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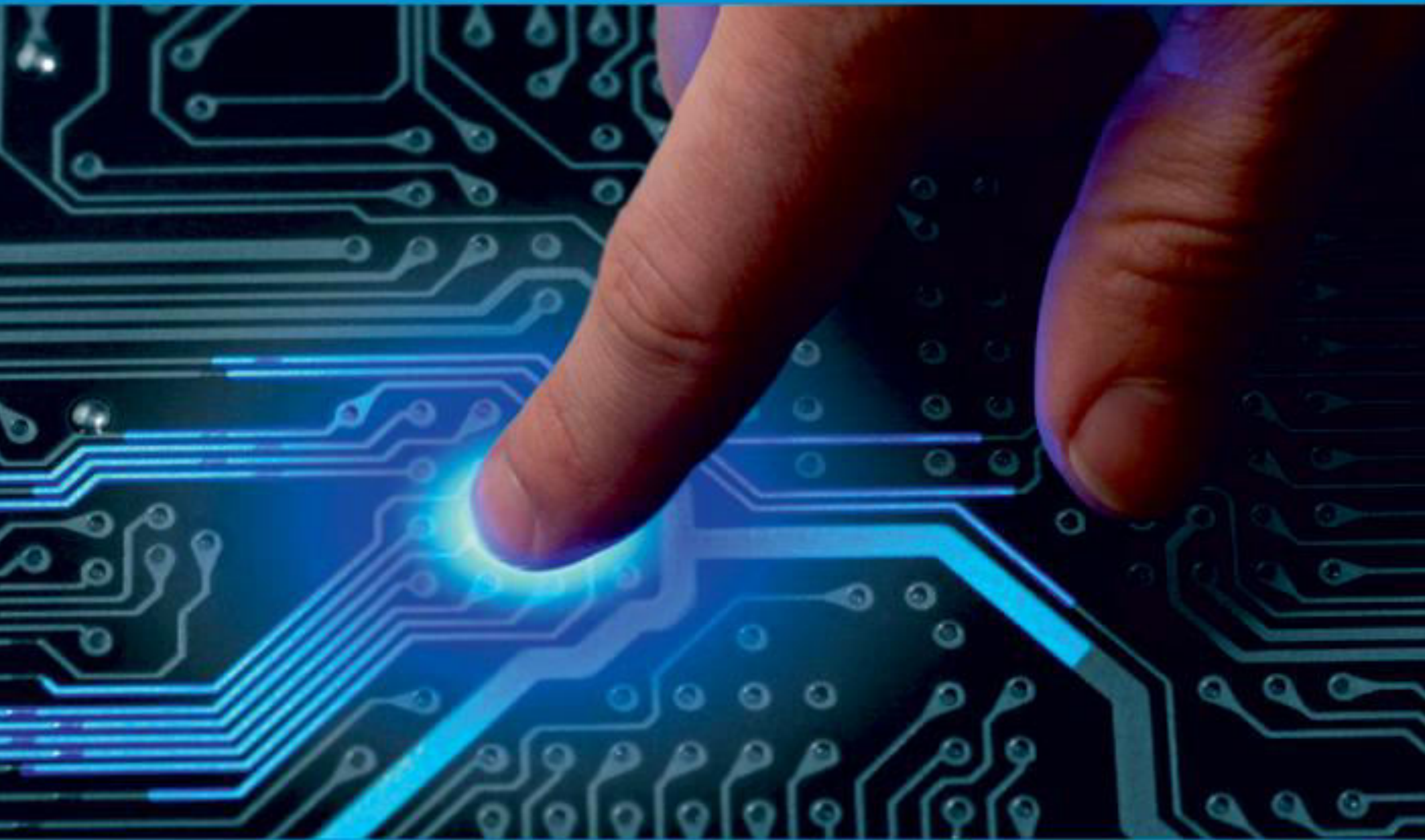

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Smart Traffic Control System using Machine Learning

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ABSTRACT: With the advancement in technology, it is important to make changes in the traffic light control system framework that is currently used, the system does not take any input and it does not have any detecting system. Currently inductive loops and sensors are being used to detect vehicles passing by, the solution implemented is inefficient and expensive way of making traffic light system adaptive. The existing condition can be improved using CCTV cameras. The main thought behind its use is visual tracking of objects that acts as the main component for deep learning and computer vision.

