Adaptive Traffic Light Based on Yolo-Darknet Object Detection

Article · November 2019

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Abstract. Nowadays roads and streets are getting overcrowded, especially in bigger cities. Hence the main goal of our project is to build a traffic monitoring system that is able to detect the movement of cars and to track and count the different vehicles by analyzing a camera picture with the help of computer vision[1]. The System works on the following: it accepts the video from a file or a live camera, makes the ROI in the area that we want to controls, mark vehicles using OpenCV and YOLOV3 dataset with rectangles, and count the vehicles. To accept visual information we use Spyder for OpenCV. To maximize the speed of the program we used a tiny version of YOLO. The system detects objects well and the system works at 15 fps of the video stream daylight. The ROI makes the detected vehicle only occur in one certain lane, it makes the system run faster because the system won't detect unnecessary objects that outside the designated area that makes the system overworked. With a faster, adaptive, and efficient traffic light monitoring system we believe traffic intersection congestion can be reduced.

1. Introduction

Traffic jams in an intersection are one of the most recurring traffic-related problems that haven't really found a fix or solution that is robust. This happened because every traffic light should have the ability to adapt according to traffic conditions, while most of the traffic lights operated by a traditional timer.

There is some solution out there for adaptive traffic light systems like a magnetic-based telemetry sensor to monitor how crowded is the traffic that can be monitored in real-time. This kind of system has been implemented in England and Australia. But this system could cost so much because it needs to plants the sensor literally inside the highway itself, also, as the sensor was planted inside the highway, it means it could be a mess if there is something happen and the sensor needs to be fixed.

With the advance of technology in computer vision, this opens a new possibility to have a vision based adaptive traffic light system. With a vision based adaptive traffic light system, the device that needed, in a nutshell, is only a camera and computer. This means this system will cost less because most intersection or traffic lights already have some CCTV like camera, so the things that needed are just to calibrate the camera and install the proprietory software for a self-regulating traffic light.

2. Method

2.1. Region of Interest Masking

Region of interest or ROI masking is part of camera calibration. There is some reason why we need to mask the region of interest area, in this case, the highway lane.

By creating a region of interest area, this will help us to have a better detection result as the detection only occurs in the ROI area. Therefore, it will also reduce system horsepower that needed to operate object detection as an object detection operation usually will take much system resources by only detecting the object in the necessary area.

2.2. Detection

The detection in this system will be done by the Darknet object detection framework. Darknet is one of open source object detection framework that has a very special object detection method that called You Only Look Once or YOLO[2].

This YOLO method works by making the grid in the target image, and then doing object detection and object classification simultaneously in each cell grid by using the Darknet neural network. Therefore, this what makes the YOLO method really fast for doing real-time object detection, just as we need for an adaptive traffic light system where we need to detect an object in real-time and fast as possible.

2.3. Traffic Light Control

In this paper, we proposed a traffic light regulation system that is based on the result of vehicle detection from the camera and then doing the regulation based on which lane that needs to be prioritized. Our goal is to reduce congestion and waiting time by dynamically regulate all the lane to look for which lane should have better priority.

To achieve this, we created a system based on a paper written by Maram Bani Younes and Azzedine Boukerche [4]. This system works by calculating the number of vehicles that waiting on the lane, and by setting up a certain threshold point so that every lane that passed that threshold point then needs to be prioritized.

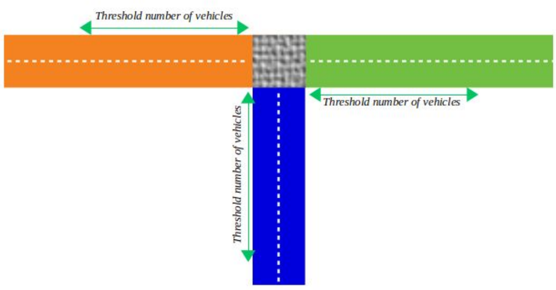

Fig. 1. Traffic Light Control Illustration

3. Result

The System was tested using sample offline video with a system powered by Gen 5 Intel Core i5 processor with NVIDIA GT 930M video card. With this system, we could run detection at 2,4 fps average when using YOLOV3[3] dataset, and around 15,5 fps average when using Tiny version of YOLO detector. This result shows that YOLO detector is lightweight enough and very possible to run better on a better high-performance system.

