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Real-Time Traffic Control System by Using Object Detection *Algorithms*

SUPERVISED BY

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Agenda

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TRAFFIC LIGHTS & CONTROL IN EGYPT

¡MOST OF THE TRAFFIC LIGHTS IN EGYPT HAVE FIXED GREEN / RED DURATION AS SHOWN DESPITE THE STREET SITUATION OR THE TIME.

¡Traffic Control in Egypt is categorized into three sections

1- manual controlling

2- automatic controlling based on the timer value

3- electronic sensors rarely used

DRAWBACKS OF THE CURRENT SYSTEMS IN EGYPT

¡1- manual controlling requires a large amount of manpower which is not efficient.

¡2- automatic traffic lights use a timer for every phase, which is fixed and does not adapt according to the real-time traffic on that road.

¡3- electronic sensors are not a practical solution due to the high-quality information that needs expens*ive technologies*.

The proposed solution

THE SMART TRAFFIC CONTROL BASED ON THE REAL-TIME SITUATION

The main idea of this project:

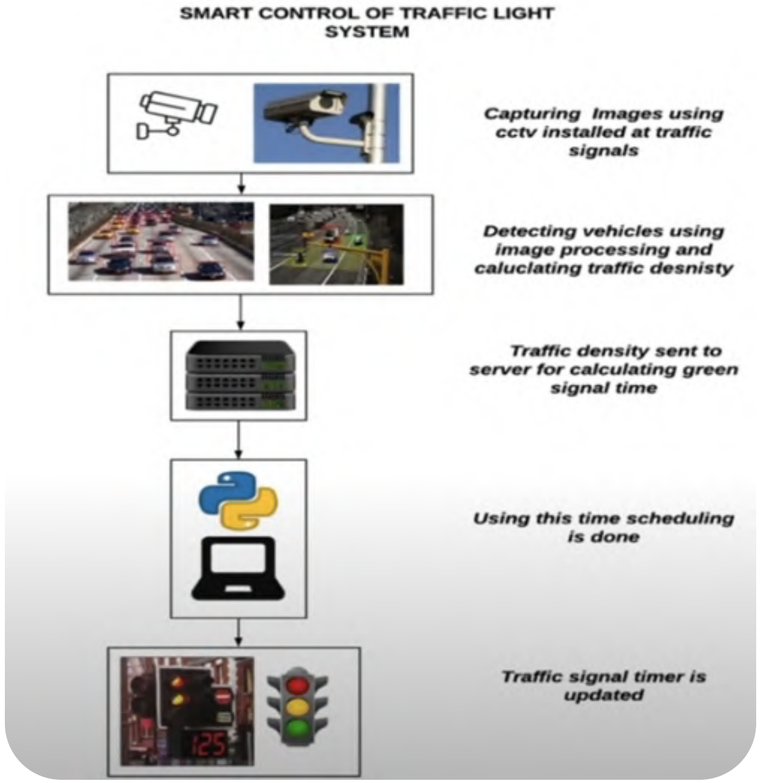
Design a traffic light controller based on the computer vision that can adapt to the current traffic situation by using available resources.

Steps:

1- use a live video feed from the CCTV cameras

2- density calculation by detecting the vehicles

3- vehicles are classified as cars, motorbikes, bus/trucks to obtain a more accurate estimate of the green signal time. [3]



The proposed system

DETAILS

the traffic flow has no specific pattern that is followed, and the static signal timers pose a huge problem to the already critical problem of congestion.

therefore, implementing a system that reduces the chances of such scenarios by automatically computing the optimal green signal time based on the current traffic.

this system can override the older system of hard-coded lights which causes unwanted delays, reduce the number of accidents and fuel consumption, and help in controlling the air pollution.

