A Review on Pre-Collision Road Accident Detection

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Abstract- **Road accident rates are very high these days, especially for two-wheelers. Prompt medical assistance can help save lives. This system is designed to alert the nearby medical center of the incident in order to provide immediate medical attention. The proposed framework automatically learns the representation of the characteristics from the space-time characteristics of the pixel intensity. We consider the vehicle accident an unusual accident. The possibility of an accident is determined using the artificial intelligence approach and alerted by preventive measures.**

Keywords- Road Accident, Spatial, Temporal, Artificial Intelligence

I. INTRODUCTION

Smart cities use various innovative technologies to improve people's quality of life [1], [2]. The European Commission launched a very visible and important initiative of this kind in 2010 [3], called the European Initiative for Smart Cities. In smart cities, sustainable transport is a critical dimension where the following needs to be built:

I. Intelligent public transport systems based on real-time information,

ii. Traffic management systems to avoid traffic jams e

iii. Applications respectful of the environment and safety

However, the growing size of cities and increasing population mobility has led to a rapid increase in the number of vehicles on the roads, creating many challenges for road authorities, including road accidents that require immediate attention to avoid the loss of life Road accidents caused approximately 1.2 million deaths in 2004, including 50 million injuries [5]. Due to various security concerns, all major cities in the world have already installed a significant number of traffic surveillance cameras. Using these legacy surveillance camera networks will be a viable solution, but these systems rely primarily on human observation. It is virtually impossible for human observers to monitor and detect unusual events without missing such a large number of camera scenes in real time [6]. This increases the need for automated solutions for incident detection.

In recent years, industry and university researchers have worked to develop automatic recognition methods using computer vision and pattern recognition techniques, but the current state of the technology is still limited to being applied in the real world. Developing a vision-based algorithm for this task is very difficult. In practice, the performance of computerized road accident detection algorithms can be questioned by many factors [7] - [9]. These factors include imaging conditions (different lighting and changing weather conditions), environments (cities, highways), as shown in Fig. 1.

Figure 1: Video Samples under Different Environmental Conditions [1]

II. CLASSIFICATION OF ROAD TRAFFIC ACCIDENTS

A road accident can be divided into the following types: pedestrians, pedal cyclists, motorcyclists, motorists, and commercial and passenger vehicles, collisions with animals, mass accidents and force majeure. [3], [4].

Pedestrians

It is very common to meet a pedestrian while driving a car. One study found that the Islamabad Police Department reported 53.3% of pedestrian victims or 56% of reported fatal road accidents. [5].

Pedal cyclists

Due to the slow motion of pedal cyclists, they are not seen by vehicles taking control of another car and suddenly hitting pedal cyclists. Since the motorcycle travels much faster than the bicycle, motorcyclists are less vulnerable than cyclists [6].

Motorcyclists

Motorcycling is a good and famous activity in many parts of the world due to its small footprint, high mileage and less pollution. When a vehicle hits a motorcyclist, in most cases the motorcyclist will surely be seriously injured due to the lack of safety devices on a bicycle. A motorcyclist's chances of survival are lower when a vehicle hits a car than with an injured person [7].

Drivers of cars, commercial and passenger vehicles

Most often, an accident occurs when a person is within a few kilometers of their home [8]. The main reasons for road accidents are excessive speed, occasional behavior, reckless and dangerous driving. Table II shows the common types of automobile accidents [9].

Animal Vehicle Collision

As the name suggests, it is a collision between an animal and a vehicle. Statistics show that animal fatalities from accidents in northeastern China are on the rise compared to hunting [10]. Statistics show that 67% of drivers in northern Tanzania believed animal accidents were due to excessive speed and poor visibility at night [11].

Mass Casualty Incident

It is an accident that causes more victims than a normal accident [12]. These incidents include: multiple vehicle collisions, building collapses, transit accidents, HAZMAT (hazardous materials) incidents, weapons of mass destruction (WMD), multiple gunshots and chemical exposure.

III. ACCIDENT DETECTION STAGES

The course of the accident can be divided into three phases: pre-collision, collision and post-collision. Each stage provides us with a significant amount of information, but also presents challenges, as explained below.

