Real-Time Traffic Control System by Using Object Detection Algorithms

Abdulrhman Zakaria, Walid Hussein
Faculty of Informatics and Computer Science
The British University in Egypt (BUE)

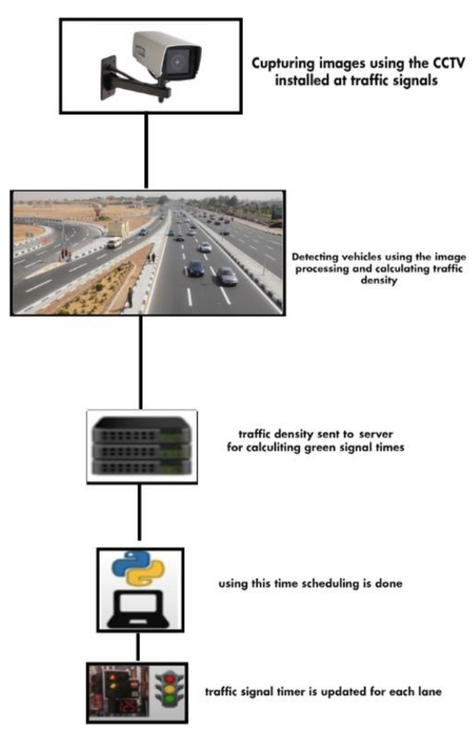
Abstract

Overcrowding traffic became a serious problem in Egypt with many buses, vans, and cars in the street. Solving traffic congestion by using the fixed cycle traffic lights doesn't solve the problem in all situations, and in some cases, a policeman is replacing the traffic lights controlling the movement instead of the traffic lights, he sees the availability and situation of the road and decides the period of each direction. From here the idea of self-adaptive smart traffic control by the neural network such as YOLO or Masked R-CNN due to its high accuracy and speed which is once trained the prediction is fast and accurate. This traffic control system was able to achieve the real-time traffic situation detection and take the most efficient decision to manage the intersected traffic lanes without waiting for a fixed time which always leads to over waiting for the cars when the cars are less than the suggested time or some cars must wait for 2 turns in the traffic because the car count was higher than the suggested time.

June 15, 2022 - Traffic light with CCTV camera

Introduction

The project aims to solve the traffic congestion in Egypt through the self-adaptive traffic light which works in a synchronized smart method without any human involvement or any attached sensor. All that is needed is a CCTV camera and embedded computer which it can capture frames per second, and this computer process this image frame and detect the number of cars passing through the lanes by neural networks techniques as the convolutional neural network technique so it will be able to make its own decision by python code implementation, such that it will be able to switch between the traffic lights according to the car types as each car type has own weight then after retrieving these values the green and red timer start to count down until reaching to the yellow timer again which is responsible for repeating the detection process.

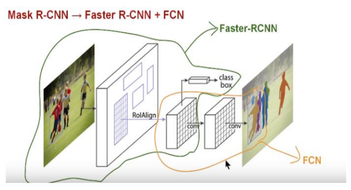


The flow diagram of the real-time traffic controlling system.

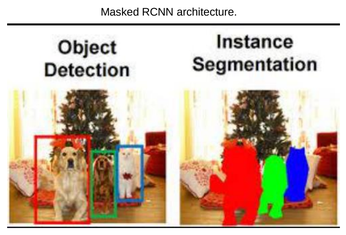
Material and Methods

Masked RCNN ALGORITHM

the masked CNN is better than the other versions of the CNN its approach is divided into object detection which classifies a variable number of objects in the image, and it does the semantic segmentation which understands the image at the pixel level as we want to assign the object to each pixel in the image, for the object detection it uses the faster R-CNN model, and for the segmentation, it uses the fully convolutional network (FCN). Faster R-CNN uses a regional proposal network (RPN) as it performs the object detection in two stages determining the bounding box and determining the regions of interest by the RPN protocol and the for each ROI pooling we determine the class label of the object, Moreover, FCN is used to predict the mask from each ROI, and usage of ROI Align preserves the spatial orientation of features with no loss of data



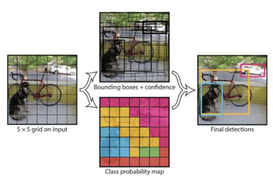
Masked RCNN architecture.



Object detection vs instance segmentation

YOLO ALGORITHM

the YOLO (you only look once) is very fast and famous for its real-time systems it was created to solve the problem of the bounding box prediction as the siding window cannot get it accurately and doesn't use the computer resources as much as the other model for testing, as firstly it divides the image to the grid and checks each box to check if there is an object or not, and it is checked through a matrix consist of Pc (probability of each class), Bx, By (coordinate of each box), Bh, Bw (box width and height), Cn (classes that the comparison done related to it).