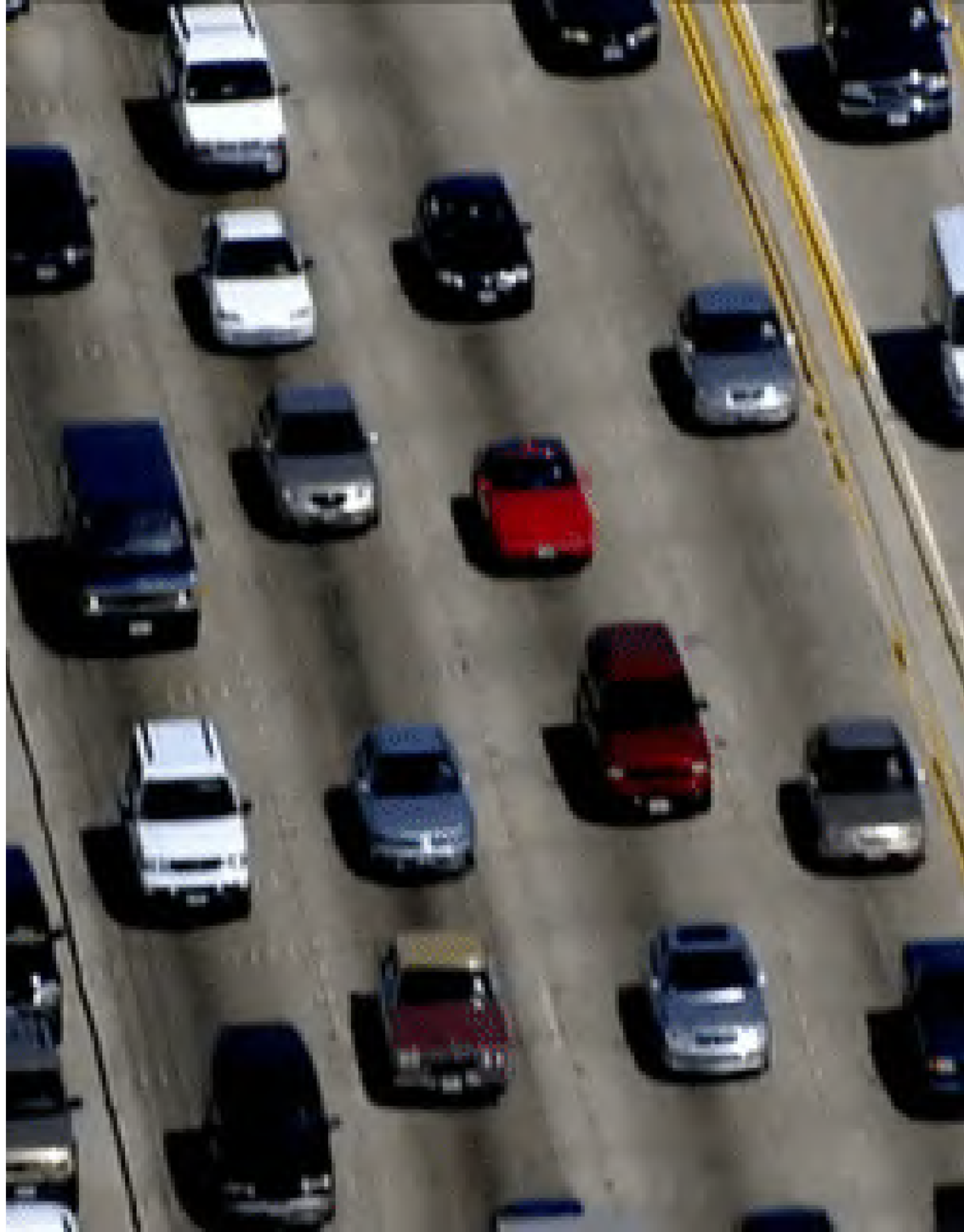
The proposed system

ADVANTAGES

The system is virtually not expensive or new hardware to be installed.

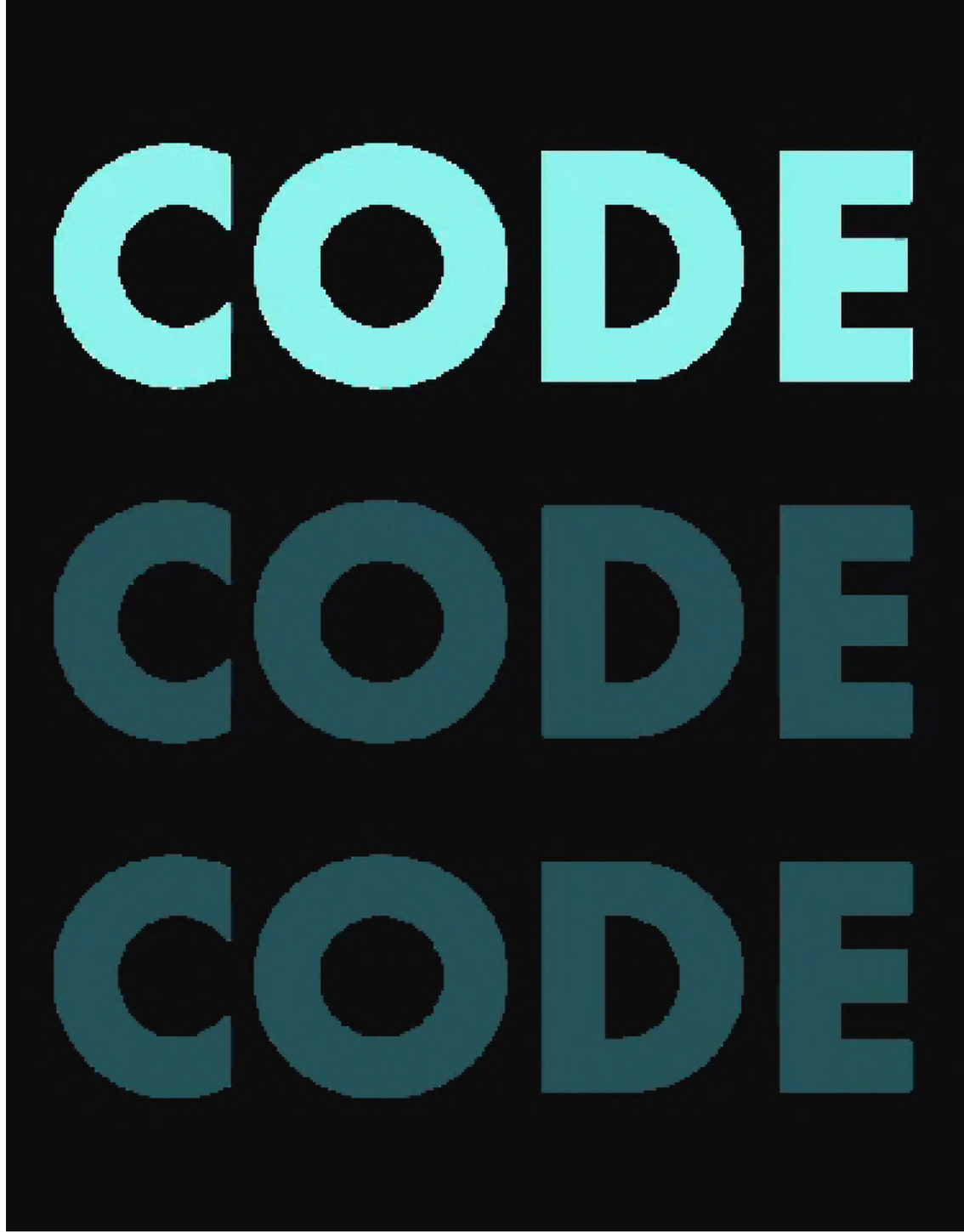
¡Autonomous: no need for manpower.

