Walchand College Of Engineering, Sangli

(An Autonomous Institute)

Department
Of
Computer Science and Engineering

TY CSE Mini Project-3
Report
On

IntelliSignal

Submitted by

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Under the Guidance
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CERTIFICATE

This is to certify that the Project Report entitled, **"IntelliSignal"** submitted by Mr. Mayur Kamble, Mr. Meet Gandhi and Ms. Megha Jivanagi to Walchand College of Engineering, Sangli, is a record of bonafide Project work of course *"5CS347 Mini Project-3"* carried out by them under our supervision and guidance and is worthy of consideration for the award of the degree of Bachelor of Technology in Computer Science & Engineering of the Institute.

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Acknowledgement

We would like to express our profound gratitude to **Mrs. M. A. Shah** (**HOD** of Computer Science & Engineering Department), and **Mrs. Swapnali Aitwade** our guide, for their guidance to the completion of our project titled **IntelliSignal**. Your useful advice and suggestions were really helpful to us during the project's completion. In this aspect, we are eternally grateful to you.

We would like to acknowledge that this project was completed entirely by us.

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Declaration

We hereby declare that work presented in this project report titled **"IntelliSignal"** submitted by us in the partial fulfillment of the requirement of the award of the degree of **Bachelor of Technology(B.Tech)** Submitted in the **Department of Computer Science & Engineering, Walchand College of Engineering, Sangli**, is an authentic record of our project work carried out under the guidance of Prof. Swapnali Aitwade.

Date: 27/05/23

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IntelliSignal

2 Problem Statement

Develop a system that effectively manages traffic flow in urban areas due to varying vehicle densities, resulting in congestion, delays, and inefficient use of road capacity. The system should dynamically adjust signal timings based on real-time vehicle density information to optimize traffic flow, minimize congestion, and improve overall transportation efficiency.

3 Abstract

Traffic density in urban cities varies immensely depending on the time of the day. But the signal timer is fixed irrespective of the time. Sometimes there may be less vehicles at the signal resulting in wastage of seconds after lane gets empty. Due to this traffic may get accumulated on another signals. We used Yolov8 object detection algorithm to detect number of vehicles in the lane using CCTVs at the signal and deduce the timer for the signal based on the algorithm that we developed.

4 Introduction and Related Work

With the increasing number of vehicles in urban areas, many road networks are facing problems with the congestion of roads and the corresponding level of service. Many traffic-related issues occur because of traffic control systems on intersections that use fixed signal timers. They repeat the same phase sequence and its duration with no changes for whole cycle. Increased demand for road capacity also increases the need for new solutions for traffic control that can be found in the field of Intelligent Transport Systems.

A study shows the condition of traffic flow around the globe and urban cities of Bengaluru ranks 2nd, Pune ranks 6th with New Delhi and Mumbai in top 50. The study projects average time of 25-30 mins for travel distance of 10km in the cities [1].

In recent years, video monitoring and surveillance systems have been extensively used in traffic management for security, ramp metering, and providing information and updates to travelers in real-time. The traffic density estimation and vehicle classification can also be achieved using video monitoring systems, which can then be used to control the timers of the traffic signals so as to optimize traffic flow and minimize congestion.

Reference [2] makes use of a support vector machine algorithm along with image processing techniques. From live video, images in small frames are captured and the algorithm is applied. Required region is cropped and fed to the vehicle detection module. Image processing is done using OpenCV and the images are converted to grayscale images before SVM is applied. This system not only detects traffic density but also detects red light violations.

There are various attempts to detect vehicles on the lanes using photoelectric sensors set at some distance apart. Some techniques of fuzzy logic and ANN are also implemented.

Calculation of signal timers must be fast and for that to be fast the object detection module should be fast. There should be minimal delay to avoid confusion and accidents on the intersection of roads.

5 Objectives

a. To study and choose appropriate object detection algorithms from You Only Look Once (Yolo), Single Shot Detector (SSD) and R-CNN (Region-CNN).

b. To implement Yolov8 and return number of vehicles from object detection module.

c. To develop and algorithm to calculate signal timer dynamically according to vehicle density.

d. To integrate and display the appropriate signal timer for the lane.

