

Smart City Transportation Deep Learning Ensemble Approach for Traffic Accident Detection

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ABSTRACT

The dynamic and unpredictable nature of road traffic necessitates effective accident detection methods for enhancing safety and streamlining traffic management in smart cities. This paper offers a comprehensive exploration study of prevailing accident detection techniques, shedding light on the nuances of other state-of-the-art methodologies while providing a detailed overview of distinct traffic accident types like rear-end collisions, T-bone collisions, and frontal impact accidents. Our novel approach introduces the CNN model architecture, a lightweight solution tailored explicitly for accident detection in smart city traffic surveillance systems by integrating RGB frames with optical flow information. Empirical analysis of our experimental study underscores the efficacy of our model architecture. The -CNN (trainable) model outperformed its counterparts, achieving an impressive 87%. Our findings further elaborate on the challenges posed by data imbalances, particularly when working with a limited number of datasets, road structures, and traffic scenarios.

1. INTRODUCTION

There are different factors that cause traffic accidents. Among the most common factors that increase the probability of their occurrence are the geometry of the road [1], the climate of the area [2], drunk drivers, and speeding [3,4]. These accidents can cause harm to the people involved and, although most of these present only material damage, each one affects people's quality of life in terms of both traffic

mobility and personal safety. Thanks to technological advances, video cameras have become a resource for controlling and regulating traffic in urban areas. They make it possible to analyze and monitor the traffic flowing within the city [5]. However, the number of cameras needed to perform these tasks has been increasing significantly over time, which makes control difficult if automation mechanisms are not implemented because the number of

professionals needed to comply with all the points also increases. Several approaches have been proposed to automate tasks within the control and follow-up process. An example of this is a system based on video camera surveillance in traffic. Through these, it is possible to estimate the speeds and trajectories of the objects of interest [6], with the objective of predicting and controlling the occurrence of traffic accidents in the area. The scientific community has presented different approaches to detect traffic accidents [7]. These include statistics-based methods [8–10], social network data analysis [11,12], sensor data [13,14], machine learning, and deep learning [15–18]. These latest techniques have presented improvements in various fields of science, including video based problem solving (video processing). Therefore, it is important to study these tech.

2. LITERATURE SURVEY

Detecting anomaly with typical aberration in vehicle scene entities remains an important subdomain of traffic behavior modeling [8]. Due to the accessibility to traffic video scenes, there has been an upsurge of research in the areas of video analysis and anomaly detection [9-13]. Since most computer vision models typically analyze general traffic scenes and

separate the abnormal from normal traffic events, the methods such as Markov model [16-17], Markov Random Field [11- 12] and Sparse Reconstruction [20-22] have enjoyed some successes. However, with the advent of deep learning, there has been significant improvements in detecting traffic anomalies. Therefore, a clear majority of studies deploy deep neural networks to detect them. Li et al. in [15] proposed a multi-granularity vehicle tracking technique with modularized elements, where it uses Faster R-CNN, a deep learning framework to build its object detection module. Likewise, its modularized element consists of the object detector, background modeler, mask extractor and tracker. Their method used both box and pixel-level tracking strategy to ameliorate anomaly prediction results. The pixel level tracking in [15] was inspired by the winning solution of the 2019 AI City Challenge [26]. Needless to say, the combination of both those strategies followed by the backtracking optimization technique helped [15] attain first rank in the anomaly detection track of the 2020 NVIDIA AI City Challenge [29].

3. SYSTEM ANALYSIS

3.1 EXISTING SYSTEM:

The current system primarily focuses on tangible infrastructure rather than

leveraging Intelligent Transportation Systems (ITS) for traffic management, including congestion and accident detection. Various methods proposed by researchers involve the use of smartphones, VANET (Ad-hoc networks), GPS, GSM technologies, and mobile applications to automatically detect accidents. However, existing systems have drawbacks, such as unreliable hardware, particularly sensors, and delays in sending accident alerts due to factors like GSM module responsiveness.

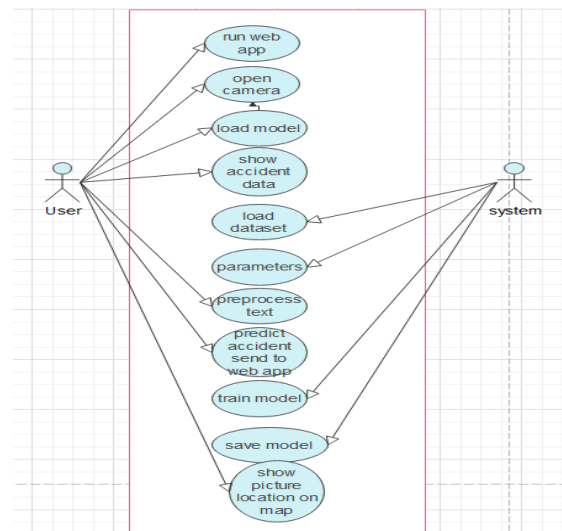
3.2 PROPOSED SYSTEM:

- We propose an innovative vision-based accident detection system, specially optimized for real time implementation on camera from webpage. This system is designed to minimize computational overhead, making it highly suitable for smart city infrastructures and traffic surveillance systems. Its lightweight architecture successfully blends computational efficiency with practical applicability, establishing a cost-effective, reliable, and deployable solution for the modern smart city.
- Novel Model Architecture: Our research proposes a distinctive model architecture that extracts RGB frames and optical flow information from video sequences. Incorporating transfer learning techniques and the CNN

