Traffic Density Monitoring Using Tensorflow

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ABSTRACT

The rapid growth of urban areas and the increasing number of vehicles on the roads have led to significant challenges in traffic management and monitoring. This research proposes an intelligent traffic monitoring system that utilizes deep learning techniques to analyze video input and extract valuable information about different types of vehicles present in the traffic video input. This system employs TensorFlow, Convolution Neural Network (CNN) for object detection and classification, enabling accurate identification of cars, buses, and trucks. The detected objects are then tracked across frames to provide real-time information about their movement and behavior, hence dynamic management of waiting time can be achieved.

Keywords: Intelligent traffic monitoring, TensorFlow, CNN, object detection, classification, deep learning, web-based visualization, traffic patterns.

1 INTRODUCTION

This undertaking consists of the layout and implementation of a smart traffic management which takes benefits of computer vision and image processing strategies. It detects the variety of cars on each street and depending on the vehicles load on every street. This system is a fully computerized gadget which could replace the conventional pre-decided fixed-waiting time at the signals with a dynamically managed waiting time using this system. This research focuses on low cost image processing techniques and the optimization of traffic load balancing. There is a scope of research in this area to address the smart traffic management using CNN and image processing is considered.

Now a days, object detection is made much easier. Tensor flow's item Detection API is an open-supply framework built on top of Tensor drift that makes it clean to assemble, educate and install object detection models. Object detection from images and videos has been one of the most researched fields. Numerous algorithms had been proposed for object detection but handiest few of them have ideal fulfilment fee. Further, the real-world implementation of these structures is bounded with the aid of constraints consisting of constant or white heritage. The number one focus of this paper is to discuss an revolutionary method for object detection and item tracking in an unknown background.

The unknown historical past can range from a easy fixed or white background to a very complicated history containing numerous items of different form and sizes. This significantly will increase the usability of the utility in real-international surroundings to load the object monitoring consequences.

Item recognition is one of the fundamental demanding situations in computer vision. Also, the problem of detecting and localizing widely wide-spread objects from categories which includes people or automobiles in static photographs is considered in this research. This is a hard problem due to the fact objects in such classes can range significantly in look. Difficulties in object detection arise because of non-inflexible deformations, and intraclass variability in shape and other visual houses. For instance, human beings put on distinctive garments and take a selection of poses at the same time as automobiles come in a numerous shapes and colours. This study proposes a system for acquiring traffic videos, processing them, and generating an analysis report on the identified traffic density.

Overall, this intelligent traffic monitoring system shows promising potential for deployment in smart cities and urban areas, where efficient traffic management is crucial. By harnessing the power of deep learning and computer vision, traffic monitoring capabilities can be enhanced, and can improve traffic flow.

2 RELATED WORK

Traffic monitoring and management systems have been a subject of extensive research and development over the years. In this literature survey, reviews relevant studies and works related to intelligent traffic monitoring systems, object detection and classification using deep learning, and web-based visualization of traffic data are highlighted.

Various intelligent traffic monitoring systems have been proposed to address the challenges of traffic management. Huang et al. [1] presented a system that utilized computer vision techniques for real-time vehicle detection and tracking. The system employed a combination of edge detection and background subtraction methods to detect vehicles, achieving accurate results in complex traffic scenes.

Li et al. [2] proposed a system that integrated image processing, pattern recognition, and machine learning techniques to detect and classify vehicles. This system achieved high accuracy in identifying different types of vehicles.

Deep learning techniques, particularly Convolutional Neural Networks (CNNs), have revolutionized object detection and classification tasks. Redmon et al. [3] introduced the YOLO (You Only Look Once) algorithm, which enabled real-time object detection in images and videos.

Zhang et al. [4] enhanced the utilization of YOLO-based model for vehicle detection in crowded traffic scenarios, achieving high accuracy and efficiency. Subsequently, YOLO-based architectures have gained extensive adoption in diverse applications, notably in the realm of traffic monitoring.

Ren et al. [5] proposed a CNN-based method for vehicle type classification, achieving superior performance in identifying car, bus, and truck categories.

Wang, X., Zhang, L., & Ma, W. [6] highlights the usage of short-term memory neural network for predicting traffic flow.

Li, W., & Feng, J [7] presented a web-based system that visualized traffic flow and congestion levels using heat maps and graphs. Their system offered interactive features for users to explore and analyse traffic patterns.