A. Pre-Collision

The case before the collision is the most important information to explain an accident scenario. This information can also be good evidence for crime scene investigations. The pre-collision situation is a flagrant violation of traffic rules by one or both vehicles, including violation of the lane, violation of signals at intersections, violation of the speed limit on congested roads, sudden movements on the road, etc. We can say that the step before the collision is an unusual activity and therefore it can be easily detected by applying anomaly detection methods based on the different parameters like speed, trajectory, position, etc.

B. Collision

Collisions are essential for accident detection, but they are very complicated to detect and cannot be directly detected with any general image processing technology. One way to detect a collision is to identify joints in vehicle trajectories based on space-time dimensions. The biggest challenge, however, is distinguishing between collision and occlusion.

For this, we use trajectories through space-time points of interest and enhanced dense trajectories.

C. Post-collision

As mentioned above, collisions and occlusions are difficult to classify and can lead to false positives. These false alarms can be further refined taking into account the post-collision scene. The two most common scenes after a collision are:

i.   Fallen objects at the collision point: As we have already established, the intersection of the paths of two vehicles can be a collision or an occlusion. However, if the two paths continue after the intersection and no sudden zig-zag movement occurs. The intersection is therefore only an occlusion, not a collision. However, if sudden movement or interrupted trajectories has occurred, the likelihood of a collision is high. Measure how long the object will remain static.

ii. Beware of crowds at the collision point: the last and final stop of the accident is the crowded road or pedestrians walking towards the collision point.

IV. APPROACHES FOR ACCIDENT DETECTION

The existing methods for traffic accident detection developed till date can be categorized into three approaches:

A. Modeling of traffic flow patterns

In this category, typical legal traffic patterns (eg Straight, U-turn, Right turn, etc.) are modeled as a baseline and any deviation from this pattern is considered an abnormal traffic event. This approach only works if the normal traffic pattern occurs repeatedly in a fixed area and therefore collisions essential for incident detection cannot be detected.

B. Analysis of vehicle activities

Methods in this category first detect moving vehicles and then extract motion characteristics such as distance between two vehicles, acceleration, direction, etc. of a vehicle relative to the tracks of moving vehicles. However, poor tracking performance in congested traffic scenes becomes their bottleneck and limits their use.

C. Modeling of vehicle interactions

These methods are inspired by sociological concepts and model the interaction between vehicles and detect accidents. However, a large amount of training data and the use of shifting information alone will limit the performance of these methods.

V. RELATED WORK

The car population is growing faster than economic and demographic growth. Traffic accidents and fatality rates, particularly for two-wheelers, are also increasing at an alarming rate. Most of the fatalities from accidents are due to the lack of immediate medical attention on roads such as motorways. Establishing immediate medical care in the

accident area can further reduce the mortality rate. The result is the idea of an alarm system that recognizes the accident and its severity in order to alert the nearby medical center of the availability of an ambulance or medical help for the area of the accident. The proposed system checks whether an accident has occurred and determines the severity of the injury for the accident victim / driver.

Once a decision is made about a serious accident, the system searches for the nearest medical center and notifies them of the accident. The rescue team can immediately rush to the scene, as the victim's cell phone points to the right place. The system also sends messages to friends and family to inform them of the incident. The incident detection and alert system has undergone extensive overhaul in recent years. Research in this area has proposed a telematic model that has three main modules [1].

The system must record the vehicle position via a GPS receiver, send the position information via SMS to the vehicle owner's mobile number and via GPRS to the telematic operator's server. Another prototype offers faster detection and a support system for road accident victims [2]. A prototype architecture has also been proposed to improve the survival chances of passengers involved in car accidents [3].

Dinesh Singh et al. [1] proposed a new framework for automatic detection of road accidents in surveillance videos. The proposed framework automatically learns the representation of features from space-time volumes of raw pixel intensity instead of traditional hand-made features. We consider the vehicle accident an unusual accident. The proposed framework extracts an in-depth representation using noise autoencoders that have been trained on normal traffic videos. The possibility of an accident is determined based on the reconstruction error and the probability of deep visualization. For the probability of a deep representation, an unassisted model is trained using a class support vector machine. In addition, the intersections of vehicle paths are used to reduce the false alarm rate and increase the reliability of the entire system. We evaluated the proposed approach for real-life incident videos collected by the CCTV surveillance network of the city of Hyderabad in India. Experiments on these actual accident videos show the effectiveness of the proposed approach.

Ki and Lee [2] detect accidents by setting a predefined threshold value for certain parameters such as the position, acceleration and direction of vehicles. Moving objects are obtained by making the difference between two consecutive images.

