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Congestion Control System Using Machine Learning

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Abstract - In today's fast-paced world, technology and population growth are increasing at an unprecedented rate. As a result, governments are increasingly interested in managing and developing their road networks, especially in densely populated countries where traffic is a major issue. However, traffic officers may not always be able to handle large volumes of traffic, particularly during festivals or other peak periods. Therefore, we conducted research to address these issues, specifically focusing on how to automate traffic management and how to ensure that ambulances can navigate through heavy traffic. This paper presents a solution to these road congestion problems by leveraging the new technology of Machine Learning (ML). We used ML algorithms, datasets, and mathematical calculations, programmed in Python, to conduct our research. Our focus was on developing automated traffic management solutions that could handle large volumes of traffic and ensure that emergency vehicles such as ambulances can quickly move through congested roads. Python is a programming language that offers a versatile platform for performing a variety of operations, including object detection, image processing, video processing, and more We have designed some algorithms which can handles larger traffic. The design also has second proposed system for helmet discovery and license plate recognition to detect and identify the two-wheeler riders without helmet and thereby penalizing them. Object discovery utilizing YOLOV4 is the main concept. Object discovery is acted at various levels to label the headgear regulation lawbreaker and their license plate number. Using a License Plate Recognition API, the license plate number is before gleaned. A database is maintained that consists of details of two- wheeler possessors. An dispatch conforming of violation details and a link to pay the penalty is transferred to the helmet law violators. An interface is developed using Tkinter that can be used by executive officer to check for the violators in the vids handed as an input and also to cover the entire process.

Keywords: **Alex Net, COCO, Python, TensorFlow, YOLO.**

1.INTRODUCTION

The urban areas are equipped with advanced technology, including various electronic devices, sensors, and big data management systems. Among these technologies, the development of city roads stands out. However, the most common challenge faced by these cities is traffic management. This is often caused by factors such as malfunctioning traffic lights or a higher number of vehicles on one side of the road than the other during rush hours. Therefore, there is a need for intelligent traffic management solutions, which can be addressed using Machine Learning-based object detection techniques.

The statistics show that the primary obstacle faced by emergency vehicles, such as ambulances, is navigating through traffic, particularly during peak hours. Currently, there is no dedicated monitoring system in India, except for CCTV footage, and over 56% of accidents occur while transporting patients. To reduce the number of fatalities, there is a need to create a cost-effective smart traffic management system that leverages unconventional technologies. The proposed system caters to the needs of emergency vehicles, such as ambulances, fire trucks, and police vehicles, by creating a smart traffic light system that can communicate with each other through relay signals via microcontrollers. The system employs a Compact Prediction Tree (CPT) algorithm, which is a derivative of Deep Neural Network (DNN), to perform computations at the same rate as regular deep learning algorithms. CPT is a recurrent neural network algorithm that supports lossless compression of the training data while retaining all relevant information for each prediction. The system also aims to distinguish between riders with and without helmets by detecting their faces in video frames, extracting the area of the rider's head, and classifying whether the rider is wearing a helmet. Additionally, the system proposes an automated system for detecting high-priority vehicles and giving them priority on the road.

This paper proposes a method to detect helmetless riders using pre-recorded videos that could be further developed into a continuous surveillance system for motorcyclists. Furthermore, the system proposes an automated system for detecting high-priority vehicles and providing them with priority on the road. The system also includes an algorithm for retrieving motorcycle number plates from CCTV footage, generating emails, and storing violator details with minimal human intervention.

2. LITERATURE SURVEY

[1] The objective of the paper "Employing Cyber-Physical Systems-Dynamic Traffic Light Control at Road Intersections", published in the IEEE Internet of Things

Journal, was to propose a dynamic traffic light control system for road intersections using road safety units (RSUs) and VITCO/RITCO protocols. The study found that this system could effectively manage two lanes with a car capacity of up to 100 and an estimated vehicle arrival rate of 90 per lane, with red and green intervals of 20 seconds. However, the model's main limitation is its high hardware dependency, making it costly to implement.

