Automatic Crash Detection System

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ABSTRACT: Crash is defined as a colliding of a vehicle with another vehicle or with some other object which cause damage. Crash is an unusual activity which cannot be detected, In the telematics insurance sense, four-wheeled vehicles are fitted with battery-installed e-boxes, allowing online vehicle motion tracking with the help of an inertial measuring device and a GPS unit. The key service provided by the e-Box is the automated reconstruction of the actual circumstances of the crash, and the identification of potentially hazardous conditions, with the subsequent automated activation of rescue operations for both drivers and passengers and the vehicle itself. How to build such a system for two-wheeled vehicles is far from straightforward, as the two-wheelers dynamics are very different, and so are the ways in which accidents can occur. A novel collision detection algorithm for two-wheeled vehicles is presented in this study, and its validity is proved against experimental evidence.

KEYWORDS: Two-wheeled vehicles; Crash detection; Road accidents; insurance telematics; Telematic e-Box.

INTRODUCTION

Traffic health is more and more taken into account nowadays. Nevertheless, there are always injuries and support is usually needed as soon as possible. Discussion of automated accident detection methods has emerged which would automatically cause an emergency call (eCall). An example of this is a European eCall initiative1 where a vehicle automatically calls to the nearest emergency center in case of a crash and sends some data like exact location of the crash [1].

Car accidents are one of India's leading causes of death, causing more than 100 fatalities every day. More than 43,100 deaths in 2010 alone were the result of 10.6 million traffic accidents. There will be 21 traffic accidents for every 100 licensed teenagers aged 16 to 19, making car accidents the leading cause of death for that age group in India [2]. In the past decade, a range of technical and sociological advancements have helped to minimize traffic deaths, e.g. seatbelt use is estimated to save 136 lives per 1 per cent rise. Advanced life-saving technologies, such as electronic stability control, also show great potential for injury prevention, e.g. crash analysis studies have shown that nearly 40 per cent of fatal traffic collisions could have been avoided with the use of electronic stability control.

To cause an eCall, incidents must be identified by the device. Crash detection strategies for cars are discussed mainly in the literature. In general, crash detection algorithms are based on measurement of acceleration or crush. The crash detection algorithms for two wheel vehicles, bikes, are not being extensively examined. The identification of motor bike accidents is achieved in the prior art using the sensors attached to the motorcycle [3]. However, the sensors in the motorcycle do not know the seriousness of the accident, unlike in the vehicles, the motorist and motorcycle that fall off each other in case of accident. In addition to causing eCall, motorist safety jackets have been investigated, which could inflate the airbag during the crash.

Car accidents are one of India's leading causes of death, which causes more than 1000 deaths a day. More than 90,100 deaths in 2011 alone were the result of 10.6 million traffic accidents. There will be 21 traffic accidents for every 150 licensed teenagers aged 16 to 19, making car accidents the leading cause of death for that age group in India.

Over the past decade, a range of technical and sociological advancements have helped to minimize traffic deaths, e.g. seatbelt use is estimated to save 200 lives per 1 year. Advanced life-saving technologies, such as electronic stability control, also show great potential to minimize injury, e.g. collision analysis reports have shown that about 40 percent of fatal traffic collisions could have been avoided using electronic stability control. In fact, every minute that an injured crash victim does not receive emergency medical services will make a significant difference in their survival rate, e.g. research shows that decreasing accident response time by one minute is associated with a difference of six per cent in the amount of lives saved [4].

This paper provides a new way of identifying potentially dangerous conditions in the movement of two-wheeled vehicles that may be correlated with road accidents. To do so, the collapse occurrence is carefully evaluated in two-wheeled vehicles, and so is the enumeration of all potential situations that might constitute a crash occurrence even without a collapse occurring. Furthermore, an interesting evaluation of the data collected in a thorough experimental campaign leads to an creative method for further selecting those which may actually be linked to crashes among anomalous incidents, thus enabling us to significantly reduce the number of false positives sent to the final offline classification system.

