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Smart Traffic Vehicle monitoring and Signal Allocation using YOLO

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Abstract

The traffic control system in India is now inflexible to the continuously increasing number of vehicles on the road. Fixed traffic light timing systems are a poor method of controlling traffic flow. Traffic lights are the fundamental component in traffic flow control through predetermined waiting and going times. A smart approach to adjust traffic light timing based on the number of vehicles in each lane is part of an intelligent traffic system. The average journey and waiting time for passengers will be reduced while the safety, dependability, and speed of the traffic flow is all increased. Designing an effective automated Traffic Time Saving system is the goal. The system is used for traffic management. In this proposed application first takes a picture of the car. Images are first converted from RGB to grayscale, then the vehicle picture is retrieved using image segmentation. After applying segmentation to the ready image, neural networks determine whether or not individual section contains a car. The successful parts will be counted by a counter. Lastly, a Graphical User Interface (GUI) will show the appropriate times for each light color.

1. Introduction

Vehicle counting is a method for estimating the volume of roadway traffic in order to evaluate the flow of traffic for automated transportation systems. The widespread use of cameras in urban transportation systems have made surveillance video a key source of data (Ye et al.). Due of the accessibility of handheld/mobile cameras and big- data analysis, real-time traffic control systems have also recently gained popularity (Qiao et al.). In this study, we provide a method for counting the number of vehicles in a video of highway traffic that was shot with portable cameras (Vogel et al.). Three steps are used to analyse a video: object detection using the YOLO (You Only Look Once) technique, monitoring with a correlation filter, and counting (Rosyida et al.). In the area of object identification, YOLO obtained a spectacular result, while in the area of tracking, correlation filters improved accuracy and comparable speed. As a result, we create multiple detection and tracking with correlation filters utilizing the YOLO framework's generated bounding boxes (Jin and Ma).

Due to the rise in automobiles, especially in large cities, research into traffic signal control systems has expanded significantly (Ikmalhisam and Noordin). Traffic signal timing systems are a poor method of traffic regulation, which causes a lot of problems for drivers nowadays (Cao and Y. Wang). The timer in a traffic light may occasionally be manually set by traffic signal authorities. Yet, this will result in a time-consuming process where the user must wait for the colour green (X. Li and Sun). While a lane is empty of vehicles, a green colour signal will occasionally appear because the signal timing is static; once a predetermined amount of time has passed, only the following lane's vehicles can proceed. Due of this, users are forced to wait for extended periods of time (Nellore and Hancke). The current system has a significant list of flaws, including the absence of a traffic time-saving mechanism, an unfriendly application, the requirement that drivers wait for extended periods of time, and an increase in travel and waiting times for passengers (Shahbazi and Y.-C. C. Byun).

2. Literature Review

Li et al. (2020) used the traffic simulator SUMO to create a model to solve the issue of controlling traffic signals. Deep Q-network method served as the foundation for the suggested model. The model's input was the number of vehicles and their average speed at a single or several intersections, as well as the current state of the traffic. The agent gave the best traffic signal phase and duration to shorten the average waiting times for both single-intersection and multi-intersection scenarios (D. Li et al.) (Jiang, Z. Wang, and Chen).

In order to perform intelligent decision-making based on the traffic circumstances on the present lane and its neighbouring lane in a four-lane intersection, Mittal and Chawla (2020) proposed a hybrid neuro- fuzzy adaptive traffic light system. The ANFIS system was implemented using Sugeno. The system was broken down into three parts: lane selection, timing adjustments for the green signal extension, and system training. ANFIS model performance was compared to those of fuzzy systems and fixed timing systems. The experimental findings demonstrated that the suggested ANFIS system outperformed other systems in terms of efficiency (Mittal and Chawla).

Jafari et al. (2021) thought about controlling the timing of the signal at a single intersection in Tehran based on the size of the vehicle line-up and the proportion of input and output vehicles. In order to manage traffic lights, a model of the intersection's traffic system was constructed, and the state-space parameters of the intersection were planned. The created model predictive controller's stability was examined, and it was deduced from simulation results that, in comparison to the fixed-time model, the length of the vehicle wait was reduced for all lanes of the intersection. This demonstrated the proposed controller's efficacy (Jafari, Shahbazi, and Y.-C. Byun).