¡ Real-time traffic light switching according to current traffic density.



The neural network models

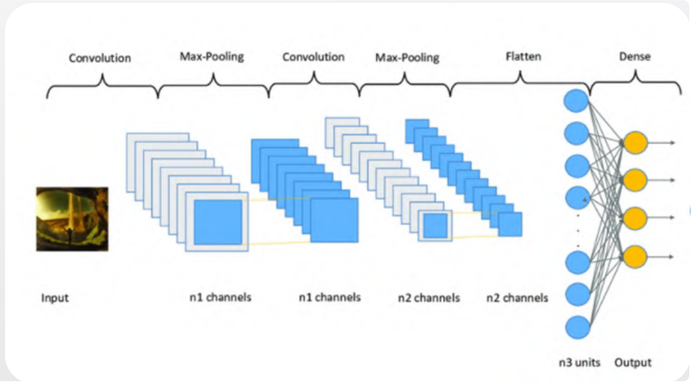
- CNN
- Masked R- CNN
- YoloV5



A code snippet of the CNN

```
cnn = models.Sequential([
        #cnn #detect image features ReLU function over other activation functions
        #is that it does not activate all the neurons at the same time.
        layers.Conv2D(filters=32, kernel_size=(3, 3), activation='relu', input_shape=(32, 32, 3)),
        layers.MaxPooling2D((2, 2)),

        layers.Conv2D(filters=64, kernel_size=(3, 3), activation='relu', input_shape=(32, 32, 3)),
        layers.MaxPooling2D((2, 2)),
        # dense
        layers.Flatten(),
        layers.Dense(64, activation='relu'),
        layers.Dense(10, activation='softmax')
```

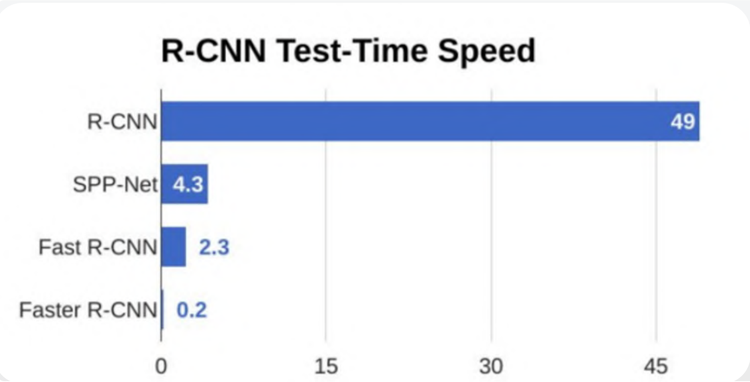


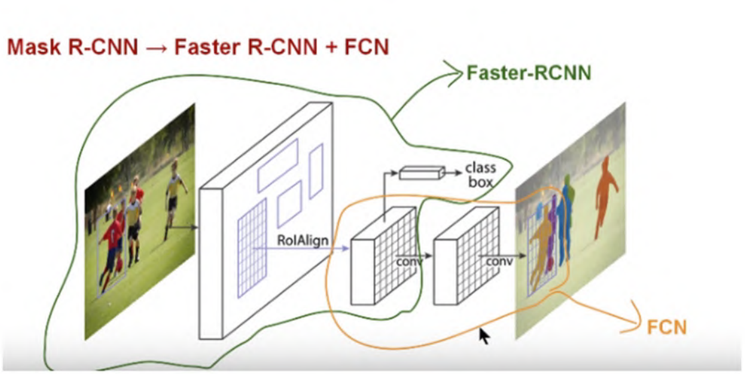
CNN consists of the input layer, an output layer, and a hidden layer that includes multiple convolutional layers, pooling layers that are used for automatically detecting the important features without any human supervision. Used for object classification

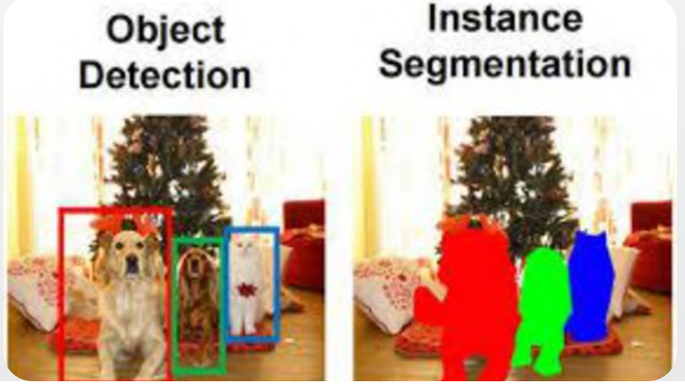
CNN can be used?