Our objective is to develop a traffic control framework by using a detecting system that provides input to the current traffic control system intending to determine and adjust according to the changing traffic density patterns and also continuously provide vital signals to controllers. This system helps in significantly decreasing the travel time, preventing traffic congestion, increasing street limits, and providing priority to emergency vehicles. In this paper, we track and detect vehicles on the video stream, we also maintain a count of the number of vehicles that cross a particular predefined line, we try to provide an idea about the reality of the street situation across the road network. The goal is that the travel time is significantly reduced during odd hours. The adaptive traffic control system framework uses YOLO to detect objects in each video frame and SORT to track objects over various frames. Mathematical calculations are applied to the detected objects to count interactions between the previous and current frame position of the vehicle with respect to the defined line.

The accuracy of the system drops in case the vehicles have large shadows or are really close to each other. It is difficult to detect dark vehicles. Night scenes also create challenges as night beams of vehicles can create large areas that meet threshold criteria. The main focus is on the harsh and abrupt traffic conditions of Indian roads. Due to the conditions presented by Indian traffic conditions other adaptive systems are not able to work properly. Proposed model has already been tested and it provides an edge over other adaptive traffic control system. We can adjust the timer according to the road situation. The system will improve traffic conditions at a low cost.

KEYWORDS: Computer Vision, Deep learning, Inductive loops, YOLO, SORT.

I. INTRODUCTION

There has been a non-stop increment in the population of India especially in metro cities and due to same reason, the amount of motor vehicles and correspondent travel vehicles are rapidly increasing. The traffic of the metro is packed with congested road issues. Regarding city development, proper management and infrastructure of the roads is a lot helpful for the citizens to travel efficiently and ably from one location to another, especially during peak office hours, to improve their traveling experiences, reach their destination place on time and enjoy safe traveling. Our intelligent traffic light system will have a captivating job to control the traffic and avoid the congested road [1][3]. Traffic congestion is a major concern, not just involving the citizens, but also reduces the interests of the business activities [7][9]. In some common circumstances, there are few deformities in the traffic signal control system:

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Enormous Traffic Jams: Major problem is faced by everyone due to traffic jams every day. There is a tremendous increase in the number of vehicles on road, and the same is the reason for traffic clog everywhere especially the urban communities. The peak time of traffic jams is the morning during the office hour and also during evening after the office hours. Due to heavy traffic, a lot of time is wasted of the population. [5]

Emergency cars: There is no availability of emergency cars on the road. This should be considered and make it available as it can save many lives. Due to the absence of crisis measures like these, there should be good traffic control system which will help in the resolution of congested driving conditions and prevent the loss of life.
Traffic path: The street is packed with vehicles and the proceeding time is very less. The traffic path holds up until the green light and the time is fixed for road crossing. Vehicles can't pass through these lines in the permitted time. The sub path has many vehicles and the proceed time is also generally long.

Minimized traffic but timespan is same: At many situations like after midnight or during stormy weather conditions where there is no as such traffic or very minimal traffic is there, at these times also the timer is set to be exact and thus it is just not necessary, and hence individuals had to halt for a more extended period, and if they try to avoid this situation and break the role, obviously there will be fine for them. Thus, to solve this irregularity is, we can build up a system in which traffic signals timing are set automatically rather than waiting for the whole 2 minutes were not necessary.

Apart from that, syncing traffic flags is very important with neighbouring cities. Carnegie Mellon University, and at Pitts-burg for pilot Project uses this model. However, this framework is not just bound to bright flags, and the programming innovation of artificial brainwork also plays a vital role in this. There is a connection between flags where they can communicate and adjust to the traffic accordingly. Fibre optics is the one innovative technology that helps screen vehicles numbers so there is minimum blockage where ever it can do it. The results were quite remarkable as the halting period of drivers was reduced to 25% from 40, which is quite amendable.

II. LITERATURE SURVEY

We need advance and Smart Traffic Control System which uses Machine Learning based on the Traffic environment to control the traffic efficiently rather than the current traffic lights which uses old microcontrollers-based system which provides very low efficiency and lesser flexibility. The older traffic light system faces many problems as it uses certain previously written lines of code which can't adjust and update the traffic light based on the current real-life scenarios. The time intervals for different signals are hard-coded and cannot be easily changed in current traffic light system which increases the traffic as it cannot adapt the change in traffic time to time. The Smart Traffic Control System using Machine Learning based on Traffic Environment provides excellent results on various parameters like efficiency, performance and along with the superb flexibility and sustainability [17][19].