LITERATURE REVIEW

In this paper we're introducing a framework for automatic motorcycle crash detection. In this model, three separate inertial measurement devices are mounted to the driver's front, the motorist's torso and the motorcycle's rear. Crash dummy testing is achieved by tossing the dummy at various altitudes to mimic the effect of a crash on the motorist, and the motorcycle is powered to collect real data. To identify the crash and normal driving a maximum posteriori classifier is educated. The prototype program implemented shows promising results for automated detection of a crash [1]. This paper explains how smartphones, such as the iPhone and Google Android systems, can identify traffic incidents automatically using accelerometers and acoustic data, alert a central emergency response center immediately after an incident, and provide situational awareness via images, GPS coordinates, VOIP communication networks, and incident data collection. This paper provides the following contributions to the smartphone traffic accident detection study: (1) this paper present a structured accident detection model that incorporates sensors and context data; (2) this paper demonstrate how smartphone sensors, network connections and web services can be used to provide first responders with situational awareness; and (3) this paper provide demon empirical findings [2]. This paper focused on the identification of automobile accidents at low speed.

How to distinguish whether the consumer is inside the car or outside the car, walking or running slowly is the biggest challenge that the low speed accident encounters. In this work, the effect of this obstacle is minimized by a proposed mechanism which distinguishes between the speed variation of the low speed vehicle and the person walking or running slowly. The proposed system consists of two phases; the detection process which is used to identify low and high speed car accidents. The notification process, and immediately after an incident is identified, is used to send specific information such as photos, video, incident location, etc. for quick recovery to the first responder [3]. The paper introduces a novel method for predicting the occurrence of an accident and also for determining the successful route to reach the accident spot using Floating Car Data (FCD) technology. The proposed technique uses the sensor integrated with the smartphones and even the on-board sensors fitted with the vehicle to identify the occurrence of the accident. When the accident is identified, the successful route to reach the accident spot is intimated to the relatives and to the nearest hospital, taking into account both the distance and the traffic [4].

The proposed system consists of two phases; the detection process which is used to identify low and high speed car accidents. The notification process, and immediately after an incident is identified, is used to send specific information such as photos, video, incident site, etc. for quick recovery to the emergency responder. Practically tested in real simulated world, the device has achieved very good performance results [5]. This paper proposes a new dimension to enable early reaction and rescue of victims of an accident; to save lives and properties. Our device uses GPS and GSM capabilities along with the android phone to provide a solution that can be used to reliably locate the location of the accident and give the emergency update to the ICU of the nearest hospital and the relatives of the victim. The proposed device consists of two units: Embedded App Crash Detector and Android Control Panel. Crash Detector Embedded System uses a three-axis accelerometer sensor, location encoder, bumper sensor and one false alarm button to identify the state of the crash[6]. This paper introduces the implementation of a program that uses smartphones to identify and monitor vehicle accidents in a timely fashion.

Data is continuously obtained from the accelerometer of the smartphone and analyzed using Dynamic Time Warping (DTW) and the Hidden Markov Models (HMMs) to assess the magnitude of the accident, minimize false positives and alert first responders of the position of the accident and the medical details of the proprietor. Furthermore, incidents can be accessed over the Internet on the smartphone, providing quick and accurate access to the accident information [7]. This paper aims to develop a system using IoT, which helps to track and automatically warn car accidents. That can be done by the incorporation of smart sensors inside the car with a microcontroller that can activate at the moment of an accident. The other devices, such as GPS and GSM, are incorporated with the network to obtain the accident location coordinates and send it to registered numbers and local ambulance to inform them of the accident in order to receive urgent assistance at the site [8]. The vehicle is connected to a hardware device which uses a vibration sensor to detect the collision. The hardware system also contains a fire sensor, which detects fire breakouts. It communicates with a Smartphone application through Zigbee Bluetooth whenever a collision or fire is sensed. If the driver does not wish to communicate any information, the reset switch will allow him to cancel. Once the Bluetooth link is created, the application will monitor and communicate to their companions the victim's GPS location along with the patients' entire medical report, as well as the nearest hospital via an SMS.

METHODOLOGY

The proposed automated crash detection algorithm for two-wheeled vehicles is running on board, with the goal of detecting any event comparable to a crash, the detection of which activates a logging device that sends a few seconds long snapshot remotely for further off-line review. The entire design aims to identify and recognize any anomalous incident in which additional assistance might be required by the driver (e.g. towing the disabled vehicle after a crash) or whose knowledge can better clarify the nature of the event (e.g. addressing a rider's liability in a contested scenario). A schematic representation of the entire system appears in Fig. 1.

While the system's efficacy is determined by the combination of the on-board and off-board research stages, this paper focuses on the first one. In developing this algorithm, the degrees of freedom are constrained by the cost constraints of transmitting large data logs, and by the computational effort needed to evaluate many events within short time frames. Hence it becomes important to find a approach that increases the amount of false positives while reducing the number of misdetections in order to provide an accurate and reliable service.

