

Smart Traffic Light Control System

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Introduction

Problem statement

Traffic jams have been one of the most challenging problems in developing countries with increasing population and automobiles. Things that can cause traffic jams include drivers not obeying traffic rules and the government cannot manage and control the lanes well, etc. Traffic jams not only cause extra delay and annoyance for the driver but also cause air pollution, fuel consumption, noise pollution due to car horns and increased transportation cost.

We have tried to solve this kind of problem in many ways like using traffic police to control the traffic, installing fixed traffic lights and building bridges. Among these traditional solutions, installing fixed traffic lights is the most simple and commonly used solution because fixed traffic light installation doesn't need to use much manpower like using traffic police and it's more cost effective than building bridges.

But there are also some problems with using fixed traffic lights. When the traffic lights are fixed, the green light opens the road with many cars and the road with few cars for the same period of time. So sometimes it may be inconvenient using fixed traffic lights. Sometimes when a green signal opens the empty road for a period of time, it can even make a traffic jam.

Objective

In this case , we should try to use Artificial intelligence to control traffic signals instead of using a fixed sequence control system. In this project, I am going to create a smart traffic control system which controls the signal with Artificial Intelligence Technology. In this control system , the program will detect how many vehicles are on the lane by using computer vision and will generate a fair duration of the green light signal for each specific lane.

Comparative Analysis

Benefits From this Project

If we use a smart traffic light system, we can reduce traffic jams more efficiently than using fixed traffic lights. At the same time the bad effects of traffic jams will be reduced, the city and the pollution will be more clean. This system will be an innovative step toward a sustainable society. Developing AI for smart traffic lights and implementation will not be as expensive as building bridges and does not use a large amount of manpower as manual control (using traffic police). If we can do some improvement, we can upgrade the system to give real time alerts about the cars that disobey the traffic rules.

Model Developing

The Processes of the System

In this system,

- The camera will take a picture of the lane (lane 2) when the previous lane(lane 1) is turning yellow.
- By detecting this picture with object detection, the AI model will count the number of vehicles in this lane and return the detailed data of the vehicles.
- According to the data obtained from the AI model, the python program will generate the amount of green light time duration for the lane.
- The generated time duration will be sent to the microcontroller of the traffic light.
- The green light will be displayed with the generated time duration.
- When the green light turns to yellow, the process will be done with another picture of the upcoming lane.

There are two parts to develop the system. The first one is to detect and count the number of vehicles in the image with object detection and then another one is to generate the amount of time duration for the green light and send the output as a signal to the microcontroller of the traffic light.

Writing a time scheduling algorithm

Choosing programming language - I think python is the best all-round option for developing this smart traffic system because in this system we have to use computer vision to get input data. In python many special libraries, platforms and AI framework for computer vision have been developed and they are open-source. There are also other top choice programming languages such as Java (which is faster than python), Javascript, C++ and Julia . But python is well documented and python is simple and easy to read so it is easy to develop.

Facts that should be considered in writing a time scheduling algorithm with Python program ;

1. Set a time to take a picture - when the picture is taken too early the amount of cars waiting in the lane will not be correct, when the picture is taken too late the needed time to detect the vehicles may not be enough.
2. Creating a function to generate the appropriate time period for the green light signal - the generated time period must be enough for the cars to pass .
3. The maximum and minimum green light signal time that can be set.
4. Preparing a backup signal time period for just in case when the AI model cannot return output in time.

Choosing Algorithm for object detection

Object Detection is a function that detect the location of objects with a bounding box and classify their types or classes in an image. The input of the function will be an image or a frame of a video with one or more objects. The output will be one or more bounding boxes of the objects and a class label for each bounding box.