Numerous two-wheelers, cars, trucks travel on roads of towns and metropolitan cities every day all the time which results in increase in traffic. The traffic jams are based on many factors such as financial, social and cultural events which also results in road blockage. This has direct corelation with the road accidents, wastage of travel time of public, hindrance for the transportation with emergency cases. There is a great loss to many sectors due to crammed roads such as slower delivery service, reduction in productivity and efficiency of employees of companies, loss of economic opportunities, wastage of tax-payer's time. These aspects result in increased costs. These factors lead to an increase in costs. To overcome the challenges posed by this congestion, it is best to build modern infrastructure and at the same time improve existing infrastructure. [12][18].

A major problem with the existing traffic control systems is that it doesn't consider the other traffic signals in the city based on the traffic and it works on the pre-defined parameters regardless of the traffic. People face lots of problem due to traffic congestion such as extra cost of fuels to drivers and wastage of travel time which eventually results in delay. The change and proper improvement in traffic control system will adversely reduce the traffic congestion on the roads and adaptive strategies to minimise the jams and changing according to the traffic conditions in real time will be very effective [13]. The proposed methodology of traffic control will be optimal as it is dependent on all the nearby traffic signals so it will change based on the traffic continuously. The values used in the machine learning model, do not include queue size and time spent on it. The proposed model can be expanded to connect multiple near-by traffic signals at the same time. This connected ecosystem will contain more traffic signals to the desired location than most

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independent traffic signals. This approach will take the form of queue length and queue waiting time across the entire street for all the intended regional road signals [10][14].

For automatic vehicles, a new method was put forward which uses deep learning algorithms. Automatic vehicles in which research is conducted have better traffic control systems as the new method concludes that there is a direct correlation between traffic signal acquisition and appropriate planned vehicle modes. For greater accuracy, a more comprehensive set of data is required to improve the efficiency of deep learning algorithms. To scale the capability of the vehicular traffic control, sample images from area outside the primary research should be augmented. At the same time, the same data processing on the detector, as well as the tracker, should help meet the higher requirements [6][8]. There are various limitations related to YOLO model for the detection of vehicles in the traffic at traffic signals. This model uses strict limits on the area in the box where the object is tied as each cell in the grid can only predict two boxes and be in the same class. These triggers limit the number of items next to which the model can predict. This model faces issue with very smaller objects such as large group of ants. It faces problems in assembling items in exaggerated or unusual sizes or views as the YOLO model is trained to predict how packaged boxes are installed. The internal structure consists of lower sample layers that are different from the input image as this model considers comparatively rough features to predict the elements that comprise the boxes [2][4].

III. TRAFFIC LIGHT CONTROL SYSTEM

Till now different approaches have been proposed for smart traffic signal control systems which are majorly based using Induction Loops, using RFID tags, or other Microcontroller Circuits which turned out to be incredibly costly, inaccurate and difficult to maintain. So, our objective is to develop a traffic control framework that is cost-effective and is most accurate when put next to all or any present models.

In India, Traffic Lights contains fixed-cycle controllers which are non-adaptive. The purpose of this project is to build the detecting and tracking system using cameras, which can count vehicles in real-time those longing an outlined line. By using the count of vehicles on either side of the traffic signal, we've optimized the traffic lights duration by assigning them time consistent with the traffic behaviour in real-time. Depending on the less traffic or more traffic than usual, our model will adjust the traffic lights accordingly by manipulating the duration of the Traffic Lights which can help in decreasing the travel time. The adaptive traffic control system framework uses YOLO to detect objects in each video frame and SORT to track objects over various frames.