6 Methodology

A. System Overview

Our system takes an image from CCTV mounted on the lane to detect number of vehicles. This frame is input to Yolov8 algorithms trained on COCO dataset by Microsoft. This dataset has total about 80 labels. It has good accuracy. Output of this module is given to timer generation module which will run the algorithm on the basis of constraints and output a timer for the signal.

B. Vehicle Detection Module

YOLO (You Only Look Once) version 8 is used for vehicle detection on the image from CCTV. YOLOv8 is the newest state-of-the-art YOLO model that can be used for object detection, image classification, and instance segmentation tasks. YOLOv8 was developed by Ultralytics, who also created the influential and industry-defining YOLOv5 model. YOLOv8 includes numerous architectural and developer experience changes and improvements over YOLOv5 [3]. This model is trained on COCO dataset. The COCO dataset consists of over 200,000 labeled images and contains 80 object categories, including people, animals, vehicles, and everyday objects. Each image is annotated with object bounding boxes, object segmentations, and object keypoints. The availability of a large number of diverse images and detailed annotations makes the COCO dataset valuable for advancing the state-of-the-art in computer vision research. The benefit of Yolo is that it leverages GPU parallelism power to compute results faster and accurately. It used CUDA and CUDAnn libraries to use Nvidia GPUs for processing.

YOLOv8 gives output in the form of bounding boxes which consists values of probability of object being present, coordinates of center of object along with width and height of object and lastly class of object from object classes the model is trained on (P_i, x, y, w, h, C_i).

YOLO is blazing fast and uses little processing memory. While YOLOv1 was less accurate than SSD, YOLOv3 and YOLOv5 have surpassed SSD in accuracy and speed. SSD can handle objects of various scales. It utilizing feature maps from all convolutional layers, and each layer operates at different scales. It is also not computationally heavy. However, SSD also struggles to detect small objects. Furthermore, SSD becomes slower if it contains more convolutional layers.

C. Timer Generation Module

Timer for the signal is calculated on the basis of number of vehicles detected by the above module.

To calculate the timer some parameters are to be considered:

a. Distance of last vehicle in the lane (d).

b. Length of intersection (i).

c. Average acceleration of vehicle in traffic (a)

d. Maximum velocity reached in the traffic (v)

Here initially time required to reach max velocity is calculated

$t_1 = v / a$

Then distance covered in this acceleration is calculated

$d_1 = 0.5 * a * t_1^2$

This distance is subtracted from total distance for last vehicle and for remaining distance the time is calculated