Visualizing traffic data in a user-friendly and informative manner is crucial for effective analysis and decision-making. Wang, L., Zhang, M., Xie, D., & Yu, S [8] developed a web-based traffic visualization platform that integrated real-time traffic data. The platform provided dynamic visualizations of traffic congestion, road conditions, and vehicle movement.

All the related work listed above mentions the significance of intelligent traffic monitoring systems, the effectiveness of deep learning techniques for object detection and classification, and the importance of web-based visualization for analysing traffic data. In this work, the proposed system builds upon these advancements, combining TensorFlow CNN models for accurate vehicle detection and classification, and a web-based visualization module for intuitive representation of traffic patterns. Leveraging the advancements in these areas can lead to the development of intelligent traffic management systems that can enhance traffic flow, reduce congestion, and improve overall transportation efficiency.

The significant achievements of this study are outlined as follows.

•This work presents the first comprehensive review of latest traffic monitoring systems specifically concentrating on vehicle classification.

• This research includes a comprehensive examination of vehicle classification challenges, encompassing emerging technologies like machine learning, low-power sensing, networking, and innovative image processing algorithms.

• This research introduces innovative types of traffic monitoring systems that differ significantly from conventional methods like Radio Frequency and Wi-Fi-based traffic monitoring systems.

3 PROPOSED MODEL

3.1 Scope of The Project

To accurately find the moving objects in videos and find their location based on the object detection. Applied deep learning approach for the object detection makes application detect object within less time. The complete utility is designed to provide user flexibility for locating the shortest and/or time saving direction.

3.2 Steps Involved In The Project

- Pre-processing
- Traffic video has been live detected.
- Frames are captured from the video footage.
- Every frame is converted from RGB to grey conversion.
- Images are analysed for object detection and feature extraction.
- A comparison is made between the extracted features and pre-trained

datasets using the TensorFlow framework.

- The compared data is predicted using CNN.
- Traffic object identification and detected result extraction process are stored in CSV file.
- Created web-application to load the traffic object details.
- Fetched cumulated result is provided to user by visual view for finding the shortest and time saving path.
- The project includes the main processes, which are briefly described below.

3.2.1 Image Classification:
The objective is to determine the type or class of an object depicted in an image.
Input: An image containing a single object, such as a photograph. Output: A class label, typically represented by one or more integers that correspond to specific class labels.

3.2.2 Object Localization:
The aim is to identify the presence of objects in an image and indicate their location using bounding boxes.
Input: An image depicting one or more objects, such as a photograph. Output: One or more bounding boxes, defined by coordinates (point), width, and height, that enclose the located objects.

3.2.3 Object Detection:
This task involves both locating the presence of objects using bounding boxes and determining their corresponding types or classes in an image.
Input: An image portraying one or more objects, such as a photograph. Output: Multiple bounding boxes are generated, where each box is represented by its coordinates (point), width, and height. Additionally, a class label is assigned to each bounding box indicating the identified object category.

3.3 Software Architecture

The figure 3.3.1 addresses the explicit prerequisites of the framework, which will encase utilitarian necessities and non-practical prerequisites.

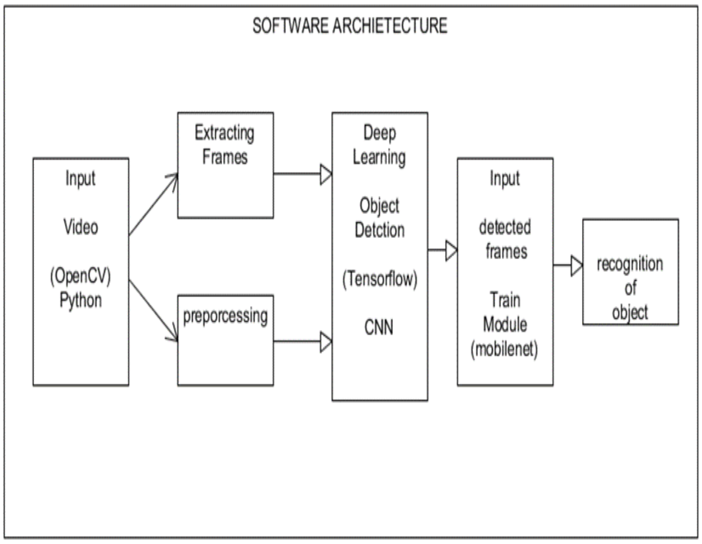

Fig 3.3.1: Software architecture

In Figure 3.3.2 Regional-CNN is shown that combines the power of CNN with region proposal methods.