- CNN in object detection & classification is good
- but it is very slow to be implemented in a real-time system because some operation like max-pooling consists of several layers, also it finds difficult to recognize the same object in different light conditions. [5]

The masked R-CNN





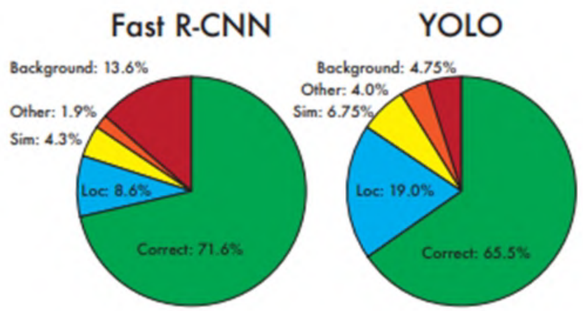


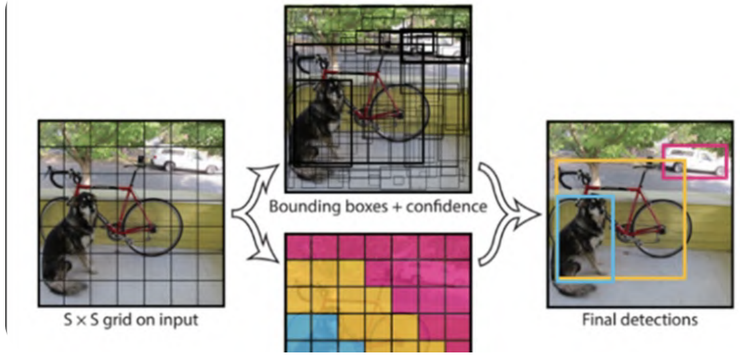
Masked R-CNN works on the image instance segmentation (pixel level) by FCN in addition to faster CNN

masked R-CNN can be used?

- very fast and suitable for real-time because no need to feed 2000 region proposals to the convolutional neural network every time instead the convolution operation is done only once per image eliminating the selective search algorithm and letting the network learn the region proposals. [7]

The Yolo V5



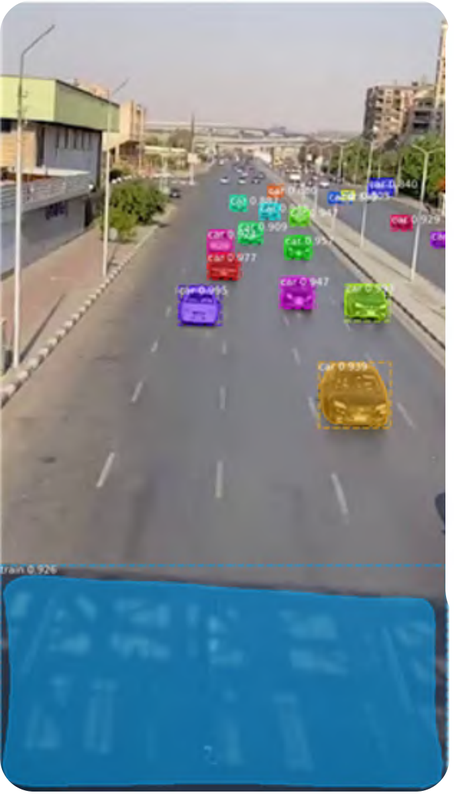


¡the YOLO (you only look once) is very fast and famous for its real-time systems it was created to solve the problem

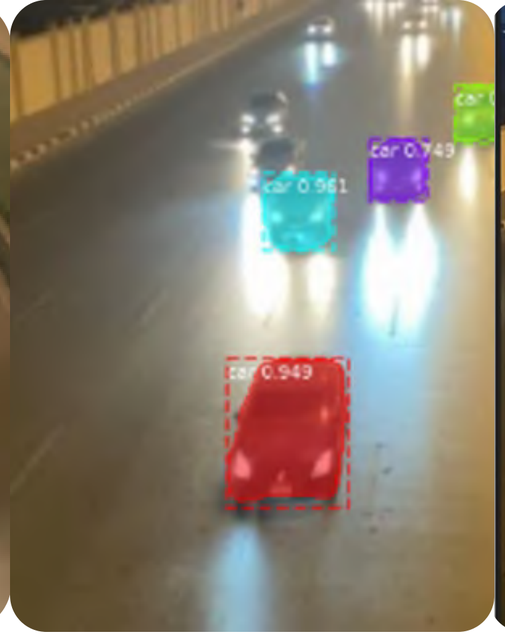
Yolo can be used?