A simple and affordable adaptive signal control strategy for poor nations was put out by Zhu (2019). The crucial information for the suggested strategy was gathering the green and red redundancy times of each phase while the volume of traffic is low. To cut down on the overall redundancy time, the signal timing was altered. After comparing cases with various sensor placements, it was discovered that the position optimized by the suggested strategy had the shortest traffic delay (Zhu et al.).

3. Methodology

The proposed system helps in better time-based monitoring and thus has certain advantages over the existing system like minimizing number of accidents, reducing fuel cost. The proposed system is designed in such a way that it will be able to control the traffic congestion as well as track the number of vehicles.

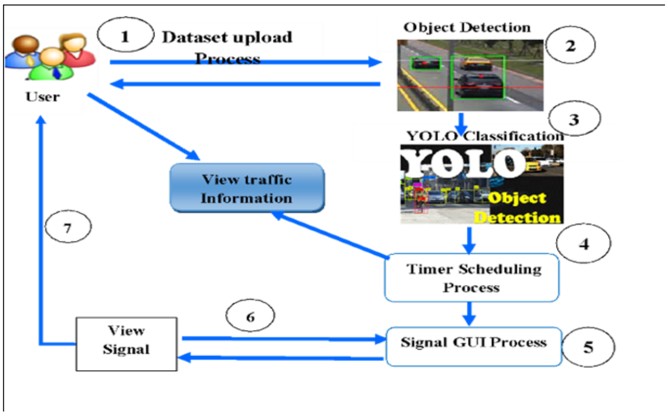

FIGURE 1. System Architecture

3.1. Dataset Image Upload process

The first module of this application gives users access to the UCI repository as a source for image datasets. After that, the user can upload the dataset using the browse option. PNG or JPEG files can be used for the dataset image.

3.2. Image segmentation

One of the crucial steps in determining the number of vehicles in each flow of traffic is image segmentation. The separation of a digital image into various subgroups (of pixels) known as Image Objects is referred as image segmentation.

By reducing the image's complexity, this process makes image analysis simpler.

3.3. Detect Object and Boundary Boxes

A bounding box is a virtual rectangle that creates a collision box for the target object for the purposes of object detection. These rectangles, which show the X and Y coordinates of the significance object in each image, are created by data annotators across images. This helps machine learning algorithms find what they are looking for and identify collision pathways more easily while also saving a substantial amount of processing resources. Bounding boxes are one of the most popular image annotation techniques in deep learning. This strategy can be less expensive while enhancing the usefulness of annotations as compared to alternative image processing methods.

3.4. YOLO object Classification

It is a technique that uses neural networks to detect objects in real time. The efficiency and speed of this algorithm account for its popularity. It has been applied in several applications to count and categorize the vehicles in traffic.

3.5. Vehicle count detection

Neural network object analysis will determine whether every segment is a positive segment (a vehicle). The affirmative Segment will be counted by a counter. Lastly, a separate table will be maintained for positive counts. The system will finally show the overall number of moving vehicles.

3.6. Traffic GUI Process

The successful parts will be counted by a counter. Lastly, a GUI will show the appropriate times for each light hue.

4. Results

The experiment is conducted by using Windows 10 Dual core processor, 4 GB RAM, and 250GB hard disk. This experiment using Python and PyCharm for developing the GUI tool. The proposed YOLO algorithm is compared with Convolutional Neural Network (CNN) algorithm with four performance factors such as precision, recall, F-Measure, and accuracy.

Table 1 and Figure 3 shows the performance of classification algorithms. It is exposed that the proposed CNN performs well than the SVM algorithm. The proposed YOLO algorithm achieves

Step-1: Import the essential libraries.

Step-2: Build a function to filter the boxes depending on respective threshold and probabilities.

Step-3: Provide a function to determine the connection between two boxes ((Intersection over Union).

Step-4: Develop a technique to deactivate Non-Max.

Step-5: Predict the bounding boxes after creating a random volume (19,19,5,85) with the shape.

Step-6: Create a function that accepts CNN outputs as input and outputs the suppressed boxes.

Step-7: Make predictions for a random volume using the yolo eval function.

Step-8: Utilize recent images with a YOLO algorithm that has been previously learned.

Step-9: Create a method to predict the bounding boxes, then save the images with any of these bounding boxes present.

Step-10: To use the predict function, analyse an image and generate predictions.