[2] The aim of the paper published in the IEEE Transactions on Circuits and Systems for Video Technology is to develop a real-time traffic light recognition system based on smart phone platforms. To achieve this, the paper proposes the use of an ellipsoid geometry limit displayed in the HSL shading space to extract interesting color regions. These regions are then screened with a post-processing step to obtain candidate regions that meet both color and brightness conditions. Additionally, a new bit capacity is proposed to effectively combine two heterogeneous features, HOG and LBP, to describe the candidate regions of the traffic light. A Kernel Extreme Learning Machine (K-ELM) is planned to justify these aspirant domains and together label the entertainment industry and type of traffic lights The result obtained was a visualization of a Finite Traffic system which reduces GPU dependency of feature vector from 512 to 256. However, a limitation of this model is that it can handle only a single angle for HSV.

[3] The objective of the paper published in IEEE Transactions on Control Systems Technology was to develop an Adaptive quasi-dynamic traffic light control system. To achieve this, the researchers used micro-bother analysis to derive online preference estimators for a cost metric related to controllable light cycles and limit parameters. These estimators were then utilized in an online angle-based algorithm to iteratively adjust all the controllable parameters and improve the overall system performance under various traffic conditions. The result obtained was a dynamic system capable of functioning in different traffic conditions and congestion. However, a limitation of this approach is that it only considers a single lane/intersection and is therefore insufficient for complex road networks.

[4] The objective of this paper, published in IEEE Transactions on Intelligent Transportation Systems, was to design an emergency traffic-light control system for intersections affected by accidents. The authors used deterministic and stochastic Petri nets (PNs) to structure the system and provide emergency response to manage accidents. The outcome showed an improvement in real-time accident management and traffic safety at intersections, with support for deadlock and livelock situations. However, the model did not provide evidence for accident prevention

[5] The aim of the article published in IEEE Transactions on Intelligent Systems was to develop a method for identifying different car makes and models using a single traffic camera image. The proposed approach utilizes a new vision-based traffic light detection technique for autonomous vehicles, which consists of two phases: candidate extraction and recognition. The method can achieve accurate and robust detection results, and the entire system is capable of meeting real-time processing requirements, processing video sequences at around 15 frames per second. However, the technique places a strong emphasis on candidate extraction, and simpler feature extraction methods could potentially be employed.

[6] The goal of the research presented in IEEE Transactions on Intelligent Transportation Systems was to develop a method for identifying the make and model of a car using a combination of neural network ensembles, linear binary patterns histograms, and Histogram of Gradient classifiers, based on a single traffic-camera image. The results showed that by using feature standardization, the system achieved a 100% accuracy rate, while without feature standardization, it achieved a precision of 99.82%. However, a major limitation of the approach is that it is not suitable for scaling to a citywide implementation.

3.PROPOSED WORK

The virtual traffic signals which comprise the four roads and four traffic lights for each. In general, 30 seconds are allotted to every road to clear traffic. Thus, we're planning to be covering each side of traffic by camera and with the help of machine learning Acquiring images or live vids and recycling this by using applicable libraries of python which is YOLO. . We have different types of vehicles. The ambulance is one of them. We can't stop for signals to clear traffic. Therefore, we need to learn our project about the difference between vehicles. For training the systems the AlexNet CNN architecture is used. Below are the given steps
1. The camera sends the images to the system in some intervals for processing.

2. This can be determined by the density of traffic from the roads and based on the calculations time of the traffic clear is changed which is shown in result.

3. The system decides which signal is open for which time and it'll trigger the traffic signals.

The result can be explained in four simple way are
1. Create a real-time image of each track.