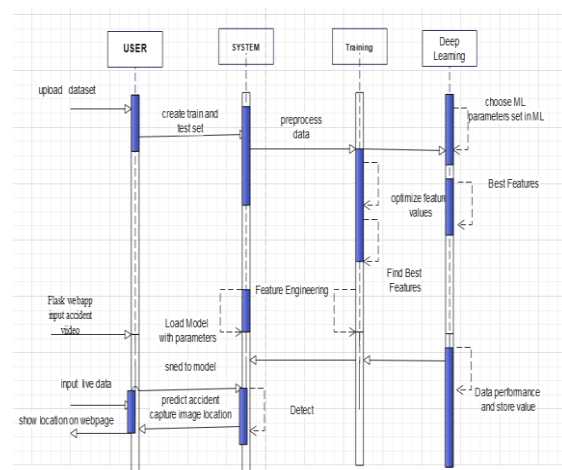
architecture, this model significantly enhances accident detection performance, distinguishing our approach from existing methodologies.

4. SYSTEM DESIGN

4.1 USE CASE DIAGRAM



4.2 SEQUENCE DIAGRAM



5. IMPLEMENTATION

5.1 Input and Output Designs

5.1.1 Logical Design

The logical design of a system pertains to an abstract representation of the data flows,

inputs and outputs of the system. This is often conducted via modeling, using an over-abstract (and sometimes graphical) model of the actual system. In the context of systems design are included. Logical design includes ER Diagrams i.e. Entity Relationship Diagrams

5.1.2 Physical design

The physical design relates to the actual input and output processes of the system. This is laid down in terms of how data is input into a system, how it is verified / authenticated, how it is processed, and how it is displayed as output. In Physical design, following requirements about the system are decided.

5.2 Input & Output Representation

5.2.1 Input Design

The input design is the link between the information system and the user. It comprises the developing specification and procedures for data preparation and those steps are necessary to put transaction data in to a usable form for processing can be achieved by inspecting the computer to read data from a written or printed document or it can occur by having people keying the data directly into the system.

5.2.2 Output Design

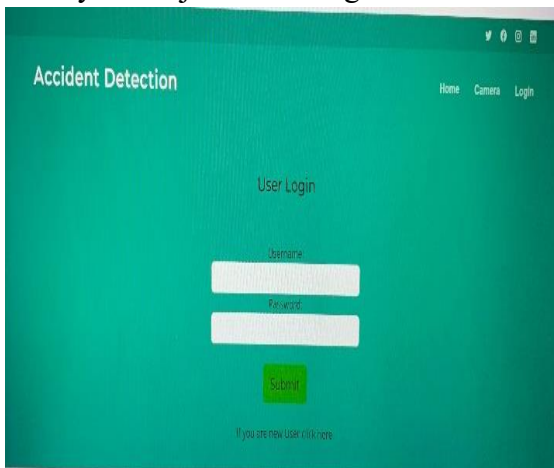
A quality output is one, which meets the requirements of the end user and presents the information clearly. In any system results of processing are communicated to the users and to other system through outputs. In output design it is determined how the information is to be displaced for immediate need and also the hard copy output. It is the most important and direct source information to the user. Efficient and intelligent output design improves the system's relationship to help user decision-making.

6. OUTPUT SCREENS

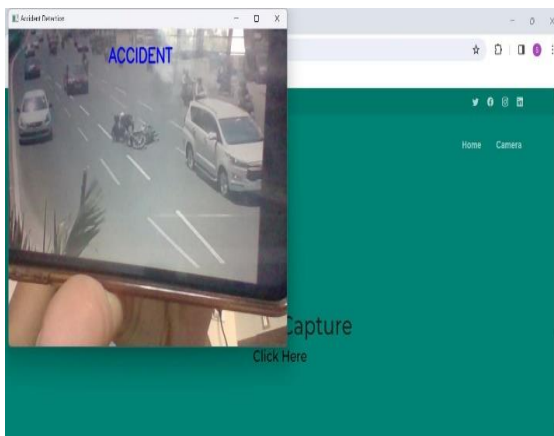


7. CONCLUSION AND FUTURE SCOPE

Pre-trained neural networks are not able to compute a vector with relevant features for very specific problems. Therefore, it is necessary to adjust the weights of these



models using examples of the problem to be



solved. The technique that best represents a temporal segment of a traffic accident does not eliminate any data, because the similarity values between the segments of the techniques with frame selection present negligible differences between them, while the computational cost, processing time and accuracy in accident detection present

better results by not conditioning the selection of frames to a metric. Artificial vision has made great advances in the understanding of video scenes. One of the best-performing techniques is artificial neural networks. Many of these models are based on architectures composed of convolutional layers and recurrent layers, in order to extract as much information as possible from the input data. The proposed method is based on this type of architecture and achieves a high performance when detecting traffic accidents in videos, achieving an F1 score of 0.98 and an accuracy of 98%. The proposed model shows high performance for video traffic accident detection. However, due to the paucity of such datasets in the scientific community, the conditions under which the model works are limited. The solution is restricted to vehicular collisions, excluding motorcycles, bicycles, and pedestrians due to the negligible number of these types of examples available. In addition, the model has errors in determining accident segments with low illumination (such as nighttime videos) or low resolution and occlusion (low quality video cameras and locations).

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