- very fast and suitable for real-time system
- it divides the image into the grid and checks each box to check if there is an object or not, and it is checked through a matrix consisting 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).
- **simpler architecture**. Unlike faster RCNN, it's trained to do classification and bounding box regression at the same time

Pc
bx
by
bh
bw
c1
c2
c3

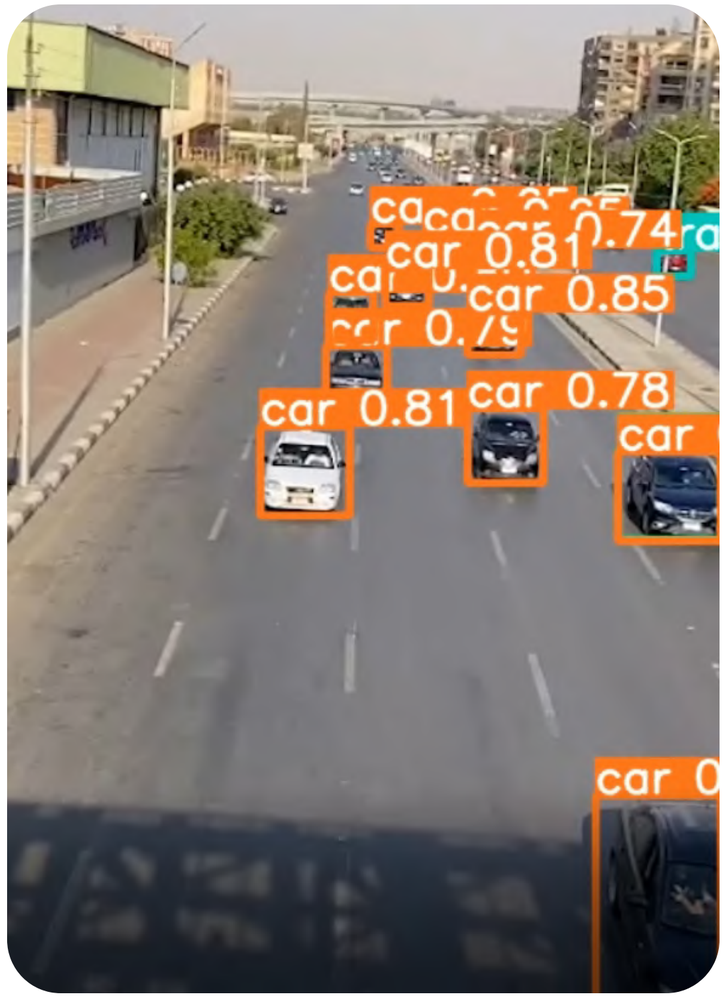


```
Read a new frame:  False
1
Processing 1 images
image
molded_images
image_metas
anchors
executed in 4.056s
car :7
bus :0
truck :1
motorcycle :0
person :0
```

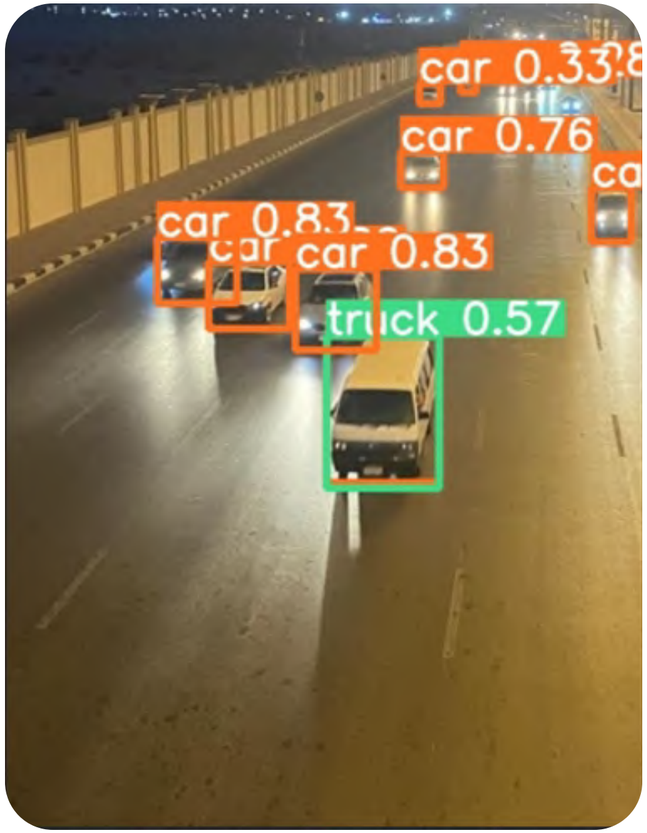


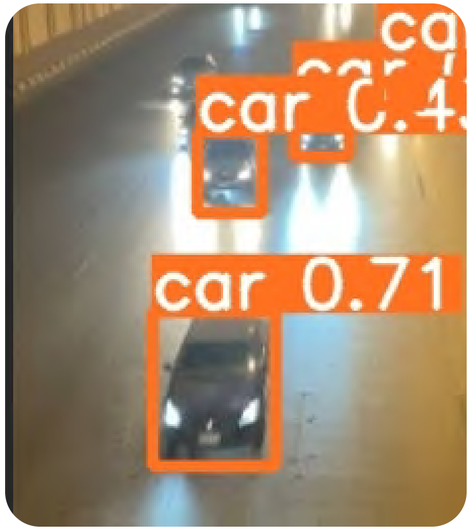
Make your point visually

the reading was not accurate in 3 out of 4 images as shown, and the execution time was 4.056 for 1 frame which can be risky and not efficient. for the system.