FIGURE 2. YOLO Algorithm

TABLE 1. Performance Analysis

Algorithms	Precision	Recall	F-Measure
CNN	80.25	81.53	80.71
YOLO	84.52	85.25	86.73

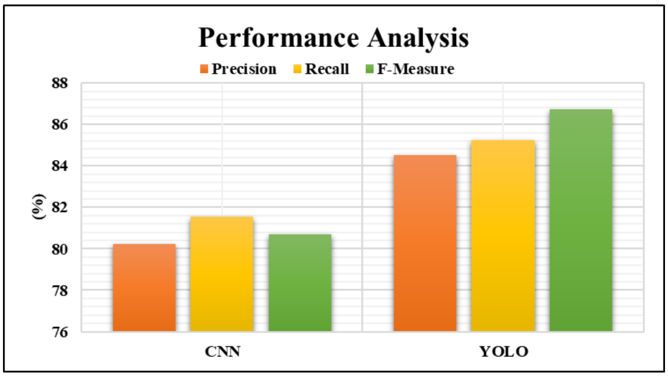

FIGURE 3. Performance Analysis

4.27% greater precision, 3.72% greater recall, and 6.02% greater f-measure value than CNN.

TABLE 2. Accuracy

Algorithms	Accuracy
CNN	80
YOLO	86

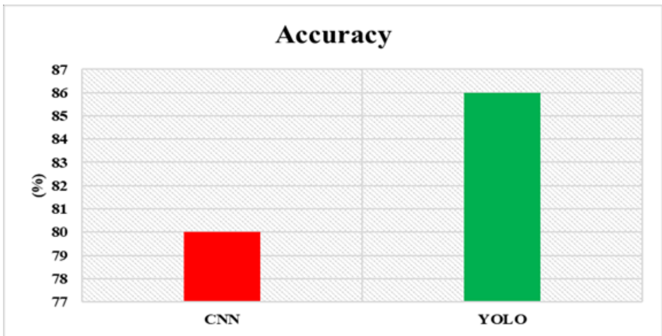

FIGURE 4. Accuracy of YOLO object Detection Algorithm

Table 2 and figure 4 illustrates the accuracy of classification algorithms. It obvious that the proposed YOLO algorithm achieves greater accuracy than CNN algorithm.

The following figures are the screenshots of proposed application. Figure 5 illustrates the main menu for the proposed smart traffic vehicle monitoring application.

