A survey on Road Accident Detection and Reporting

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ABSTRACT: On road accident is a major issue of concern. Even with all modern developments in the field of vehicle design, road lane design and management, accidents do occur. Timely accident detection and taking immediate action with respect to emergency health care of victims by informing an emergency center such as a hospital or a police station about the accident on time plays a vital role inhuman safety androad traffic management. Accident detection can be done under various domains. Most of the papers surveyed use application of sensor technology, besides trying to detect accidents automatically using machine learning and computer vision from surveillance systems. Any kind of accident detected is automatically sent as an alert to the required destination. Each of these methods has different percentages of accuracy and their own limitations. This survey paper discusses various approaches to detect the occurrence of traffic accidents on a road supervised under surveillance camera.

Keywords: Accident monitoring, Accident detection, Accelerometer, GSM, GPS

Introduction:

According to the Global status report on road safety 2015 [1], the total number of deaths caused due to road accidents has levelled out at 1.25 million a year. India faces the highest number of accidents and accidental fatalities in the world. In India, there are many kind of places like hilly area plateaus, and due to improper road facilities accidents are more and death rate due to this accidents are more [29]. The maximum number of accidents are reported in the transport sector, that is, on road as well as railways. Some approximations claim that Indian roads alone accounted for approximately 105,000 accidental fatalities in 2010. This is almost 15 percent of the global road fatalities when India has just 1% of the total global vehicles. The incidents of accidental deaths have shown increasing trend during the year 2000-2015 with an increase of 50 percent in the year 2010 as compared to the year 2000. According to Planning Commission of India, the total annual economic loss is 2.5% of India's GDP due to rising number of road fatalities. According to National Crime Records Bureau, Ministry of Road Transport & Highway, Law commission of India, one serious road accident in the country occurs every minute and 16 die on Indian roads every hour. According to the "WHO Report 2015: Data Tables"[2] the total number of fatalities in India in 2013 is 238,562 and reported number of road traffic deaths is 137,572 with the estimated road traffic death rate per 100,000 population being 16.6. The leading cause of death is road traffic injuries especially among young people and it costs countries about 1-3% of the gross domestic product [3].One of the major factors that is increasing this number is the delay in reporting of the crashes to emergency centers like near-by police stations and health care centers. According to [1], in 2015 the 2030 Agenda for Sustainable development was launched which aims at reducing the number of deaths and injuries arising due to road crashed to half its number by the year 2020. In regard to this, authors provide a review on the existing technologies that aim to detect accidents automatically and alert the emergency centers without much delay.

Literature Review:

The proposed system in [4] deals with an automatic accident detection system involving vehicles which sends information about the accident including the location, the time and angle of the accident to a rescue team like a first aid center and the police station. This information is sent in the form of an alert message. But in the cases where there are no casualties a switch is provided which can be turned off by the driver to terminate sending the alert message. A GSM module is used to send the alert message and a GPS module is used to detect the location of the accident. The GPS and GSM module are interfaced to the control unit using serial communication [5].The accident itself is detected using two sensors- Micro Electro Mechanical System (MEMS) sensor and vibration sensor. MEMS sensor also helps in measuring the angle of roll over of the car. A 32-bit ARM controller is used as the main high speed data-processing unit. The vibrations are sent from the vibrating sensor to the controller after passing through an amplifying circuit. Similarly the roll over angle is sent from the MEMS sensor to the controller.

<u>Advantages and results</u>

Both the accident and the accident location can be detected as opposed to only one in the other approaches. There is also a method to stop sending the alert message and hence save time of the rescue time. The use of GPS adds to the advantage of the system being cost-effective, portable and detecting the accurate location [6] and the time taken for the entire detection process and sending of the message is greatly reduced as compared to other methods. Overall the system is portable, has a small size, and is of low cost and expandable.

In [7], traffic accidents have been detected successfully using an Internet of Things (IoT) and cloud computing framework. Traffic accidents have been detected using Support Vector Machine (SVM) that hasbeen improved with the Ant Colony Algorithm (ACA). ACA is used for the parameter selection of SVM which plays an important role in the accuracy that can be achieved by SVM. The IoT sensors used here for monitoring the vehicles are the highly sensitive magneto resistive sensors. In fact multiple sensor modules are employed to detect the presence of vehicles including sensors that detect thechanges in the magnetic field on the road,the sound signals from brakes and collisions and two different sensors that help detect the direction of the vehicles.SVM is trained with historical traffic information and tested on future traffic data. The algorithm tries to find a decision plane that separates the class of 'traffic accident' from the class of "no traffic accident'. This is improved by using ACA which is an optimization algorithm [8].

Results

The metrics that have been used to detect the efficiency of detection include: (1) False Alarm Rate (FAR): ratio of error alerts to all detected events,(2) Detection Rate (DR): ratio of detected events to the real world accidents and (3) Average Time to Detect (ATD): time average between detected and happened.