Yolo has better performance on the same video





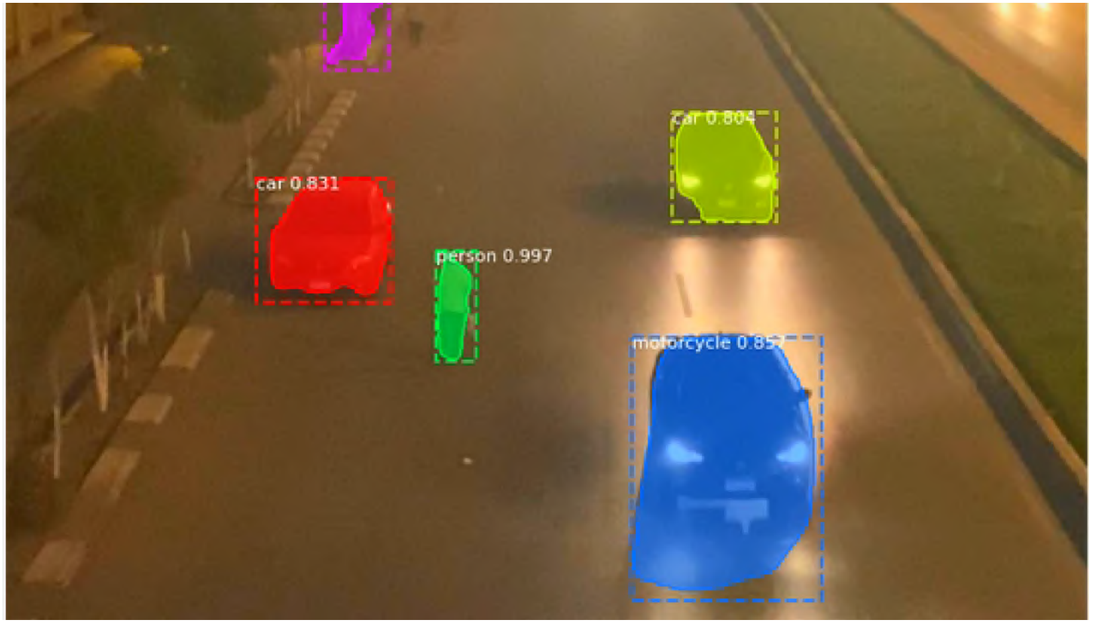

```
Done. (0.118s)
Done. (0.111s)

Done. (0.113s)
```

Make your point visually

the reading was all accurate as shown, and the execution time was 0.118s for 1 frame which can never be risky to our real-time system.

DETECTION COMPARISON THE SAME FRAME



the certainty level was higher in All classes
increase the sureness of the decision-making?

all the detected classes were right with an accuracy 100% which
increase the correctness of the decision-making

SCHEDULE ALGORITHM STEPS

Object Detection by the model

```
#green and Red time calculation function
def greentime_OnTurn_calc(noOfCars_lane,noOfBikes_lane,noOfBuses_lane,noOf

    GreenTimeLane = math.ceil(((noOfCars_lane*CarTime) + (noOfBuses_lane*B
    print("green time for the other lane is :", GreenTimeLane)


    if(GreenTimeLane<default_green_min):

            GreenTimeLane = default_green_min
            next_G = GreenTimeLane
            next_R = next_G

    elif(GreenTimeLane>default_green_max):

            GreenTimeLane = default_green_max
            next_G = GreenTimeLane
            next_R = next_G

    else:
            next_G = GreenTimeLane
            next_R = next_G

    print(next_G , next_R)
    return next_G , next_R
```

Apply the green time calculation and get the result

```
 #int to string to concate in the image
s = f'{n}'
yolo_detection(i)
car , bus , truck , bike = yolo_output()



Next_Green , Next_RED = greentime_OnTurn_cal

if(Next_Green != 0):

    t = Thread(target= Greencountdown, args=
    t2 = Thread(target= red, args=(Next_RED,
```