YOLO object detection

Pc
bx
by
bh
bw
c1
c2
c3

Yolo matrix that contains coordinates and classes

Results

1- Yolo detection & masked RCNN in poor light condition

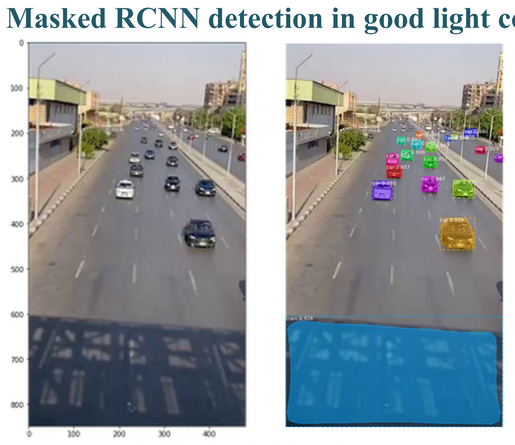
Detection of cars in 2 lanes by Masked RCNN, YOLO v5

The drawbacks of masked R-CNN

1- finished in 4 seconds

2- it detected some wrong classes

2- Masked RCNN detection in good light condition



Masked RCNN detection during the day

Evaluation of the experiment

1- it detected a train, and this was not truly good

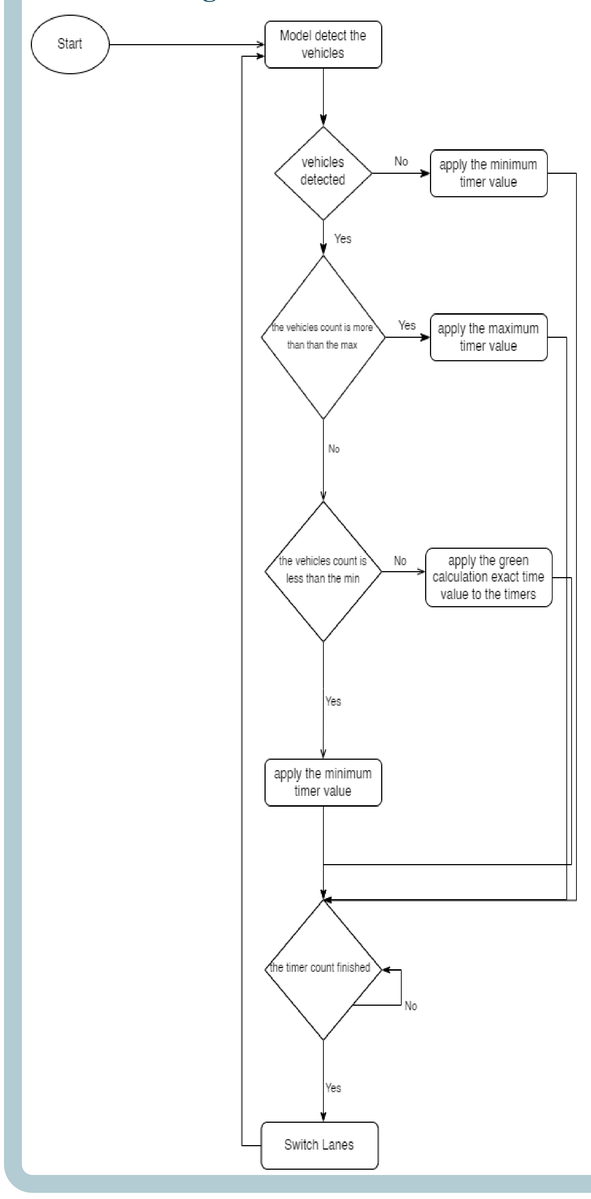
2- all the cars were detected which is very good.

3-The duration taken for this was 2.595 seconds

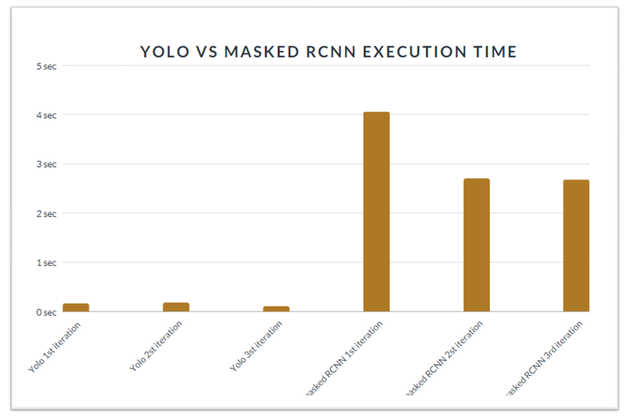
Comparison Between Models

Duration	traditional traffic controller	YOLO	Masked RCNN
total time to pass all cars	112 second	51 second	49 seconds

Schedule Algorithm Flowchart

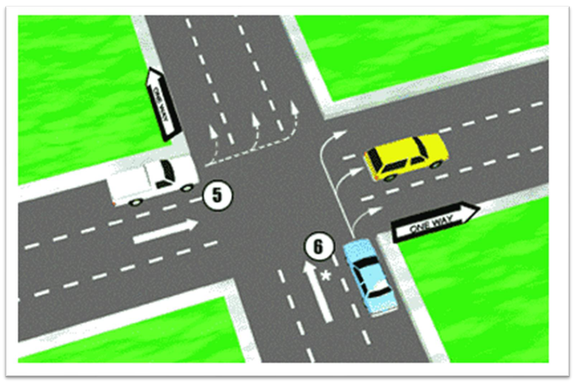


Estimating The Time For The Three Iterations



Execution time taken by each YOLO and Masked RCNN to detect objects in the image

Road Architecture



2 roads are intersected, and both move in one direction.

Conclusion

In this paper, traffic control by AI is seen as an important area of study applying the real-time traffic light system is a breakthrough in technology, as using the artificial intelligence in traffic will decrease the waiting time and the traffic congestion, moreover, it will decrease the car accidents as the roads will be more organized and the majority of cars will not wait for 2 turns of the traffic light to pass the road and will decrease the costs spent on the expensive sensors, and will decrease the human-power usage, lower the unwanted delays and the waiting time which will affect the fuel usage and consumption and the pollution.

Contact Information

Abdulrhman Zakaria, Information System Department, Faculty of Informatics and Computer Science, The British University in Egypt. Email Address: Abdulrhman186883@bue.edu.eg