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Accident Detection and Alert Systems for Immediate Emergency Services: A Literature Review

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Abstract: ***Accidents are a major issue world-wide due to increase in traffic and rash driving and is a matter of all time concern. Accidents are responsible for a large number of casualties each year. In some cases deaths are caused due to unavailability of immediate medical aid to the victim which can be avoided with the help of an automated system that will reduce the time consumed in activities such as taking the victim to the nearest hospital, completing formalities such as filling forms and also involving police in case of major crashes. This review compares various algorithms and technologies that have been developed for detecting different types of accidents. The purpose is to analyze various algorithms studied in this survey in terms of efficiency, advantages and disadvantages and enhance the best suited algorithm for developing an efficient system that synchronizes emergency services for Accident Detection.***

Keywords: Accident Detection, Global Positioning System (GPS), Internet of Things (IoT), synchronization

1. Introduction

In the survey conducted, few papers on accident detection algorithms have been studied thoroughly and analyzed to understand the previous developments in the field of accident detection, the different ways in which such a system can be developed to provide different functionalities and also to design a new system which can combine the advantages of these algorithms. The study is depicted in a tabular format with suitable parameters describing the usefulness of the algorithms.

Automatic accident detection focuses on increasing the safety, automatic accident detection, emergency assistance and road hazard warning dissemination [1].

Internet of things for smart cities addresses an urban Internet of Things (IoT) system that is specific to an application domain. Urban IoT, supports the Smart City vision, providing most advanced communication technologies and services to the citizens [2].

The impact of rapid Incident Detection on Freeway accidents fatalities focuses on reducing the time between the occurrence of accidents and estimates the impact of freeway incident detection systems along with providing fatality reduction benefits in an economic way [3].

Using smartphones to detect car accidents and provide situational awareness to Emergency response provides solutions to the major problems in detecting traffic accidents to avoid false positives and increases preparedness to emergency responders [4].
Efficient Accident Detection and Rescue System using ABEONA Algorithm forecasts traffic congestion events and directs the driver to change the route accordingly [5]. Providing Accident Detection in vehicular networks through On Board Diagnostics (OBD)-II devices and Android based smartphones combines the existing vehicles with smartphones to facilitate Intelligent Transportation Systems (ITS). It proposes an Android application that uses an OBD-II interface to detect accidents using the Gravitational force (G force) experienced by the passengers in collisions along with air bag triggers [6].

2. Literature Survey

This section gives a comparative study of the formerly developed algorithms for accident detection. The survey throws light on the key aspects of the papers studied and also highlights their positive and negative points.

Reference [1] proposed a Mobile Application for automatic accident detection and multimodal alert which uses an Accident Detection Algorithm. It uses eCall system to automatically detect Vehicle accidents along with Collisions and Roll-overs. The Acceleration Severity Index (ASI) evaluates the potential risks for occupants. In [2], a Communication Flow Algorithm has been proposed in which Backend Systems interact with IoT using Database Management Systems and Web sites. Gateways inter-connect the end devices to the main communication infrastructure of the system. IoT peripheral nodes produce the data that is to be delivered to the control center.

[3] proposed an Incident Detection Algorithm to identify incidents, verify the nature of incidents and provide emergency services based on the nature. In [4], a WreckWatch Approach has been introduced in which the device accelerometer detects wreck utilizing device sensors to detect traffic accidents and notify first responders. Users utilize map to view wreck information and other motorists can view accident locations immediately and avoid accident locations. Also, users can upload or view images of the wreck to the server to provide first responders with additional information related to the accident.

The ABEONA Algorithm is proposed in [5], in which an accident is detected using crash sensors of the air bag sensors. A GPS is used to locate an accident spot and Vehicular Ad-Hoc Networks (VANET) are used to broadcast messages. It enables rescue services to forecast traffic congestion events and re-route their path accordingly to reach the location as soon as possible. Traffic signal module in this system, receives the information about the accident and the VANET signal receiver is switched ON to search for ambulance closest to the traffic signal.

[6] Introduced an application for accident detection in vehicular networks through OBD-II (On-Board Diagnostics) devices and android based Smartphones. The application checks whether Bluetooth is enabled returning an error otherwise. It attempts to contact the ODB-II device defined. In case it is found the different protocols supported are checked to determine which one is valid for the current vehicle. If bidirectional communication is established successfully, the application will start the system monitoring process. If either the airbag is triggered, or the deceleration detected is greater than 5 Gs, we consider that an accident has occurred. If the data channel is available then it retrieves GPS and accident details followed by sending critical data and making an emergency call immediately.

