جمهورية العراق

وزارة التعليم العالي والبحث العلمي

جامعة ديالى

كلية العلوم

قسم علوم الحاسوب

نهج لتصنيف حوادث المركبات قائم على CNN - SVM

رسالة

مقدمة الى قسم علوم الحاسوب/كلية العلوم/جامعة ديالى

وهي جزء من متطلبات نيل درجة الماجستير في علوم الحاسوب

من قبل

دعاء هادي نصار

بإشراف

أ.د جمال مصطفى التويجري

1445ه العراق 2023م

Chapter One

General Introduction

Chapter One

General Introduction

1.1 Introduction

Population is growing gradually. Along with the growth in population, the numbers of vehicles are also increasing [1].People's lives styles are becoming increasingly luxurious with the use of technologies. Everyone wants ease and comfort even while doing their daily simple works. The trend of having private vehicles for daily-based usage is growing rapidly. As more and more people are obtaining vehicles, the traffic load is increasing on the roads, causing accidents [2]

The Central Statistical Organization carries out an annual report on traffic accidents registered in the police stations of all governorates except for the Kurdistan Region. Road traffic injuries are very dangerous and match current terrorist operations, As it is a scourge that is an obsession and concern for all members of society and has become one of the problems that drain the material resources and the social problems and losses in human capacities, which affects the elements of life in which the human element is the basis of society, Traffic accidents are the second largest cause of death in the world for the age group between 5 and 29 years the table (1.1) show the traffic accidents recorded for the years 2018 - 2022 [3].

Physical control of traffic, by traffic officers or using predefined timers has been confirmed that it's not an actual solution to all the previous mentioned problems caused by traffic accidents [4]. So we need to design better traffic

management system can detect the accident and increase the survival rates after an accident. By reducing the time between an accident happening and the first responders are dispatched to the part decreases death rates so that we can save lives by giving an urgent notification to the nearest medical station [5].

With existing of thousands of surveillances cameras that covers our roads and footage the vehicles behaves on the roads providing a huge source of data that can be analysis, examinant, and detect the accident before its happening or at the moment of its happening and with existing of internet networks that can be used as carrier to the notification signals generated from the system all these factors act as the foundation of the proposed system [6].machine learning (ML) methods are employed, for the most part deep learning (DL), that are used for decision making .Because based on the road footages that have been recorded a decision must be taking by the module is there an actual accident or there is a probability for its happening and based on that decision the notification message to inform the nearest medical and other help providers stations about the accidents [7].

Table (1.1): The traffic accidents recorded for the years 2018 - 2022

Year	**No. of Accidents**	**Deaths**	**Injures**
2018	9,852	2,767	10,439
2019	10,753	2,636	11,651
2020	8,186	2,152	8,383
2021	10,659	2,828	11,230
2022	11,523	3,021	12,677

1.2 Related works

Many vehicles accidents classification and notification systems have been proposed a lots of methods, techniques and algorithms are used to apply these systems and the below articles are describing some of these systems.

1. In 2018, Arceda et al.[8]**,** they proposed a three-stage framework aimed to detect car crash accidents in video by using 114 CCTV videos: The first one is a car detection method using CNN, in this case, they used the net (YOLO); the second stage is a tracker in order to focus each car; then the final stage for each car they used the Violent Flow (ViF) descriptor with a Support Vector Machine (SVM) in order to detect the car crashes. Their proposal is almost in real time with just 0.5 seconds of delay and also they got 89% accuracy detecting car crashes with AUC 0.76, Recall 0.80 Precision 0.66, and Average precision-recall 0.81.

2. In 2019, TIAN et al.[9]**,** they proposed an automatic car accident detection method based on Cooperative Vehicle Infrastructure Systems (CVIS) and machine vision. First of all, an original image dataset CAD-CVIS is recognized to advance accuracy of accident detection based on intelligent roadside devices in CVIS. Particularly, CAD-CVIS is consisted of several types of accidents, weather conditions and accident location, which can improve self-flexibility of accident detection methods among different traffic circumstances. Secondly, they developed a deep neural network model YOLO-CA based on CAD-CVIS and deep learning algorithms to detect accident. In the model, they applied Multi-Scale Feature Fusion (MSFF) and loss function with dynamic weights to improve performance of detecting small objects. Finally, their experiment training evaluates performance of YOLO-CA for detecting car accidents, and the results show that their proposed

method can detect car accident in 0.0461 seconds (21.6FPS) with 90.02% average precision (AP).