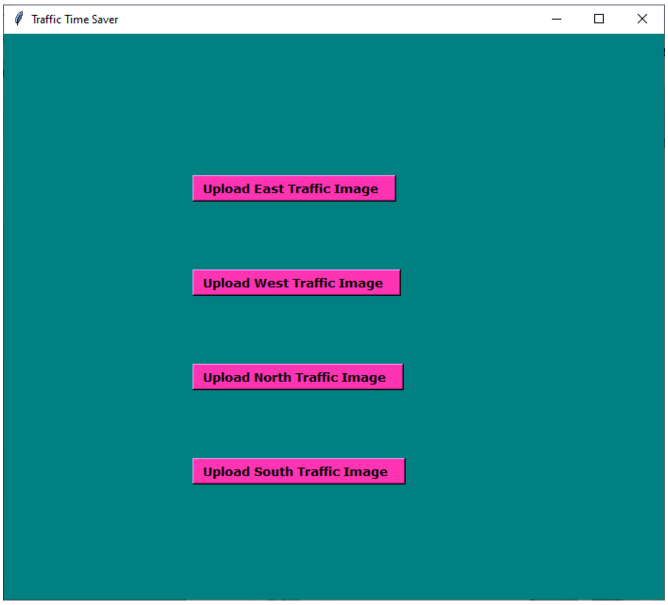

FIGURE 5. Screenshot of the Proposed Application

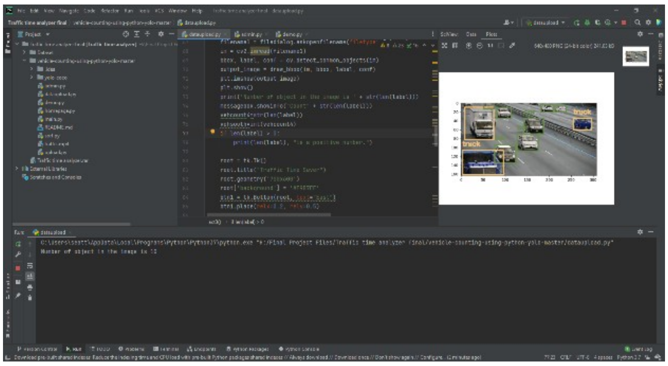

FIGURE 6. Object Detection

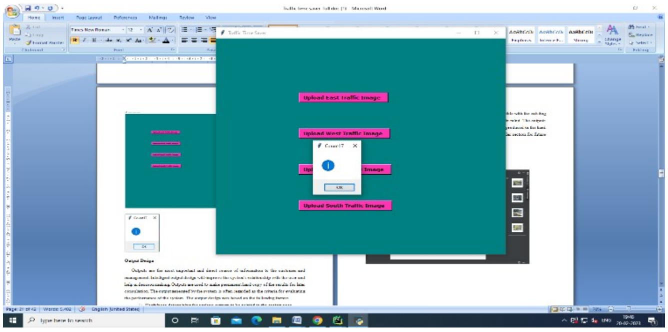

FIGURE 7. Counting the Vehicle

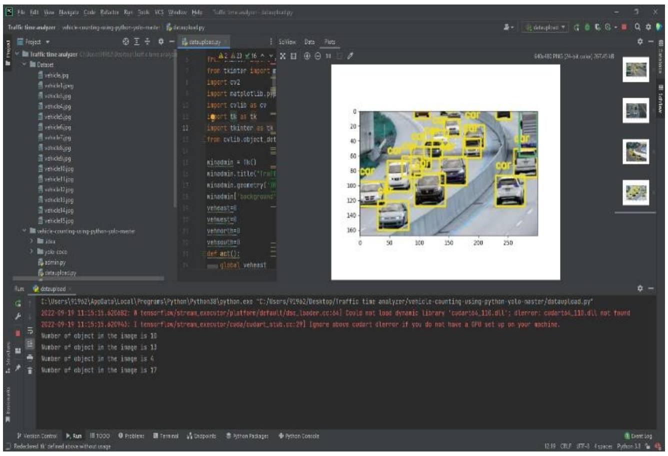

FIGURE 8. Detecting the Vehicle

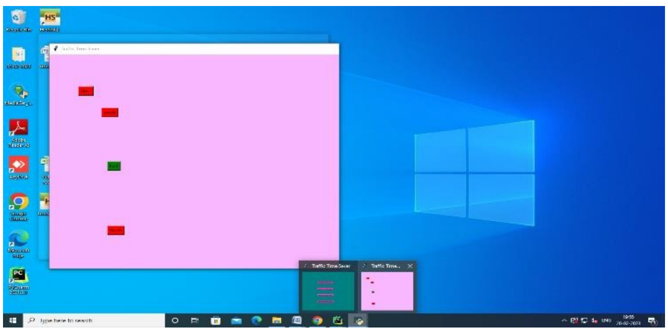

FIGURE 9. Detecting

Figure 6 depicts the detected vehicle objects using proposed CNN algorithm. Figure 7 and 8 shows the number of counts of detected vehicles.

Figure 9 illustrates that the direction of detecting vehicles such as East, West, North, and South. The proposed model successfully introduced YOLO, a novel technique to object detection, an algorithm that can enhance detection performance based on sparse training data, and a way for efficiently expanding the database. The proposed convolution neural network needed to be able to distinguish between several items, including a car and a motorcycle. Based on violations of traffic laws, the amount of the fine will be automatically calculated and displayed to the user to reduce the amount of data needed for learning. YOLO network significantly improves accuracy with even less noise.

5. Conclusion and Future Enhancement

The main objective of the proposed system is to provide a user-friendly interface for time save in Traffic signal. The system is implemented on the traffic control. In this proposed application system first captures the vehicle image. Vehicle image is extracted using the image segmentation finally converting the images from RGB to gray scale. Next, the segmentation is applied on the prepared image and then for each segment the neural networks will predict a vehicle or not. A counter will count the positive segments. Finally, the suitable periods for each light color will display in GUI. The majority of the requirements were addressed in this paper. Since the coding is primarily structured or modular in nature, additional requirements and upgrades can be made with ease.

In future, significant improvements can be added by altering the current modules or adding new modules. The application can be further improved with an IOT interface; a camera will take a picture of the traffic light, count the number of vehicles, and display the traffic signal in the interface.

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