$t_2 = (d-d_1) / v$

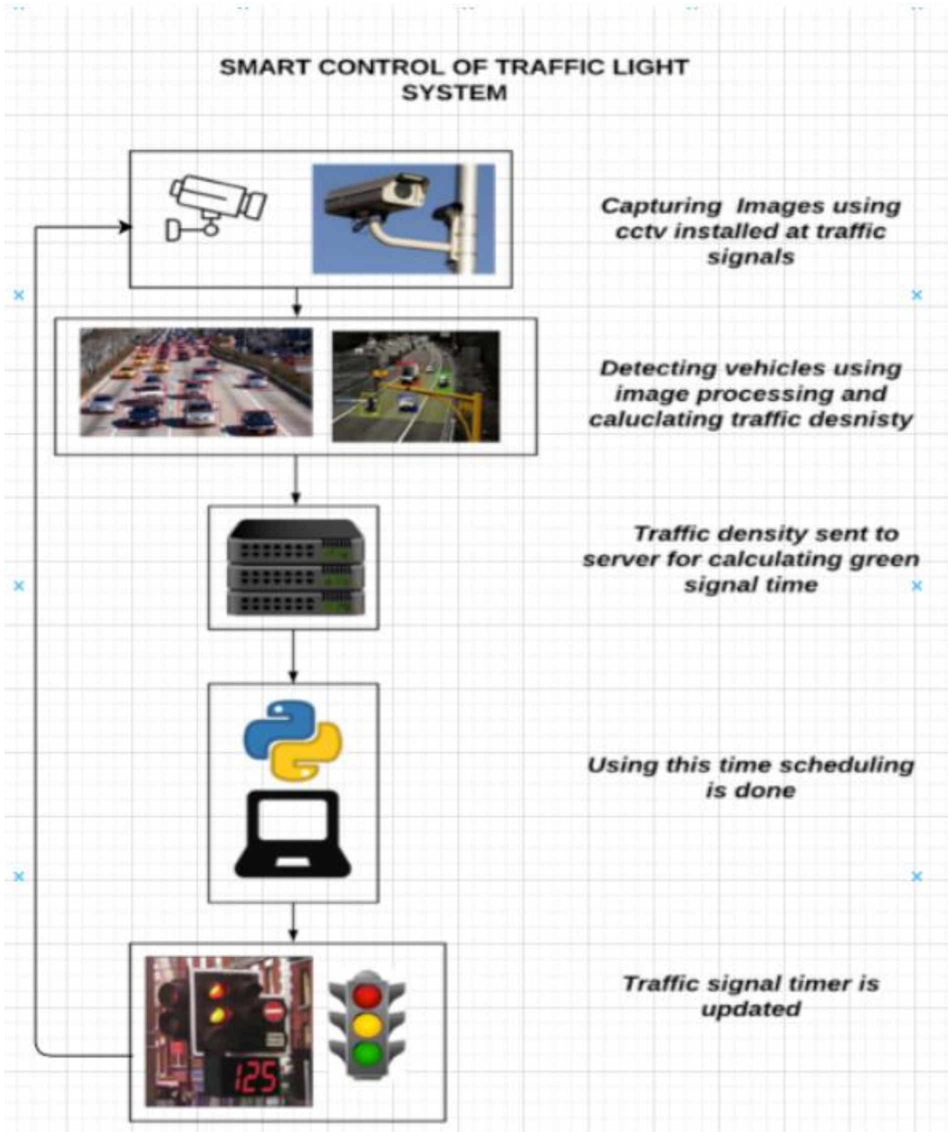
Then total time is calculated using

$t = t_1 + t_2$

If total time is greater than 30 seconds then it means that the queue is very big and if this time is displayed then traffic on other lanes will keep on increasing leading to starvation of vehicles in other lanes. That is why upper limit of timer to be generated is fixed.

This way timer is generated for each lane and it is added in next lane's timer to calculate red signal timer for that lane. And when that lane's timer runs out and when next lane's is about to turn green then this whole process again takes place.

7. Project Flow Diagram



8. Results and Conclusion

Take vehicles 24, 12, 8, 2 in lanes l_1, l_2, l_3 and l_4. The signal is about to turn green at l_1. The order of cycle at intersection is $l_1 \rightarrow l_2 \rightarrow l_3 \rightarrow l_4 \rightarrow l_1$.

Time calculated according to algorithm is

1st Signal - Green: 18 seconds
2nd Signal - Red: 20 seconds
3rd Signal - Red: 41 seconds
4th Signal - Red: 57 seconds

Now in static signal timers each signal would go on for 30 seconds. But here we see that for Signal 1 timer required is only 18 seconds and 12 seconds are saved. On calculating on average 8 seconds saved per signal it will be 32 seconds saved per cycle of 30 * 4 = 120 seconds of cycle.

If 40 seconds are saved on 2 mins of cycle i.e. effective time comes down to 1min 20 seconds. Then calculating per hour is 32 * 30 = 960 seconds = 16 minutes per hour.

Here improvement is about 16 / 60 * 100 = **25 %**

The algorithms can be further optimized according to the requirements of the intersection and width of road. The bicycles also form a third line on the lane and moving faster from the intersection. There is still a scope for improvement but this way provides optimization in traffic flow and reduction in time wastage and pollution stationary in the traffic.

9. References

[1] TomTom.com, 'Tom Tom World Traffic Index', 2019. [Online]. Available: https://www.tomtom.com/en_gb/traffic-index/ranking/

[2] A. Kanungo, A. Sharma and C. Singla, "Smart traffic lights switching and traffic density calculation using video processing," 2014 Recent Advances in Engineering and Computational Sciences (RAECS), Chandigarh, 2014, pp. 1-6, doi: 10.1109/RAECS.2014.6799542.

[3] Ultralytics/yolov5: v7.0 - YOLOv5 SOTA Realtime Instance Segmentation. Doi : 10.5281/zenodo.7347926

[4] LI Suhao, LIN Jinzhao, LI Guoquan , BAI Tong, WANG Huiqian, PANG Yu - Vehicle type detection based on deep learning in traffic scene. 8th International Congress of Information and Communication Technology (ICICT-2018).

[5] OpenCV Library: https://opencv.org/

[6] Yolov8 Documentation - https://docs.ultralytics.com/