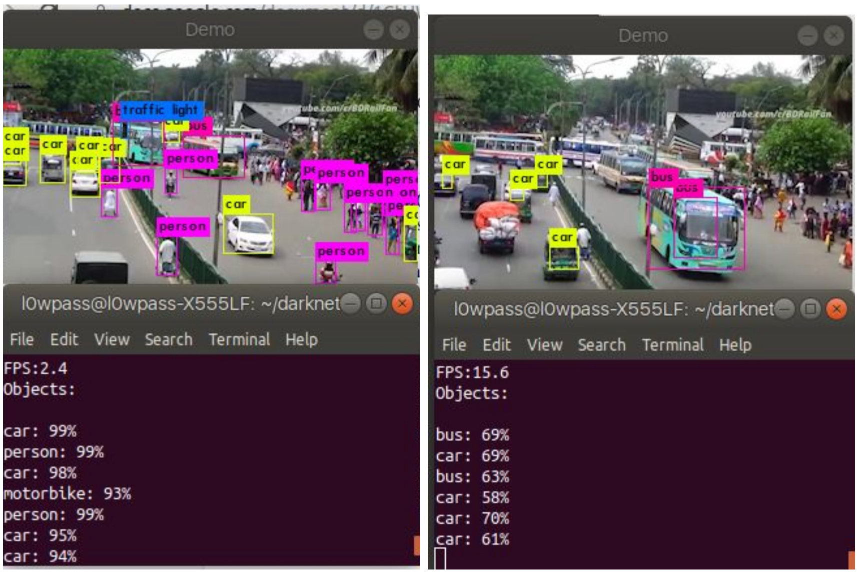

Fig. 2. Fps comparison between YoloV3 and YoloV3-Tiny

The correct rate of detection when using YOLOV3 dataset was high, but it needs a better-trained dataset that is more specialized for vehicle detection, so it could detect objects that are far from the camera. Compared to when using tiny version of YOLO, the detection result was less accurate, both from when detecting objects and when classifying objects. This problem might be caused by the dataset, where YOLOV3's dataset has five-times bigger file size compared to the tiny version of the dataset, and this might also cause YoloV3's dataset to have better-detailed information for object detection operation.