In choosing algorithms for object detection, there are some qualitative considerations to be made based on the condition of the application and available data. Here is three primary algorithm for object detection;

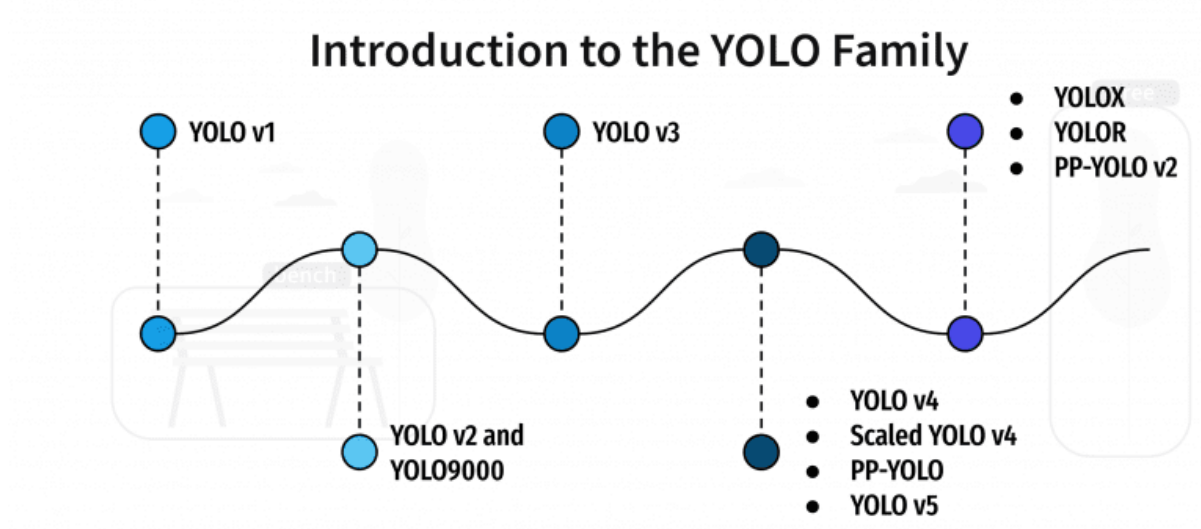
1. Faster Region-based Convolutional Neural Networks (Faster R-CNNs),
2. You Only Look Once (YOLO), and
3. Single Shot Detectors (SSDs).

Faster R-CNN is the most famous type which is complex and challenging to understand. The algorithm is slow because it can only do on the order of 7 frames per second.

The YOLO model is the fastest , capable of processing 40–90 FPS or 155 FPS on specialized configurations.

SSDs strike a balance between Faster R-CNNs and YOLO.

So I chose the YOLO model to process the detection in a short time.



YOLO model family (pyimagesearch)

Developer of YOLO model Family - **Joseph Redmon, Santosh Divvala, Ross Girshick, Ali Farhadi**

In python, there is opencv library which is a deep learning framework, so I can use YOLO with opencv_dnn in python to do object detection of the image. For more accurate data, installing extra cameras on the lane might be needed.

Project Demonstration

Detecting cars with yolov4 model with opencv_dnn in python

Fig. 1 , and Fig. 2 are photos of traffic conditions in Yangon streets detected with my object detection algorithm. The algorithm can detect the vehicles in the picture well although the vehicles with small pixels are not detected.

