find capacity of the object. In this work it is used to detect whether person is placed inside the vehicle or not, if the person sited inside the car or not. Suppose, if the person sited inside then capacity of the car increases which will be detected by capacity sensor. The vibration sensor is a type of sensor which is used to detect the object vibration. Vibration sensor is used to detect the force and impact of the object. When the accident takes place the hitting of vehicle will have some force and produce some impact which will used to detect the severity of accidents. The ultrasonic sensor is a type of sensor which is used to detect the nearby object. Ultrasonic sensor is used to detect hitting object and activates the camera to find whether it is accident or criminal activity. The camera is placed in overhead of the vehicle to prevent from damage when a vehicle meets with an accident. Load sensor is a type of sensor which is used to find weight or mass of an object with help of Load cell. Load sensor is used to detect the mass of car to find changes in weight of car while the person is inside. This will be used to find mass to calculate the Force of impact. After detecting the accident these sensors send the data to the single board processor called Raspberry pi which is used to transmit the data's as sender. Combining the sensors data and classifying them to find the severity of accidents as well as hit and run cases.

B. Transmission of Accident data

After detecting the accident using sensor, the data are transmitting through Wi-Fi or Ad-hoc network. Wi-Fi is a type of wireless connection used to transmit network connections as well as the data. Here in this module Wi-Fi is used to transmit as given in [14], [30] the data of the accident through victims mobile where the raspberry pi will be connected to the victim's mobile using Wi-Fi. If the victim doesn't have Wi-Fi in their mobile or if there is lack of network, Ad-hoc network as given in [14], [23] is used to transmit the data.

C. IoT Watson and Cloud processing

Severity of accident is predicted in IBM Bluemix cloud as given in [22]. When the data are retrieved from the sensors, the hardware processor (Raspberry Pi) is connected to the IoT Watson after enabling IoT service and connected through Device Id [14]. Sensors is linked to the node-red and then linked to the IBM Bluemix after that the data will be processed in IBM IoT Watson. IBM IoT Watson is an enterprise artificial intelligence (AI) assistant that helps businesses enhance brand loyalty and transform their customer experiences by delivering proactive and personalized services while ensuring data privacy [7], [8].

It is SaaS Cloud which helps the developer to build the IoT application, AI agents and Products, Computational Intelligent Models as given in[15], [16] etc.

D. Predicting Severity of accident using Machine Learning

To find the severity of an Accidents and impact of Accidents, machine learning concept [17], [18] is used to predict and analyse the severity of Accidents. When the real time data is fetched, by using reinforcement learning method as given in [15], [27] the data will be processed. Then the machine will be trained before testing by pre-processing method and then train the system. When data is fetched from hardware systems, it will be sent as a slice of window into engine where the data will be normalized to minimize the redundancy and clustered as given in [31] to find the range of data using k-means algorithm and labelled. Then the clustered data will be classified using classification method Support Vector Machine as given in [18], [19] with labelled as low priority and high priority, then with the help of distance from hyper-plane classify the data and then prediction will be done. The severity of accident is calculated with help of force and impact of an accident crash with predicted data as given in [24], [25]. The system is trained with the pre-processed accident dataset in which the training will be done with the help of force and impact formula given below. The Force is detected by using the data in sensors, where the distance is measured using Ultra-sonic sensor and velocity is found by vibration sensor and mass is calculated using load sensor [24], [25]. The Force is calculated using kinetic energy and work equal to

$$W=K*E \quad \ldots. (1)$$

Which is nothing but force and distance, that is equal to

$$F= (0.5\text{^}m\text{^} v\text{^}2)/d \quad \ldots. (2)$$

and measured in Newton. In the above equation m is the mass of the object in which it detects by using load sensor, v is velocity measured by using Vibration and accelerator sensor and d is distance measured by ultrasonic sensor.

E. Reporting of Accident

In this module, accident data is transmitted from IoT Watson in Bluemix to nearby emergency unit by using Breadth-first-search (BFS) in the form of A* search algorithm after enabling the gate-way of nearby emergency unit in Bluemix. After predicting the severity of accidents, the predicted output data is transmitted as SOS messages to nearby hospitals, police station and Ambulance is searched using A* along with the locations as referred in [28], [29].

The A* algorithm combines features of uniform-cost search and pure heuristic search to efficiently compute optimal solutions. A* algorithm is a best-first search algorithm in which the cost associated with a node is, as given in [16], [28]

$$f(n) = g(n) + h(n) \ldots (3)$$

Where,

g(n) = cost of the path from the initial state to node n

h(n) = heuristic estimate or the cost or a path from node n to a goal

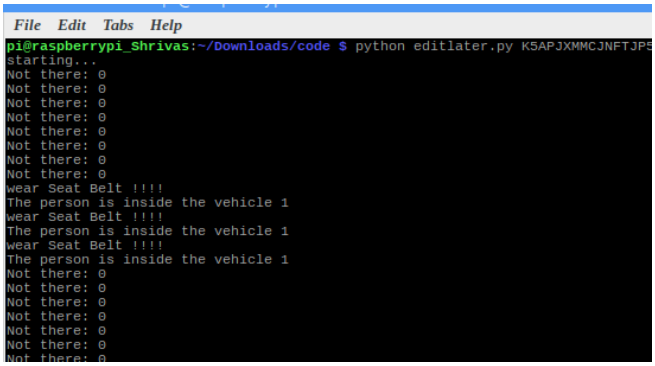
f(n) = the lowest total cost of any solution path going through node n.