3. In 2020, Lu et al.[10]**,** they suggested, a feature fusion-based deep learning framework developed for video-based urban traffic crash detection task, aiming at achieving a balance between detection speed and accuracy with limited computing resource. In this framework, a residual neural network (ResNet) combined with attention modules was proposed to extract crash-related appearance features from urban traffic videos (i.e., a crash appearance feature extractor), which were further fed to a spatiotemporal feature fusion model, Conv-LSTM (Convolutional Long Short-Term Memory), to simultaneously capture appearance (static) and motion (dynamic) crash features. Proposed model was trained by a set of video clips covering 330 crash and 342 non-crash events. In general, the proposed model achieved an accuracy of 87.78% on the testing dataset.

4. In 2021, Choi et al.[11]**,** thy proposed, a vehicle accident recognition system using deep learning methods such as GRU and CNN. As an ensemble method, a weighted average ensemble is employed. The suggested vehicle accident recognition system is validated by comparing it to single classifiers that just utilize audio or video data, which are built on multiple classifiers that use together video and audio data from console cameras. YouTube videos of auto accidents are used to verify this study. The experimental findings show that the proposed vehicle collision recognition system outperforms single classifiers and achieves ROC-AUC 98.60% with a large margin.

5. In 2022, Essam et al.[12]**,** they suggested a structure constructed on computer vision that can detect road traffic crashes (RCTs) by using the surveillance/CCTV camera and report them to the emergency in real-time with the exact location and time of incidence of the accident. The structure is built of five modules. We start with the detection of vehicles by using YOLO architecture; the second module is the tracking of vehicles using MOSSE tracker, then the third module is a new methodology to detect accidents based on collision estimation. Then the fourth module for each vehicle, we detect if there is a car accident or not based on the violent flow descriptor (ViF) followed by an SVM classifier for crash prediction. Finally, and then the system sent a notification to the emergency by using a GPS module that provides us with the location, time, and date of the accident the experimental result showed that this structure fulfilled its job with 93% accuracy and Recall equal to 94%.

6. In 2022, Sadavarte et al.[13]**,** they proposed system aims to direct a self-operating accident detection system with alert generation to offer timely assistance in critical situations. A surveillance system developed with the concept of deep learning technique of CNN built to detect real-time accidents and future connect the facts by generating an alert on a web application which handled by medical units and police establishments. The system also provided the functionality to report accidents manually in remote areas. The experimental results exhibit that the proposed system can detect an accident and send an alert on the web app with a mean absolute percentage error that is less than 20%

7. In 2022, Desai et al.[14]**,** they employed computer vision in detecting accidents from CCTV footage and alerting Rescue systems. Computer vision is quickening nearly every field within the industry. With the assistance of computer vision

technologies and AI techniques to detect accidents and alert it over android application. They used the Yolov3 algorithm for detection of accidents and cars. The idea is to take each frame of video and run it through a deep learning convolutional neural network, which has been trained to classify frames of video into accident or non-accident. It gives around 92.3% accuracy.

8. In 2022, Pour et al [15]**,** they suggest an ML framework for multimodal in-vehicle sensors to automatically detect car accidents. Through the use of leading-edge feature mining methods and typical automotive sensors, their research is a novel and creative study on the detection of real-world driving accidents. The planned highway research program's second naturalistic driving study (NDS) crash data set is used to test five various feature extraction methods, including methods grounded on feature production and feature learning with deep learning. Next are the key results of this investigation: (1) CNN features combined with an SVM classifier produce results that are superior to all other examined methods, showing great promise. (2) Two methods were used to categorize the maximum execution features: feature engineering and feature learning. As a result, their synthesis experimentation shows that these two feature sets can be united. (3) Unsupervised feature extraction produces a remarkable performance score; for CNN and SVM, this was 85.72% accuracy and 84.9%, respectively.