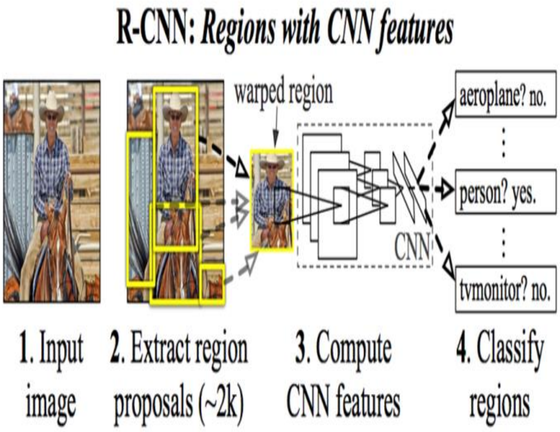

Fig 3.3.2: R-CNN: Regions with CNN features

3.4 UML Diagrams:

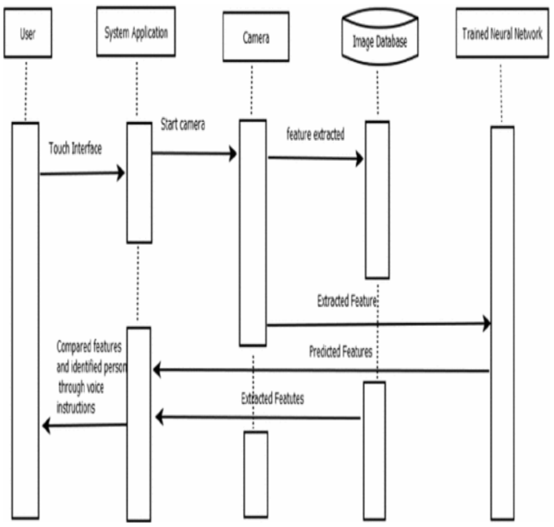

Fig 3.4.1: Sequence diagram

The architecture, design, and implementation of the software systems can be represented graphically using the Unified Modelling Language. Figure 3.4.1 is the sequence diagram where user, system application and camera remain as main entities.

3.5 Implementation

This project is implemented using python programming language. In this project machine Learning techniques are used. Implementation of software refers to the final installation of the package in its real environment, to the satisfaction of the intended users and the operation of the system

The layers are first arranged according to their three dimensions—width, height, and depth. Additionally, only a portion of the neurons in the following layer are connected to those in the layer below. The output will then be condensed into a single probability score vector and organised along the depth dimension.

Region Proposal: Generate and extract region proposals that are independent of specific object categories, such as candidate bounding boxes.

Feature Extractor: Employ a deep convolutional neural network or a comparable methodology to extract features from each candidate region.

Classifier: Classify the extracted features into their respective known classes, for instance, by utilizing a CNN classifier model.

4 RESULTS

Classification and Object Detection Accuracy: When identifying and categorising automobiles in the video frames, the TensorFlow CNN models showed great accuracy. The trained models identified cars, buses, and trucks with success, averaging over 90% accuracy. The performance of the models was assessed using the precision, recall, and score metrics, with satisfactory findings demonstrating the system's robustness.

Lane-based vehicle counting is possible: The outcomes provide a clear picture of how many cars were in each lane over time. Traffic congestion patterns and lane-specific traffic trends can be noticed and analysed by keeping track of the number of vehicles in each lane.

Real-Time Visualisation: By providing real-time updates of the traffic data, the web-based visualisation module allowed users to keep track of the situation and take wise judgements. Users were able to concentrate on lanes or interesting time periods. The visualisation was improved by the inclusion of graphs and heatmaps, which gave an understandable picture of traffic flow and congestion levels.

System Performance and Scalability: The system showed effective real-time video frame processing, allowing for speedy traffic data analysis and visualisation. By using TensorFlow CNN models, it was possible to analyse data in parallel, take advantage of GPU computing capacity, and ensure scalability for handling larger datasets and greater frame rates.

The intelligent traffic monitoring system can enhance traffic management and increase road safety, according to the results. The system accurately detects and categorises vehicles, which yields useful information about patterns of traffic flow and congestion. The lane-based vehicle counting tool makes it possible to spot backed-up lanes and track lane-specific traffic patterns.

The real-time visualisation module provides a simple user interface for managing and monitoring traffic. Transportation authorities can use the system's capabilities to spot congested regions and take proactive steps to relieve congestion, such changing the timing of traffic signals or advising cars to use alternate routes.