2. Scan and determine the traffic density.

3. Enter this information into the time allocation module. The output is the time intervals for each track, as required. Also, we can reduce the number of helmet violation cases, continuous surveillance of motorcyclists without helmet, generation of email and storage of violator details with little or no manpower. In this system, videotape input is

fed to the YOLO algorithm to determine whether motorcyclists are wearing helmets or not. The object detection is performed at three situations. originally, a motorcycle(s) with a person on it's identified and also the helmet is detected. However, also the license plate recognition is done, If the model identifies that the person isn't wearing a helmet. All these stages are enforced using YOLOv4. Once the object detection process is complete, an Optical Character Recognition (OCR) API is employed to extract the number plate of the vehicle. The OCR is fed with a cropped image of the license plate to carry out this task. The extracted number plate is compared with information of motorcyclists stored in a database using SQL queries and an dispatch conforming of violation details and a link to pay the penalty is transferred to the violator.

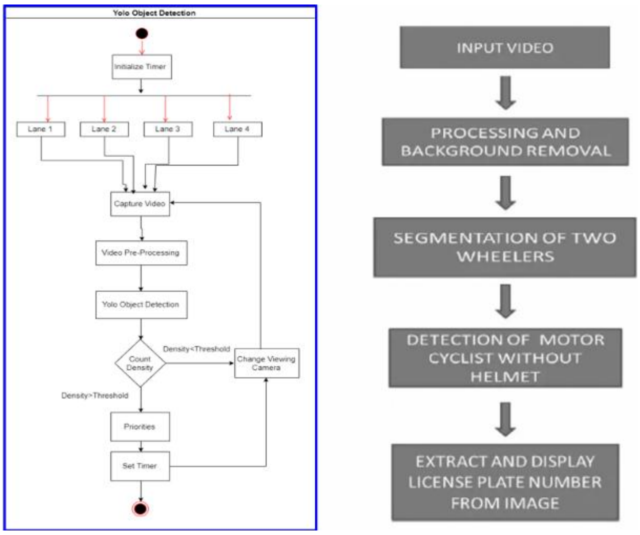

Fig -1: SYSTEM FLOW

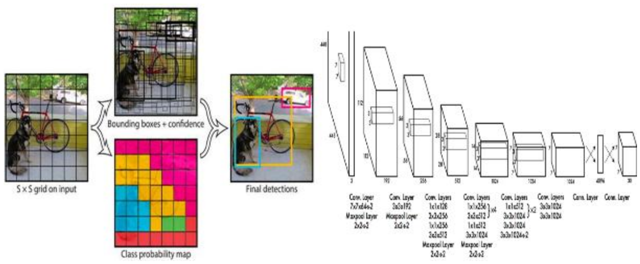

Fig -2: OBJECT DETECTION AND LAYER VIEW

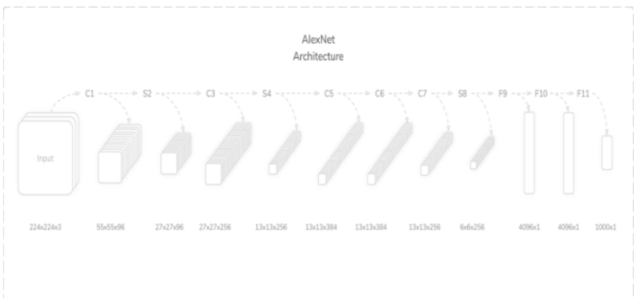

Fig -3: ALEXNET ARCHITECTURE

4.REQUIREMENT ANALYSIS

Software Requirements: -

-Desktop 4.0 And Above

- 2 GB RAM

-Processor Speed 1.2 GHz And Above.

Hardware Requirements:-

-8 GB RAM PC

-At Least 2 GHz Processor

-Windows 7/8/10

Technology Used:-

-Python

5.RESEARCH AND METHODOLOGY

1. Google Collab: Google Collab is a cloud-based Jupyter notebook environment that is available for free. It provides support for a wide range of popular machine learning libraries, which can be conveniently loaded into the notebook for use.

2. Python: Python's programming style is known for its simplicity, clarity, and the availability of powerful classes. Another advantage of Python is its ability to integrate with other programming languages, such as C or C++, making it a versatile choice for developers.

3. OpenCV: OpenCV, short for Open Source Computer Vision, is a collection of programming functions that are primarily designed for real-time computer vision applications. It is an open-source library that is available for free under the BSD license and can be used across multiple platforms. OpenCV also provides support for several deep learning frameworks, including TensorFlow, Torch/Pytorch and Caffe.