To show the preference of the designed system over other system menstioned in ralated work in section 1.3 the table(1.2) show the comparison points of these system including the designed system of this thesis.

Table (1.2): The comparison between the designed system and related works systems

Ref	Authors , Year	Methods & Models	Data	Results	Weakness point	Strength point
[8]	Arceda & Riveros 2018	1.YOLO 2.ViF 3.SVM	114 CCTV videos	They got 89% ACC , AUC 0.76, Recall 0.80 Precision 0.66, and Average precision-recall 0.81	The abstract is too short and didn't presented more details about the whole paper	Provide good presentation to the theoretical background of the algorithms and the results
[9]	TIAN,et al,2019	1.YOLOCA 2. MSFF	CAD-CVIS	Detecting time 0.0461 seconds (21.6FP) and 90.02% AP	Less information about the dataset preprocessing process	Perfect describing for theoretical background, approach details and experimental results
[10]	Lu,et al,2020	1.ResNet 2.Conv-LSTM	video clips	87.78% ACC	Less information about the dataset preprocessing process	Provide good presentation to the theoretical background of the algorithms and the results
[11]	Choi,et al,2021	1.ensemble technique 2.CNN 3.GRU	Car accident YouTube clips	AUC video = 98.6% Audio = 89.8%	The theoretical background of the model and its main mathematical equations is not clearly described	The study used an ensemble deep learning model (CNN & GRU) based on multimodal data(video & audio) and proved that its significantly better than signal classifier

[12]	Essam,et al,2022	1. YOLO 2. MOSSE tracker 3. ViF 4.SVM	surveillance/CCTV camera data	93% ACC and Recall equal to 94%.	Less information about the dataset and the preprocessing process	The study achieves higher accuracy with fewer false alarms
[13]	Sadavarte,et al,2022	CNN	Surveillance cameras data	Loss less than 20%	less information presented about theoretical background and dataset	Provide good presentation to the experimental results
[14]	Desai,et al,2022	Yolov3	CCTV footage	92.3% ACC	The experimental results is not clearly described	Used Computer vision and AI techniques to detect Accidents and alert it through Android Application
[15]	Pour,et al,2022	1. CNN 2. SVM	(NDS) crash dataset	CNN=85.7% SVM=849% ACC	The approach need for more illustration objects like flowcharts, figures and so on because its described by text only	It‘s a unique and advanced study on detecting real-world driving accidents by applying state-of-the-art feature extraction methods using basic sensors in cars

The designed system	**CNN-SVM hyprid model**	**1.First dataset 4814 images 2.second dataset 990 images**	**99.74% first dataset ACC 98.88% second dataset ACC**	**The designed system depend on some hardware's and without any one of it's the system will not work accurately**	**Perfect describing for theoretical background, approach details, dataset preprocessing techniques and experimental results**

1.3 Problem Statement

With the rapid growth of the vehicles accidents on roads and the increasing of human lives losses and the costs of repairing damages due to these accidents. A lots of researcher and specialists turn to produce an electronic system based on using machine learning ,deep learning techniques and algorithms or any other artificial intelligence methods, these system need an actual datasets as input to give the best classification with high accuracy as fast as it can and by take into account that must of these data is a raw data and need for preprocessing until it's become ready to be processed by the system in our case where the datasets its images and need to take care to the its properties like size, type and clearness . Most of the previous systems didn't explain how to deal with this properties and which of it gives the best result and how the prepressing process effect on the results.

1.4 Aim and objectives of Thesis

According to the problems that highlighted section1.3 so the aim of this thesis is to design a system for vehicle accidents classification and notification using road surveillance cameras data based on machine learning techniques fulfilled the listed objectives below.