Results show that the IoT based method outperforms the traditional sensor based method and the improvised SVM model with ACA outperforms the traditional SVM model and also has a faster convergence speed and the Mean Square Error (MSE) is lower compared to the traditional SVM.

The proposed system in [9] aims at reducing the loss of lives due to traffic accidents and performs three main tasks – (1) detecting an accident and sending the location to the nearest hospital, (2) controlling traffic light signals in the route taken by the ambulance [10] [11] and (3) monitoring vital parameters of the patient inside the ambulance itself and sending this information to the hospital. These three tasks are achieved by the working of four units into which the system is divided:

The vehicle unit: This unit consists of a microcontroller, sensors, GPS, GSM module and an accelerometer. The sensors detect the accident, the GPS gets the location and the GSM module conveys this information to the main server unit. The accelerometer can help avoid accidents by notifying the driver when the position of the vehicle is deviated from the normal. The entire vehicle unit must be installed in the vehicle.

The control unit: This unit contains the database of hospitals and is responsible for communicating messages between all the units.

The ambulance unit: This unit has a patient monitoring system to constantly measure and convey the patient's temperature and pulse rate to the hospital.

The traffic junction unit: This unit turns the signal to green when the ambulance is about 10 meters away so that the path is clear for it to move quickly. This is achieved through RF communication. Thus, this system has overcome many drawbacks of the existing accident detection systems with respect to time.

The proposed system in [12] is in the form of an Android application which detects an accident using an accelerometer which is built in the smartphone. The phone must be docked inside the vehicle and not held by any person. The working of this application is as follows:
When the device is tilted above a certain threshold and is detected by the accelerometer, the application waits for 15 seconds. Here, three kinds of input can be received. (1) If the user is active, he can press "cancel" if the device was tilted by mistake. (2) If the user is active, he can press "send" if an accident has occurred. (3) If the user is inactive and no button is pressed after 15 seconds, an accident is assumed to have occurred.

In case of (2) and (3), the current location is fetched by GPS and a pre-recorded voice message along with the location is sent to the 108 ambulance emergency response service. A study on GPS services provided by Android has been thoroughly conducted [13] [14]. Thus, through the use of just a smartphone without any extra hardware components, efficient accident detection and notification has been achieved.

The proposed system in [15] also uses an Android application where the smartphone must be placed in a holder attached to the vehicle. The Accident Detection Algorithm detects an accident based on three kinds of events: (1) A collision is detected if the accelerometer shows a reading above the threshold which is 4g ($g=9.8m/s^2$) and the approximate severity of the accident is determined by a metric called Acceleration Severity Index (ASI). (2) Rollovers are detected using a gyroscope and a magnetometer. If a rotation greater than 45 degrees occurs and if the instantaneous speed is found to be less than 5km/h, it is considered as a rollover. (3) And airbag deployed signal indicates an accident as well.

If one of these three events is detected, an alert is sent through three different sources - a Decentralized Environmental Notification Message (DENM) message containing a Road Hazard Warning, by performing an e-Call to an Emergency Medical System (EMS) and finally by SMS.

This system controls false positives by sending accident notifications only if a countdown sequence is not interrupted by any of the passengers.

The proposed system in [16] consists of several components with different functions. First, the vehicles should have embedded in it an On-

Board Unit (OBU) responsible for detecting accidents and communicating information about dangerous situations. The notification of the detected accidents is made through a combination of both Vehicle-to-Vehicle (V2V) communications and Vehicle and the Roadside Infrastructure (V2I) communications, while the destination of the information is the Control Unit (CU) which will handle the alert notification, estimating the severity of the accident and communicating the incident to the appropriate emergency services which is done through the internet service. If the internet is unable to be used, then an infrared module through RSU (Road side Units) can connect the OBU with the CU. The layouts and street structure should be exploited for the dissemination of the protocol. The makeup of every modules are as follows. The OBU [17] consists of in-vehicle sensors to detect accidents, a data acquisition unit DAU unit to periodic data and an OBU processing unit to process and find the occurrence of an accident for which it makes use of an Accident Detection Algorithm.

The two impactful events in an accident are Roll over events and strong impacts. Roll over is captured by sudden strong horizontal tilt. Applusand IDIADA [18] provides a lot of historical data, thus information on collision. The average tilt from the current vehicle taken periodically is integrated using the rectangle rule and with the help of old data, and by setting threshold, they are classified as accidents.

The internal structure of CU unit receives notification from the vehicle; it classifies the accident based on the severity and decides on the needed resources for the particular event. The various actions include storing the accident information in the database, notifying the police and emergency services with the help of information in database.

The accident severity is estimated using Data Mining classification algorithms like Bayesian Network and K2 algorithm which is run on Weka platform for historical data from The National Highway Traffic Safety Administration which maintains the General Estimates System (GES), a database with information about traffic accidents that began its operation in 1988 in the US. Based on number of attributes like time, causalities and damage, the classification is done.The improvements in this work is using this system at high speed

The system in [19] detects an accident by utilizing GPS and a Map Matching (MM) algorithm. The GPS is used to send the position and speed of the vehicle every 0.1 second to a Micro Controller Unit (MCU) which compares the current speed to the previous speed every o.1 seconds and if the speed has fallen below a threshold an accident is said to have occurred and it then checks for the location of the vehicle using the map matching module and sends an alarm to an emergency center is the vehicle is found outside the road network. The location of the accident is sent using GSM.