The advantages and disadvantages of the above algorithms are described in Table 1.

Table 1: Comparison of Accident Detection Algorithms

Algorithm	Advantages	Disadvantages
Accident Detection Algorithm	1. Automatic Accident Detection using HDy Copilot 2. Interruptible Countdown Sequence.	Use of GSM radios was restricted due to lack of API.
Communication Flow	1. Exploits the most advanced communication technologies. 2. IoT can assist people with everyday plans.	Constant internet connectivity is required.
Incident Detection Algorithm	1.Rapid incident detection. 2.Reducing crash related injuries and deaths.	Restricted to urban highway accidents.
WreckWatch Approach	1. Automatic Crash Notification(ACN) system saves lives by reducing the time required for emergency responders to arrive. 2. ACN systems use a network of sensors in a vehicle to detect car accidents and communicate with a monitoring station via a cellular radio.	1. Conventional ACN systems are expensive. 2. Lack of portability limits its usefulness to the owners and constrains increase in safety of the vehicle. 3. Preventing false positives is hard.
ABEONA Algorithm	1. Informs the emergency services and enables them to reach the accident spot early. 2. VANET automatically communicates the accident case to the surrounding vehicles. 3. ABEONA Algorithm analyzes several factors and finds out the most efficient path to reach accident spot.	Requires a VANET thereby increasing the cost.
Accident Detection through OBD-II devices and Android phones	Achieves a detailed characterization and management service.	

3. Analysis

The accident detection and multimodal alert system not only generates a voice call and SMS to emergency numbers but also broadcasts a Decentralized Environmental Notification Message (DENM) message to all the cars in the vicinity. It has a provision to control false positives by generating warning notification only if the driver fails to interrupt an automatic countdown sequence [1]. Internet of things for smart cities provides solutions for implementation of urban IoT and developing it into a smart city concept [2]. Incident Detection Algorithm identifies and verifies the nature of the accident in a short duration which in turns fast-tracks the medical response. This paper states that implementation of FMS incident detection programs holds the promise of substantially reducing the accident notification time and, hence, the fatalities resulting from highway accidents [3]. The reference [4] depicts the usefulness of smartphones as a promising media for accident detection systems by suggesting a smartphone application: WreckWatch, which accurately detects traffic accidents by taking the contextual data of the user in vehicle and high G-force filters, used to reduce the chances of false positives. [5] uses crash sensors to detect the crash and open the airbags. This not only detects but also informs the emergency services. It uses VANET. ABEONA algorithm estimates the best path to the spot taking into consideration traffic, distance etc. [6] combines existing vehicles with smartphones via wireless OBD-II interfaces which facilitates monitoring the vehicles and as soon as an accident is detected it triggers an automatic warning. The experimental results show that the whole process of reading critical data and delivering the information through email, SMS and emergency call is completed within three seconds [6].

One of the most important features of HDy Copilot is its automatic accident detection mechanism, from the eCall system. The algorithm detects accidents in situations like collisions, rollovers and airbag deployment. The algorithm is constantly analyzing the incoming USB data, particularly, the OBD-II data frames. If the connection to USB is lost, the application stops receiving the data, but does not stop its execution and continues to function. The time elapsed between the occurrence of a rollover and the start of the Countdown Activity is 690 milliseconds, which shows that

the application responds quickly. If the countdown is not stopped then an SMS is sent to the contacts after 10 seconds and a voice call is placed after approximately 5 seconds after the delivery of the SMS. This waiting time is necessary to ensure unobstructed GSM connectivity failing which the call would fail [1]. Thus, this algorithm provides the best solution to accident detection and provides better accuracy and satisfies most of the requirements of the proposed system.

4. Conclusion

After a thorough study of [1]-[6] we propose the idea of combining the accident detection and alert system with urban IoT for Smart Cities. We also look forward to synchronize all the emergency services such as making the ambulance available immediately, necessary medication to be given to the patient combined with online automatic completion of hospital formalities like filling forms, using Smartphones and the concept of IoT thus reducing the hardware cost of the system and the time consumed in these activities.

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