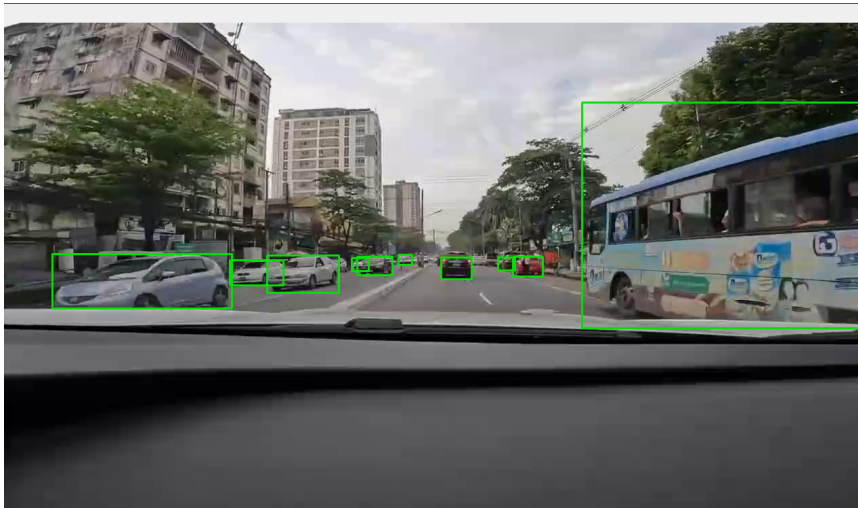


Fig. 1 . Detection of Vehicles on Insein Road

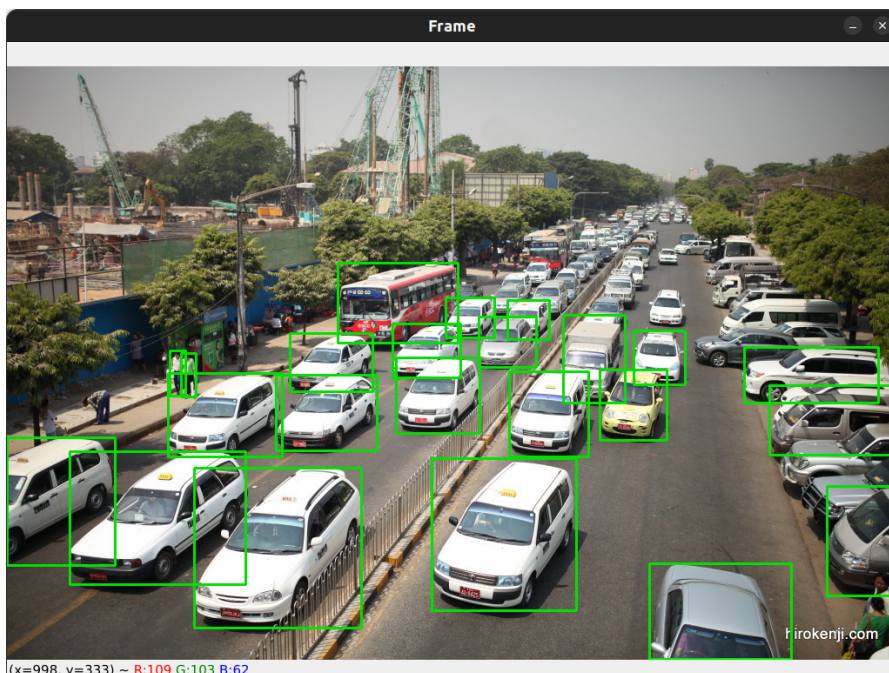


Fig. 2 . Detection of Vehicles On Kanner Road

Things to be Considered For Implementation

To deploy the smart traffic control system in the traffic light, we have to consider some point

- **No. of lanes** (we have to make some configuration in the system due to the number of lanes .)
- **Power Supply** (considering for the power supply for the is also an important part of the implementation)
- **Camera location** (To get a clear view of the road, to install enough amount of cameras and to install the cameras in right location are also the importance part of the implementation because some roads are not straight)

Conclusion

Installing Traffic Lights are one of the most important roles for developing countries. Governmental organizations have tried to reduce traffic jams in various ways. In this project , I tried to create an innovative, high-tech and efficient system to reduce traffic jams. The system is not fully developed because I don't have enough domain knowledge (not knowing how traffic police set time a for a lane regarded with the amount of vehicles , and how the microcontrollers of the traffic light are working). But I believe that developing and implementing of this system will help to archive global sustainable goals and to make green, clean, inclusive and safe cities.

Future Improvement

By grouping Smart Traffic light control systems around the city , the traffic control department can get detailed information of the city traffic flow .In this project, I planned to detect the vehicle by capturing photos because I am aware of not completing the setting time generating process and the computational power. But if we can detect live frames without having any delay, we can add some other functions like getting alerts for the traffic rules disobedience.And we can also improve our system to detect emergency vehicles and open the lanes for those vehicles

References

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