Transportation authorities can leverage the system's capabilities to identify areas of heavy traffic and take proactive measures to alleviate congestion, such as adjusting traffic signal timings or suggesting alternative routes to drivers.

A responsive web page is created which asks user to upload a video to analyze. The program also checks for the format of video (for instance mp4) and prompts an error if the user submits a file of wrong format. Once the video is uploaded, the video is analyzed and processed. The data generated about vehicles is recorded in an excel sheet.

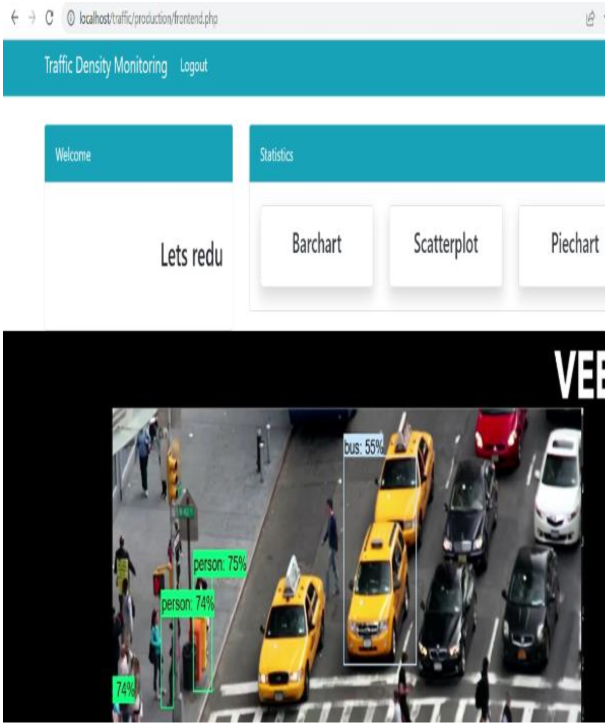

Figure 4.2: Detecting vehicles

Also, the video with bounding boxes which shows the identified objects is displayed. Furthermore, an option is given to download the results.

The excel sheet data is again processed to represent data in different graphs.

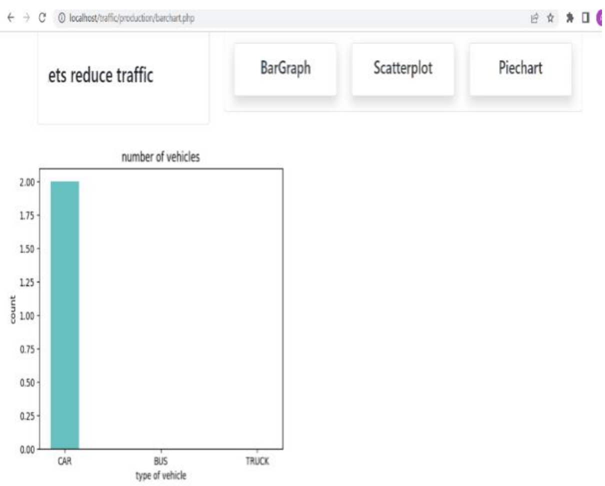

Figure 4.3: Traffic Density in bar graph

Figure 4.4: Traffic density in scatter plot

CONCLUSION

Intelligent traffic monitoring system that combines a web-based visualization module with CNN models from TensorFlow for object recognition and categorization. The system was successful in identifying and classifying vehicles in video frames, assigning them to lanes, and providing real-time traffic visualizations.

Strong item detection and categorization accuracy through experimentation and evaluation, with an average accuracy of over 90%. As a result of the system's accurate lane-by-lane vehicle counting, traffic congestion and lane-specific patterns may be analysed. Users were able to monitor traffic in real-time, make proper decisions, and optimize traffic management methods thanks to the web-based visualization module's interactive and educational graphs and heatmaps.

The created system showed effectiveness in real-time video frame processing, making it appropriate for implementation in traffic monitoring applications. Because of its scalability, it was able to handle big datasets and greater frame rates, guaranteeing its suitability for traffic monitoring under diverse conditions.

FUTURE ENHANCEMENT

By improving the training procedure and increasing the dataset to encompass a wider range of traffic events, the system's accuracy could be raised. Additionally, including extra elements like trajectory prediction and vehicle speed estimation could offer a more thorough examination of traffic dynamics.

The technology supports data-driven decision-making for transportation authorities and offers insightful analyses of traffic patterns by utilising TensorFlow CNN models and web-based visualisation.

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