A similar approach was also used by Hui et al. [3] where the parameters are calculated from the trajectories of moving vehicles obtained by background modeling using the Gaussian mixing model (GMM) and followed using the mean displacement algorithm. This method is simple and easy to implement and deploy, but is not suitable for occasional environments such as frequent changes in traffic pattern and weather conditions as it relies only on changing position and speed parameters. Dependent upon changes in speed and position alone can easily lead to false positives such as the sudden movement of a vehicle.

Aköz and Karsligil [4] get moving vehicles using moving blob detection and tracking using the Kanade-Lucas-Tomasi (KLT) tracker. Trajectories of various normal traffic vehicles are grouped using the Continuous Hidden Markov Model (C-HMM) to create a normal traffic baseline that requires a large amount of training data to capture all possible paths of activity. If a certain invisible trajectory shows a significant deviation from the baseline, an accident is reported. This method is not based on speed parameters, but on the entire flight path of a vehicle.

Sadek et al. [5] Use the flow gradient histogram to get the orientation of the flows. From the optical flow or velocity obtained, Euclidean distances between the centers of gravity of the models are calculated, then logistic regression is used to predict the probability of an accident occurring. However, this method uses logistic regression, the interpretation of which is only a probability. Vehicle tracking is a key part of accident detection, but tracking in heavy traffic and sudden movement is a difficult problem as the scenario usually includes sudden changes in the target's appearance and movement.

Important research is underway in the context of a brutal persecution. Kwon and Lee [6] proposed a robust tracking method by mitigating the limitation of movement fluency in sudden movements using the WLMC (Wang-Landau Monte Carlo) scanning method in the tracking algorithm.

Lim et al. [7] Manage sudden movement tracking using an optimized swarm-based sampling strategy for proposal selection.

Su et al. [8] Visual expression pattern used integrated into a particle filter to restore the track lost due to sudden movements by capturing the target area from the protruding areas obtained from the expression map of the current image.

These existing methods use motions or traces of moving objects and simply attempt to set a normal baseline (often using only a predetermined threshold). Any unknown event that does not meet this basis is simply declared an accident. Although deviations in motion parameters provide useful information prior to collision, they are not sufficient for impact detection.

Francesco Biral et al., [9] Supply of a new type of intersection support system (IS) for motorcycles, developed as part of the SAFERIDER project. The initial value of the longitudinal jerk (control input) of each floor is used as a measure of the correction that the driver must make to correspond to an optimally safe maneuver. An appropriate combination of human-machine interface elements such as

the tactile throttle, vibrating glove and visual display provides the driver with warning feedback.

Ferhat Attal et al., [10] developed a methodology for recognizing driving patterns based on a machine learning framework. The driving situation class is determined by data collected from three accelerometers and three gyro sensors mounted on the motorcycle.

Ferhat Attal et al., [11] presented a methodology that uses both acceleration and angular velocity signals to detect a two-wheel drive (PTW) fall. Fall detection is therefore formulated as a sequential anomaly detection problem. Multivariate Cumulative SUM (MCUSUM) control charts are used to detect such anomalies.

A framework was proposed by Amit Meena et al., [12], an incident detection unit with a GPS and a GSM modem was used to record random events and generate them on a central server. The accident situation is calculated based on the acceleration and ground clearance of the vehicle. GPS coordinates and time are sent to the incident detection server, which manages historical data, current data and rules configured in the system.

C. K. Harnett et al., [13] proposed a method using inexpensive hardware for a generic WSN gateway to Bluetooth and open source software that would allow a large subset of cell phones to download and store WSN data.

Emmanouil N. Barmpounakis et al., [14], Review of studies conducted to date on ITS services and applications oriented towards PTW and PTW, as well as the discovery of possible directions in which PTW research could be supported by new technologies and better conditions of macroscopic traffic.

A system was proposed by Prachi R. Rajapollu et al., [15], Submit a blueprint to automate the sidestand by connecting an engine to the processor. The system is stored in a box with the battery. The box has a lockable feature so that no one else other than the user can access it.

The design of a motorcycle accident detection and warning system was performed by Fahim Bin Basheer et al. Proposal [16]. Three parameters were considered, including acceleration / deceleration, vehicle inclination and pressure change on the vehicle body.