Add the values in the timer threads

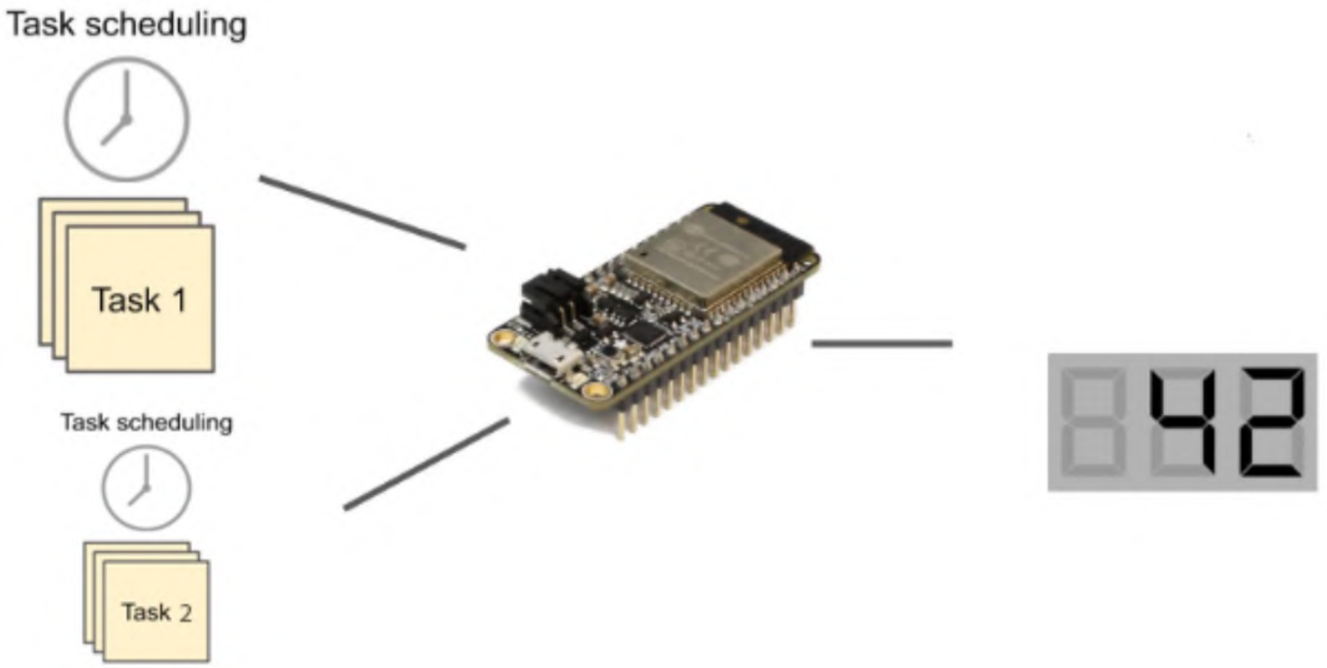
```
Green Traffic : 00:01
Red Traffic : 00:01
~~~~~~~~~~first lane turn !!
Yellow Traffic : 00:04
Yellow Traffic : 00:03
Yellow Traffic : 00:02
Yellow Traffic : 00:01