The braking distance is dependent on speed and is proportional to its square and hence the faster a vehicle is going the more bleak are the chances of avoiding a crash [20]. The forces that help in bringing the vehicle to a stand-still after the brakes are applied are frictional force and gravitational force. The maximum speed that would be achieved after applying the break and when only these two forces are in play is calculated. If the speed sent by the GSM to the microcontroller is however lesser than this maximum speed it is inferred as an accident in which additional forces have played a role in decreasing the speed. These additional forces come from the kinetic energy that is associated with a body while in motion that gets converted into destructive forces during the collision [21]

The MM algorithm is used to find the location of the vehicle on the road network. A Geographical Information System (GIS) software is used for MM using which the vehicle is continuously positioned on a digital map. Finally, when an accident is detected a flag is raised and the MCU waits for 5 seconds before sending an alarm out to the emergency center. In these 5 seconds the driver can press a button to cancel the alarm and help reduce the number of false alarms. The speed, location, time and the contact details of a relative of the vehicle occupant will be sent as GPRS data using the GPRS module of the MCU and in cases where there is no GPRS coverage an SMS is sent with the same information. After this, a voice call is initiated to the emergency center if the occupant is in a position to describe the accident.

Advantages

The system uses a GPS module which is now present in almost all vehicles and is also cheap. The system also allows the emergency center to gauge the severity of the accident by sending the previous speeds of the vehicle and moreover allows the vehicle occupant to manually turn off the alarm and hence reduce false alarms.

The technologies used in [22] project is GPS, GPRS and Android. The main modules and their functionalities include the hardware module for accident detection which is used to limit the switches and Arduino. Then the Web based Central Registration System registers these services. An Android Application is used for controlling the circuit and User Interaction in the vehicle will raise alarm and ask the user for the conduction of further outcomes [23]. A Web based Service for the Central Assistance Centre will receive notifications.

Working of the module includes registering of a new vehicle and downloading the android app in smartphone. Registering all the services such as ambulance and insurances services [24].When the vehicle collides with another object or vehicle, the limit switch gets pressed and it establishes a circuit and the signal passes to the Arduino.The Arduino is connected to the limit switches and the Bluetooth module which is further connected to the driver's Android Smart Phone.The application determines the GPS co-ordinates and transfers them to the central server from where the location is sent as an alert to all services registered.

The different technologies used include GPS, accelerometers and Kalman filters. The major need for this algorithm aremore accuracy in GPS systems as they suffer from the line of sight and poor update rate and as such, the acceleration data derived from the GPS lacks in instantaneous acceleration which is very important in determining a sudden deceleration due to accident. High and instantaneous data can be acquired from the IMU (Inertial Measurement Unit) as opposed to GPS.

The proposed system in [25] monitors the deceleration data from the GPS and IMU accelerometer sensors. These two types of data are integrated by the Kalman filter [26]. Whenever the deceleration from the GPS is available, IMU deceleration is updated by this filter. The deceleration data from the IMU is considered only in the GPS outage scenario. The Razor INS can fill the gaps in case of GPS outage and the IMU data are updated through the integration of valid GPS data. The IMU provides accelerometer, gyroscope and magnetometer reading in all three axes. The orientation of the vehicle relative to gravity can be predicted by integrating gyroscope with the accelerometer and the direction of the vehicle can be determined from the magnetometer. By integrating these sensors in three axes, the Attitude Heading Reference System (AHRS)[27] is built. The Direction Cosine Matrix (DCM) is used as a basis to integrate the accelerometer, gyroscope and magnetometer. This matrix is a form to represent a rotation through a 3X3 R matrix. The DCM matrix described in [28] has been used as a model for the IMU sensors to build the AHRS. The ARHS data gets corrupted, which is fused with GPS data using the Kalman filter. Vehicle decelerates when the brake is applied. Any deceleration more than 5Gs as obtained is considered as an accident situation by the proposed algorithm. In this situation, the system would raise an alarm for the location detection module.The results from the paper are based on the threshold

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maintained which is 5Gs, which when the deceleration is below it, an alert is sent.

CONCLUSION

The papers provide various methods to detect accidents using both hardwareand software methodswhich provide good results. Most of the discussed methods also provide the driver with the option of turning of the alarm in cases where the accident is not serious or false detections of an accident.These methods are either mostly dependent on some hardware like sensors that have to be present in the car or require a smart phone to be present within the car. While the use of such hardware can prove to be a more cost-efficient approach it has the drawback of being destroyed in the accident and hence giving spurious or no readings at all. Hence, an approach that does not depend on any hardware device or sensor that is associated with the car is required for the detection of traffic accidents.

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