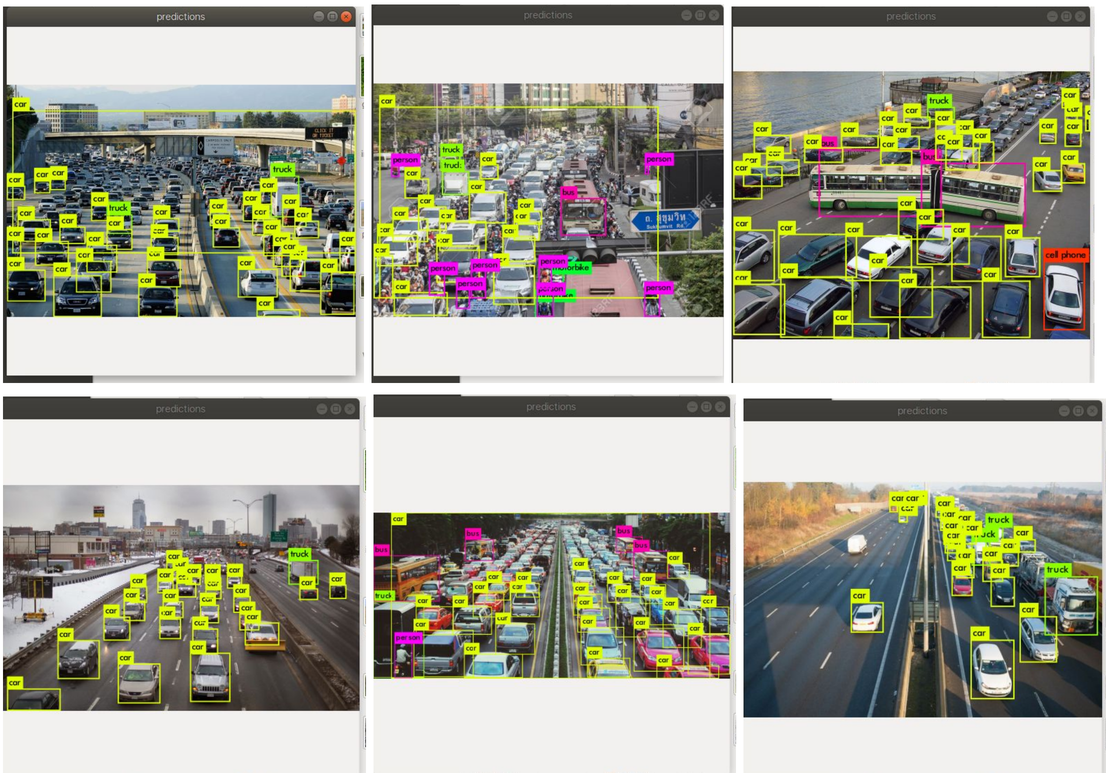

Fig. 3. Detection result using YoloV3 dataset

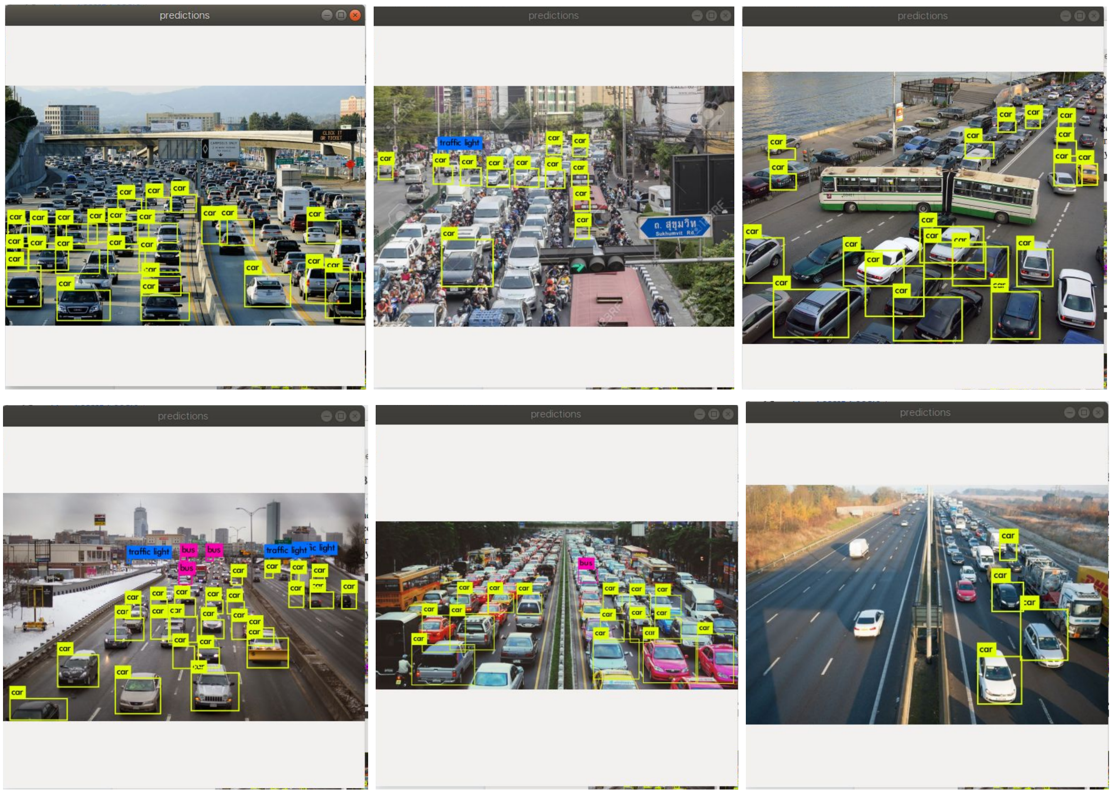

Fig. 4. Detection result using tiny version of Yolo dataset

The ROI successfully managed the system to only detects the part of the road that we want to control. This ROI masking was done through OpenCV. It helps the system only detect a lane that we want to control from two or more lane road. Therefore, it also helps to reduce system resources because detection only occurs in certain sections, not in the whole scene.

Fig. 5. Raw video scene from the camera (left), ROI created for 1 lane detecting (right)

Fig. 6. Detection result using ROI masking

4. Conclusion

The system has been successfully made using the NVIDIA GT930M, but a better graphics card is needed for a better smooth system and higher FPS. Tiny YOLO makes the system run in higher performance but with lower accuracy.

The system only detects vehicles inside the ROI that makes this system more efficient for controlling traffic light to avoiding traffic congestion. It managed to count the number and the type of vehicles detected. But the system can be improved by prioritizing the bigger vehicle so the congested traffic can be solved faster because bigger vehicle takes more space and more time to start moving.

In the future, we believe this system could be integrated with other related traffic management systems, such as automatic ticketing, road density monitor, or also a road traffic collision detector. So, there will be more data and there could be more strategy to successfully reduce traffic congestion problem.

References

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