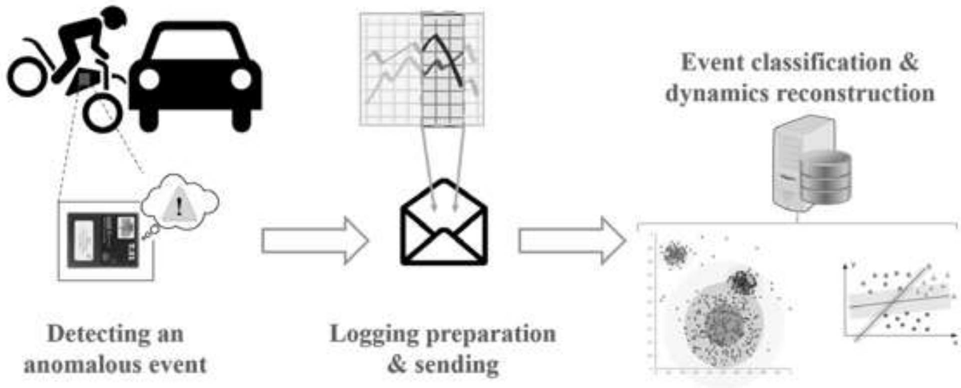

FIGURE. 1. A schematic view of the proposed system: a snapshot of the main signals is sent remotely for further analysis when a crash-like event is detected by the e-Box installed on the vehicle. Off-board, the log is compared with the dataset of equivalent events and classified based on its severity.

The online algorithm is developed and validated against data collected by telematic e-boxes, fitted with an IMU with 400 Hz sampling frequency and a GNSS unit with 10 Hz sampling frequency. The modular, cost-effective and easy-to-install measuring device of these telematic e-boxes enables the retrofitting of any motorcycle, enhancing its broad range of sensor configurations as suggested in a study.

Since the e-Boxes are manually mounted on the chassis, the mounting orientation determines inertial measurements. To ensure compatibility of the calculated quantities with the vehicle reference point, axes are digitally realigned using a self-calibration algorithm. During an experimental cam-pain performed by five drivers in different Italian regions, validation data was obtained. Tests are performed under mixed traffic conditions, on both urban and off-grid highways.

Algorithm

The proposed algorithm is designed to identify two general trends of crashes in two-wheeled vehicles: crashes with fall, in which the motorcycle ends up lying in a non-vertical position on the ground, and crashes without fall, in which the motorcycle stays vertical after impact.

The patterns connected to the two scenarios also share few common basic conditions. Nonetheless, irrespective of the circumstances of the collision, the vehicle is immediately believed to be in a safe state (e.g., regular driving), and will cease its movement after the impact (if the vehicle was not still standing still). On the contrary, seeking a common definition of all possible variations between those two cases is difficult (or even impossible). The proposed algorithm is designed to identify two general trends of crashes in two-wheeled vehicles: crashes with fall, in which the motorcycle ends up lying in a non-vertical position on the ground, and crashes without fall, in which the motorcycle stays vertical after impact.

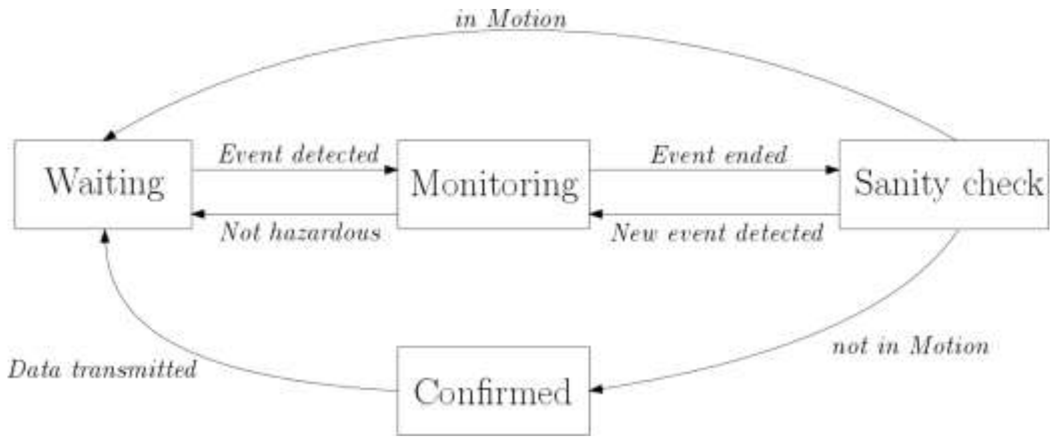

FIGURE 2: Block diagram describing the algorithm, implemented as a state machine.