In an article published by Manjunatha D et al. The proposed system [17] implemented the CAN protocol for vehicle and sensor monitoring. Control Area Network is a serial bus standard for automotive applications. The system includes monitoring of the accelerometer, engine temperature and vehicle safety in parking lots. Shabnam Abtahi and his team from the Collaborative Virtual Environment Research Laboratory at the University of Ottawa, Canada, have discussed a method for detecting sleepiness in drivers and then alerting them. Their idea is to reduce the number of accidents due to driver fatigue and thus increase transport safety. They proposed a method for detecting yawning based on changes in the geometric characteristics of the mouth. The

alcohol content in the driver's body is recorded with an infrared respiratory analyzer attached to the steering wheel. The higher the concentration of ethanol, the higher the infrared absorption [18].

Mugila. G et al.,[19], It introduces a smart earphone system that detects whether the person wearing a earphone is wearing a earphone or not and the system detects that the person is drunk. If the cyclist uses a mobile phone while riding, it means that the bike is blocked slowly. In this system, there is a transmitter in the helmet and a receiver on the bicycle. There will be a switch to ensure that the person is wearing the helmet or not. There is also an alcohol sensor in the helmet near the driver's mouth to check if the driver is drunk.

S. Chandran et al. [20] introduced a smart helmet to provide a means and a device for detecting and reporting incidents. Sensors, Wi-Fi processors and cloud computing infrastructure are used to build the system. The crash detection system sends accelerometer readings to the processor, which continuously monitors deviations. In the event of an incident, relevant details are sent to emergency contacts using a cloud-based service. The position of the vehicle is determined using the Global Positioning System.

Nagarjuna et al. [21] proposed an attempt to develop an automobile accident detection and reporting system that would inform relatives, nearest hospitals and police of the scene of the accident. The system correctly sends the message to the registered emergency numbers if the car collides more than 30 degrees and is overturned or overturned.

Table I shows a contribution of researchers in the field of accident detection.

Table I: Existing Techniques on Accident Detection

Author	Technique Used	Discussion
Yuanlong et al. (2019)	Iterative thresholding algorithm for learning spatio-temporal features and a weighted extreme learning machine (W-ELM) for accident detection.	Accuracy =95%
Dinesh Singh et al. (2018)	Spatial temporal features of pixel and deep learning approach	Ratio of True positive and false positive rate is approx. 80%. False alarm rate is high.
Nagarjuna et al. (2018)	Proposes an attempt to develop a car accident detection and communication system which will inform the relatives, nearest hospitals and police along with the location of the accident.	The system sends the message to the stored emergency numbers successfully when the car is collided and toppled or tilted by more than 30 degrees.
Banarase et al. (2018)	Lane detection	LDI is based on Euclidian distance which gives highest detection rate of 97% & has less false

		warning rate of 3%.
Yaohua et al. (2014)	Gaussian Mixture Model (GMM) to detect vehicles and mean shift algorithm for accident detection.	Detect real-time traffic accidents
Zhang et al. (2010)	Manual Interaction	Vehicle trajectory and its speed can be estimated more robustly and accurately

VI. PROPOSED METHODOLOGY

The proposed methodology is used to detect incidents in the pre-collision phase. Research focuses on the following:

I. The route of the route of various vehicles is calculated and compared with the routes of other vehicles.

ii. If two paths collide, there is a risk of an accident. Thus, a pre-collision warning system is generated.

iii. When an alarm occurs, preventive measures are taken, e.g. B. change the flight path or reduce the vehicle speed.

To achieve the above objectives:

1. The proposed framework for the automatic detection of accidental events consists in the detection of anomalies through the representation of the space-time characteristics of the vehicles and in the detection of collisions through the intersections of flight paths.

2. The possibility of an accident is determined by the intersection of the trajectories. This is done using the artificial intelligence approach.

3. The data is sent to the cloud server with the location of the vehicle and the generation of the pre-collision alarm.

VII. CONCLUSION

Detecting real-time video to detect anomalies and generate an alarm in seconds is a rather difficult task. In this proposed framework, in-depth learning will help identify anomalies in the spatial-temporal characteristics of the image, predict or detect collisions and propose preventive measures. The method is able to correctly detect incidents with a minimum of false positives on video with real incidents recorded under different lighting conditions. However, challenges such as poor visibility at night, congestion and large deviations from normal traffic patterns still represent significant challenges that need to be addressed.

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