Table 1. Represent the format for retrieving Data from sensors

Threshold of Sensor Data	Yes	No
Person Inside or not	1	0
To check whether object inside is person	Value of measured weight of person	Nil
Vibration	N=1	N=0
Distance	Distance of an object	Nil
Mass	Mass of an object	Nil
Accelerometer	Value of vibration	Nil

Table 1 represents the value of retrieved data from real time environment using sensors. In first row it describes the person inside or not, second and third is represents the vibration of the hit and distance. Mass and Accelerometer represents the weight of the vehicle, presence of person inside the vehicle and Hit speed of vehicle. This is used to find the fuzziness of the system[13], [29], especially to find sensing data which clarifies the existence of severity. This table represents the Predict values of sensor data where capacitive sensor which detects the presence of human inside the car and vibration sensor which detect the vibration of crash is binary dependent variable. Remaining sensors detect the unlabelled data.

The below figures show that sensor detection of data from crash of vehicle the graph of the prediction.



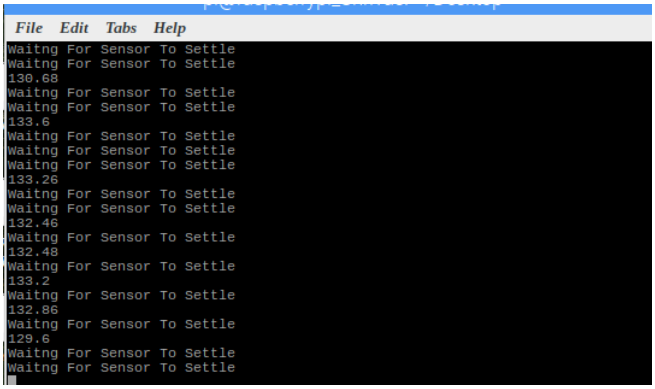


Figure 1. Outputs of Sensor Data's and predicted Data

Here in the above results the Accident is detected using sensors and then predicts the severity of Accident by transfer the data to Cloud and perform Machine learning.
The results of proposed system overcome the existing system by detecting the severity of accident is done by analysing the speed and impact of the accident using sensors and calculated using Machine learning algorithm in real-time detection rather than comparing with existing database and reporting to the nearest emergency unit using BFS algorithm.

III. ARCHITECTURE

The above experiment setup clearly shows that the flow of data from sensor to the IBM Bluemix and IoT Watson engine in which the prediction takes place and send as a message to nearby emergency unit. In the above architecture,when the vehicle held in accident,the sensor which is pre-installed to detects the accident if occurs, transmit the data to Raspberry Pi or other embedded processor with which it gets connected for processing. From Processor through Node-red

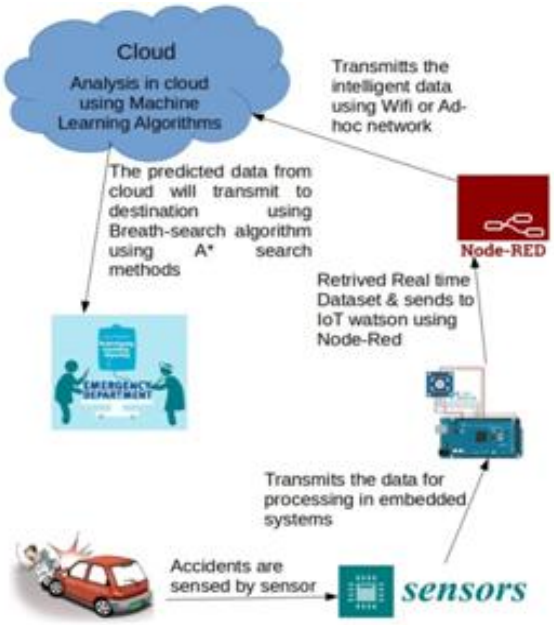


Figure 2. The architecture of the proposed works

and Bluemix sends the retrieved data to IBM IoT-Watson through network in which the prediction takes place and if severity of output value is high, predicted data will be transmitted to the nearby emergency unit using A* search algorithm else it neglects the data for transmission.

IV. CONCLUSION AND FUTURE WORKS

This work will reduce the number of deaths in accidents by reporting the incident to the nearest emergency unit at the earliest. This work will also be used to help police to find the crimes and hit-run cases. In Future, this work will be extended to indicate the driver about the possibilities of accident occurring by using machine learning and ensure the rate of speed of intimating the accident to nearby emergency unit will be increased along with victim's details.
In Future, the exact location name will be detected and transmitted using Map. Entire insurance policy detail of people will be embedded into the system. The criticality of the accident with the patient details will be automatically sent to the insurance agency.

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