4. NumPy: Python has an array data type, which can be implemented using the NumPy library for data analysis and computation. Both Python and NumPy are open-source libraries that are freely available. NumPy is particularly useful for matrix calculations and is widely used for this purpose.

5. Pandas, Matplotlib: Pandas is a Python-based open-source library for data analysis and manipulation, which is fast, powerful, flexible, and user-friendly. Meanwhile, Matplotlib is a comprehensive Python library. With Matplotlib, simple tasks are easy to perform, and complex visualizations can be created with ease.

6. Pillow: The Python Imaging Library, commonly known as PIL, is an open-source library that provides additional support for various image file formats within the Python programming language. PIL enables the opening, editing, and saving of different types of image files. With the Python Imaging Library, users can add advanced image processing functionality to their Python interpreter. The library boasts extensive support for numerous file formats, high-speed data access, and robust image manipulation features. The core image library is designed to enable rapid-fire access to data stored in several introductory pixel formats, laying a solid foundation for a protean image processing tool.

7. TensorFlow: TensorFlow is an open-source library used for dataflow programming in various tasks, including machine learning applications such as neural networks. It is a symbolic math library used for both research and production at Google. Its flexible architecture allows for easy computation deployment across various platforms. Our project involves monitoring traffic using machine learning, capturing images or live videos, and processing them using relevant Python libraries such as YOLO. We need to differentiate between different types of vehicles, including ambulances, which cannot stop for signals. For this purpose, we use the AlexNet CNN architecture to train oursystem.

For motorcycle detection, we use a trained model with COCO Dataset, which is a large-scale object detection, segmentation, and captioning dataset. COCO defines 80 classes, and we import the required libraries to access the dataset. The libraries help differentiate between required objects such as motorcycles and other objects, and the detected objects are assigned certain IDs for future reference. The function "Coco.getObjectIds" is used to get the IDs for differentiated objects. The accuracy of our trained model for motorcycle detection is 99%.

Dataset: The quality of a model's performance in deep learning and machine learning relies heavily on the dataset used. A high-quality dataset ensures high precision and recall in the model. For object detection in images or videos, we used a manually created dataset consisting of 1,380 Emergency Vehicle Images and 1,496 Non-Emergency Vehicle Images. During the training process, the dataset was divided into training and testing sets. In addition, for Helmet Detection, we created a custom Yolov4 Model using a dataset with over 1000 images of both helmet and non-helmet riders. The images were collected from Google.

6.RESULTS

Fig -4: CONGESTION CONTROL SYSTEM

Fig -5: HELMET DETECTION

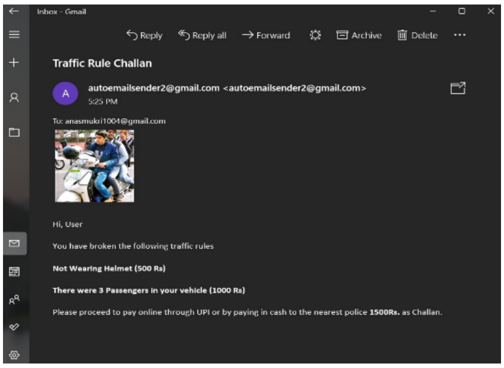

Fig -6: EMAIL OUTPUT

6. CONCLUSION

Our team is currently developing an advanced traffic control system that utilizes smart monitoring and detection technology to efficiently manage traffic flow. By analyzing the density of traffic, the system can make informed decisions to optimize traffic control and increase capacity at intersections. This innovative approach not only reduces the frequency and severity of accidents, particularly right-angle collisions, but also enables continuous and steady traffic flow under favourable conditions.

Compared to the existing system, which is inefficient due to the sheer volume of vehicles on the road, the proposed system addresses multiple loopholes by simultaneously detecting violations such as speeding, helmet non-compliance, triple riding, and more. With automated violation/fine alerts, the proposed system provides a safer and more efficient alternative to the current traffic control system.

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