1. Merging two classification models CNN and SVM in system building to work concurrently for more accurate results.
2. Using the surveillances cameras systems to recorded the road footages that used by the system to detect the accidents status.
3. Proving that the preprocessing techniques and the dataset properties have direct or indirect effect on the results.
4. Basing on the detected accident send a notification message at the moment of the accident happening to the nearest medical station to reduce the time gap between the accident happening and the arrival of the medical help to the accident location and by that the injured people will have more chances to survive.

1.5 Outlines of the Thesis

This thesis consists of five chapters each one of them presents an important part of the general idea of the thesis. The outlines of each chapter are resumed below.

Chapter two: This chapter presents the theoretical backgrounds and an overview of, artificial intelligence, machine learning, and deep learning techniques and a brief explaining of the algorithms and techniques that used to the design the system.

Chapter three: This chapter presents the stage of the system designs and describing briefly the method to accomplish each stage with the flowcharts that describing the system structure.

Chapter four: This chapter presents the evaluation, efficiency, and work mechanism of the system by showing the experimental results obtained from it.

Chapter five: This chapter presents the conclusions and the future work for the vehicle accidents detection and notification approaches with suggestions for future studies.

الخلاصة

كما هو ملاحظ هذه الايام أن الطرق تزدحم بأنواع مختلفة من المركبات. واقعا هذا الامر قد ساعد في حل الكثير من مشاكل التنقل التي واجهها العالم سابقا لكن لا يمكننا انكار التأثيرات الجانبية له وهي الحوادث. في هذه الرسالة تم اقتراح نهج لتصنيف حوادث المركبات قائم على استخدام خوارزميتي (CNN) و (SVM) الهدف الأساسي لهذا النظام هو مراقبة الطرق بواسطة كاميرات مراقبة الطرق هذه الكاميرات تقوم بتسجيل لقطات لهذه الحوادث النظام سوف يقوم بأخذ هذه اللقطات المسجلة لإكتشاف الحوادث إذا وجدت ثم يقوم بعد ذلك بإصدار التنبيه الصوتي و إرسال رسالة يخبر بها عن الحادث.

النظام تم بناءه من خلال دمج خوارزميتين لتشكيل نموذج تصنيف واحد يسمى بالنموذج الهجين(Hybrid model) الخوارزميات المكونة لهذا النموذج هي خوارزمية الشبكة العصبية الإلتفافية (CNN) و خوارزمية ألة دعم المتجه (SVM) معمارية هذا النموذج تتشكل من أربعة وحدات بناء كل واحدة تتظمن عدد من طبقات خوارزمية الشبكة العصبية الإلتفافية في الوحدة الرابعة تم بناء خوارزمية ألة دعم المتجه كأحد طبقات خوارزمية الشبكة العصبية الالتفافية وهي الطبقة التي يتم فيها التصنيف حيث يتم اكتشاف الاصناف النهائية لمجموعة البيانات المدخلة.

نموذج النظام تم تدريبه بمجموعتين من البيانات كل واحدة تحتوي على عدد معين من الصور واطر الفيديوهات الاولى باسم (Accident images analyses dataset) تحتوي على 4814 صورة بابعاد (28,28) وامتداد (jpg) والثانية بأسم (Accident detection from CCTV footage) تحتوي على 990 صورة بابعاد (32,32) والامتداد ذاته مجاميع البيانات مرت خلال مجموعة من اجراءات المعالجة المسبقة بعد ذلك تصبح الصور جاهزة لدخول النموذج .النموذج المدرب يتم حفظه كملف مستقل بعد مرحلة التدريب فان قيم مقاييس التقييم (Evaluations measures) مثل الدقة لمجموعة البيانات الاولى هي % 99.74 أما نسبة الخطأ هي 0.95%. قيم مقاييس التقييم بالنسبة لمجموعة البيانات الثانية هي الدقة % 98.88 أما نسبة الخطأ هي % 3.39 عند اختبار النظام باستخدام البيانات الواقعية مثل الصور والفيديوهات القصيرة فانه حقق أهدافه خلال فترة زمنية قدرها 30ms وبمعدل دقة إكتشاف تصل الى 94.6% ومعدل نسبة خطا 5.4%.