Challenges involved

This segment discusses the complexities of detecting car accidents using sensor data from a smartphone. A crucial step in preventing injuries is to ensure that no false positives are reported to emergency services, such as 911.

According to the US Department of Justice, in some areas 25 to 70 percent of calls to 911 were "phantom calls" where the caller hangs up immediately. California receives about 6 million 911 calls from mobile phones, of which about 1.6 and 3.6 million are phantoms. Clearly, algorithms about smartphone traffic accidents must be careful not to increase the volume of phantom emergencies.

It is difficult to strike a balance between no false positives and complete coverage of all traffic incidents that occur. Vehicle accident warning systems, such as OnStar, have a major benefit because they are incorporated with the vehicle and its deployment and crash sensors onboard air bag. The sensor data obtained from these systems are directly associated with the vehicle's forces. By comparison, mobile accident detection systems have to implicitly determine when an incident occurred based on the phone's sensor inputs. Since phones are mobile objects, they can encounter forces and sounds emanating from other sources, including a user dropping the handset. Smartphone accident detection algorithms must use noise-resistant sensor data filtering systems, but have adequate fidelity not to filter out true accidents.

Challenge 1: Identification of accident forces without contact between the electronic control units

Conventional in-vehicle accident detection systems rely on sensor networks around the entire vehicle and direct contact with electronic control units (ECUs) of the vehicle. These sensors detect acceleration / deceleration, deployment of an airbag, and vehicle rollover. Metrics from these sensors help to produce a comprehensive accident profile, such as the location of the car, the number of times it was struck, the extent of the crash and the deployment of airbags. Applications based on smartphone accident detection will provide similar information.

Nevertheless, without direct access to ECUs, the gathering of information about the vehicle is more difficult. Although many cars have data recorders for accidents / events (ADRs / EDRs), it is impractical and unnecessary to expect drivers to connect their smartphones to these ADRs / EDRs every time they get into the car. Connecting to ADRs/-EDRs would not only entail a consistent interface (physical and software) to ensure consistency, but would entail exposing a safety-critical device to a range of types of smartphones and middleware platforms.

Challenge 2: To offer first responders situational awareness and contact with victims

Situational awareness means being told at an instant in time about the environment of a specific location, knowing the state of that environment and being able to predict future outcomes in that space. There are three stages of situational awareness: (1) perceiving environmental emergency signs, such as a driver seeing the collision of two vehicles in front of them, (2) recognizing the consequences of such indications, such as the driver knowing they need to slow down, and (3) having the ability to predict what will happen in the future, such as the driver determination.

Accident warning systems may provide first responders with vital situational information about the state of the vehicle and occupants following an accident. Then, first responders can use this data to identify the passengers' physical condition and probably determine how long they will live without medical treatment. For example, OnStar automatically places a voice call from the car to an emergency dispatch service so that first responders can ask about the health of the occupants of the vehicle, provide instructions and predict whether an ambulance will be sent or not. Such accident warning systems will also assess and communicate details about the air bag deployment to first responders, which suggests a serious accident. In addition, accident warning systems, such as OnStar, can identify an accident's GPS coordinates and transmit the information to first responders.

CONCLUSION

This paper have introduced a new idea for automatic system for motorcycle crash detection. Unlike traditional systems where the sensors are mounted to the motor cycle and proposing a device with three separate inertial measuring units mounted to the front, the motorist's torso and the motorcycle's rear. Crash dummy experiments were conducted by tossing the dummy at various altitudes to mimic the effect of the crash on the motorist, and the motorcycle is powered to collect real data. A MAP classifier has been trained to determine between the crash and the normal drive. If the collision happens, the automatic 911 call and the motorist's location can be sent. This paper introduced a new method for the automated detection of possible incidents in two-wheeled vehicles. The algorithm enables the data from an insurancee box mounted on the vehicle to be interpreted correctly in order to recreate the sequence of events that could result in an suspected accident. If such an incident is observed, data is properly logged for the final assessment and accident diagnosis to be submitted to an offline server. The overall method has been tested against experimental data, and has proven its suitability for practical use.

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