detect: weights=['yolov5s.
```

Then after reaching the Yellow timer again repeat

and the system continues until it is stopped by the user.

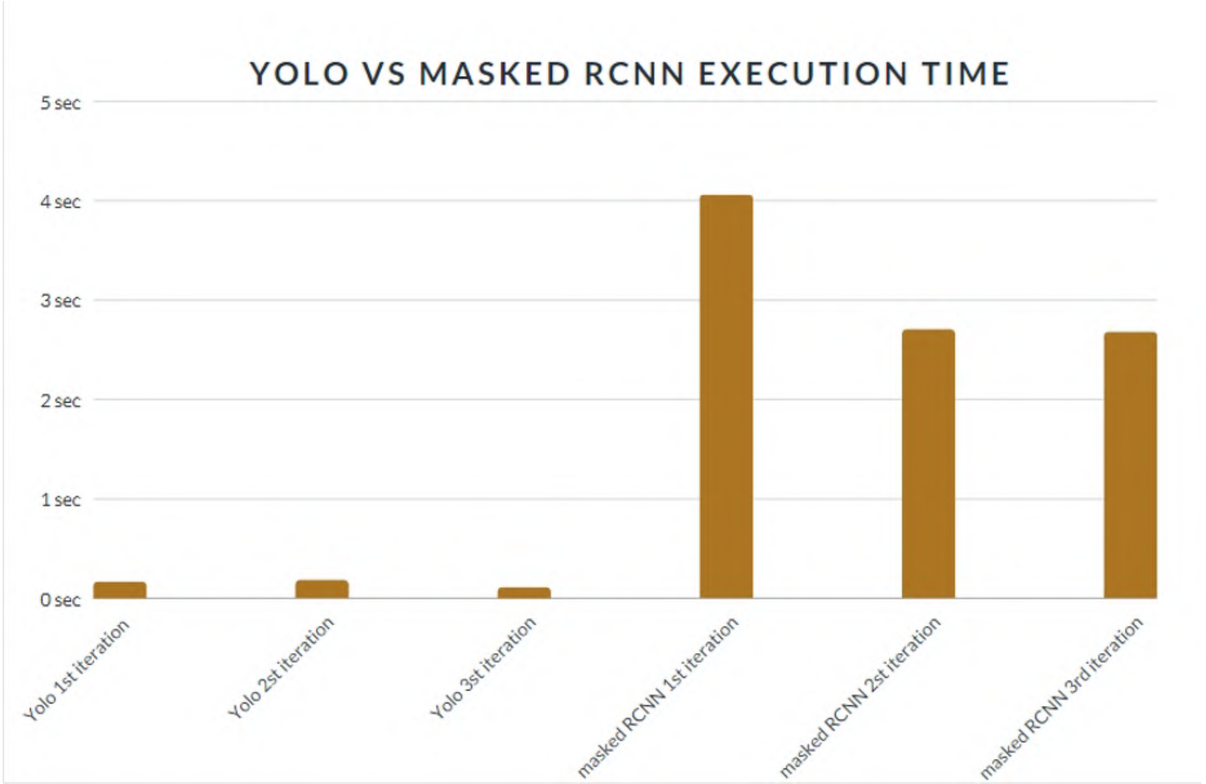
REAL-TIME SYSTEMS ADVANTAGES



the certainty level was higher in All classes
increase the sureness of the decision-making?

the Ability of expecting result and within deadline

YOLO VS MASKED RCNN



Conclusion

- ACCORDING TO THE RESULTS, THE MASKED RCNN WAS NEITHER EFFICIENT IN DETECTION NOR TIME

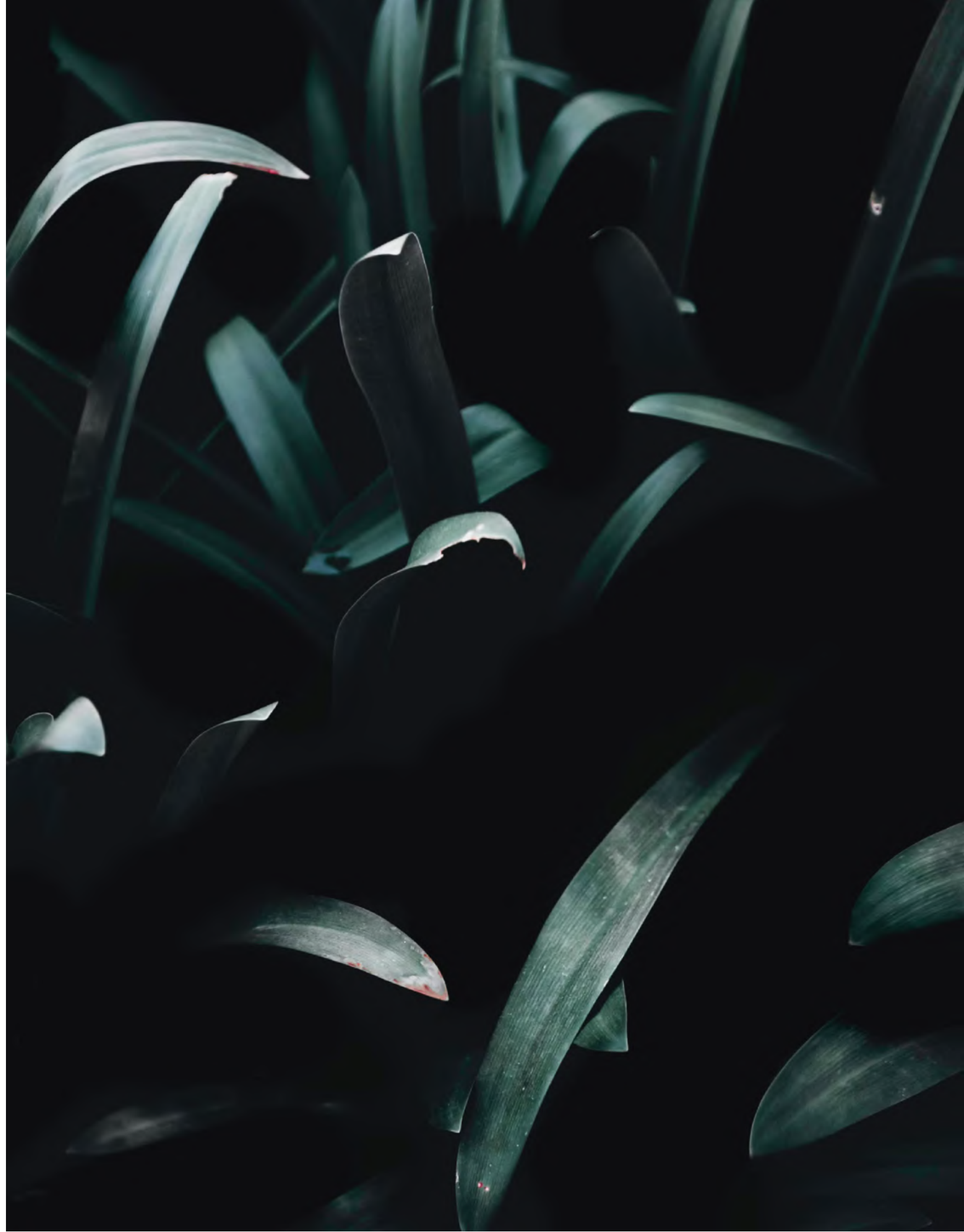
- THE YOLO, THE RESULTS WERE MORE ACCURATE EVEN IN THE POOR LIGHT CONDITIONS

Future Plane

- MOVING OBJECT DETECTION SOLUTIONS TO INCREASE ACCURACY

- FUTURE THE CUSTOM DATASET FROM THE EGYPTIAN ROADS CAN BE USED

- IDENTIFY VEHICLES RUNNING RED LIGHTS, ACCIDENTS, OR BREAKDOWN DETECTION AND ADAPTING THE EMERGENCY VEHICLES SUCH AS AMBULANCES OR THE FIRE TRUCKS CAN BE CONSIDERED TO DECREASE THE WAITING TIME BASED ON THEIR APPEARANCE IN THE FUTURE.



Reference

1- https://www.worldbank.org/en/country/egypt/publication/cairo-traffic-congestion-study-executive-note.

2- https://documents1.worldbank.org/curated/en/990291468038079976/pdf/718520WP0Box370tudy0Overview0Final.pdf.

3- https://ieeexplore.ieee.org/document/9358334

4- https://www.researchgate.net/figure/A-vanilla-Convolutional-Neural-Network-CNN-representation_fig2_339447623

5- https://iq.opengenus.org/disadvantages-of-cnn/

6- https://github.com/matterport/Mask_RCNN

7- https://towardsdatascience.com/r-cnn-fast-r-cnn-faster-r-cnn-yolo-object-detection-algorithms-36d53571365e

8- https://www.r-bloggers.com/2020/10/platypus-r-package-for-object-detection-and-image-segmentation/

9- https://ieeexplore.ieee.org/document/9651855