A. Traffic Light Duration OptimizationProblem

The ability to predict traffic conditions is important for good control. For example, assume that we realized that a certain road is subject to get jammed, if the current circumstances persist, this information could be passed to the vehicles heading towards that road to take up another route. Even for one square, we can't get the ideal arrangements as traffic will be directed to other lights. Another challenge is that traffic keeps on changing its behaviour depending on the day's weather, day of the week, the season of the year, and many other factors. Most of the traffic lights are based on fixed cycle controllers. It is configured in such a way that for a certain duration all lights will go green. The split time decides the cut-off time for each state of the traffic light. By modifying the split time, we could decrease the intensity of traffic on occupied roads. Our model will be trained in such a way that it adapts itself according to the current circumstances and focuses to eliminate congestions on roads by reducing the intensity of traffic continuously using Machine Learning. It judges the traffic intensity using the video equipment of every street. Analysing the traffic intensity, we can reduce the waiting time by handling the traffic accordingly. On every road, we place the video equipment which determines the vehicle object using YOLO and tracks its movement using SORT to give current traffic intensity data of every road. Then the traffic lights instead of operating on fixed-cycle controllers willadapt according to the traffic intensity data of each road. The road with a high number of vehicles will be given clearance to flood off by giving a green signal and other roads with comparatively less intensity of traffic will be held by allocating a red signal. The additional plus point is that we could clear off the way for the crisis vehicle by assigning priority to the crisis. It will drastically reduce the travelling time and waiting time on traffic signals which will be beneficial for National Growth.

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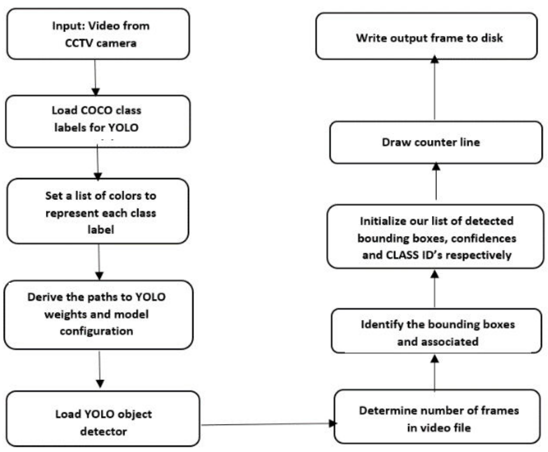
B. Learning from real-time traffic

Our model's concept or central idea is that it can help the drivers give an ideal controllable situation. For example, there are numerous occasions where the other road may be clogged because of construction work or any other reasons and by the time drivers come to know this, it is already quite late. Thus, we will help to release this data a few minutes back to the driver, which will help save their time and all the frustration experienced by these clogged pathways. Last but not least, we would also take the help of artificial intelligence to observe when there is more congestion and when there is less, which will be taken into records for future predictions.

IV. PROPOSED MODEL

In this model, we track and detect vehicles on the video stream, we also maintain a count of the number of vehicles that cross a particular predefined line. The model uses:

- YOLO
- SORT



Once the object is detected and tracked, mathematical calculations are applied to the detected objects to count interactions between the previous and current frame position of the vehicle with respect to the defined line.

A. YOLO

YOLO is used for object detection, but it cannot exclusively find out what is there in the picture, it also cannot determine where the object resides in the picture. YOLO works by dividing the information picture into an SXS lattice.an object is predicted by each lattice cell and a finite number of boundary boxes are predicted by each network cell. For each framework cell, B boundary boxes are predicted and each case has a box confidence score. YOLO recognizes an object by just paying a little more attention to the quantity of boxes B, and it also predicts C condition class probabilities.

The main idea behind YOLO is to assemble a convolutional neural network system for anticipating mathematical objects that can be used to describe physical properties. It uses a CNN system to reduce spatial measurement. To produce the boundary box predictions, YOLO uses a linear regression with a pair of entirely related layers. Those with high box confidence scores are maintained as previous guesses for the final forecast.

The class confidence score for every prediction box is calculated by using the equation:

$classconfidencescore$ (C)= $boxconfidencescore * conditionalclassprobability$

The equation is used to measure confidence in both ends, classification, and localization. YOLO uses the following mathematical definitions: The image is partitioned into a S x S grid, with each cell predicting B bounding boxes, confidence in these boxes are calculated by using an equation.

$C = \Pr(object) * IoU$

IoU: scores are as follows: Between the anticipated box and the ground reality, there is an intersection over union. The confidence score C should be zero if no object exists in a given cell. Each bounding box is made up of five predictions: a, b, d, e, and confidence. The centre of the box is represented by coordinates. concerning the bounds of the grid cells, as explained in the equation.

a: $xcoordinateofcenter$
b: $ycoordinat$e of center
d: $widthofboundingbox$
e: $heightofboundingbox$
c: $Confidence$

Conditional class probabilities are also predicted in each grid cell. These results show the likelihood of that class as well as how well the box fits the object according to the formula stated in the equation.

$Pr(Object) * Pr(Object) * IoU = Pr(Classi) * IoU$

A YOLO model is effectively implemented by using all of the formulas and conditions.

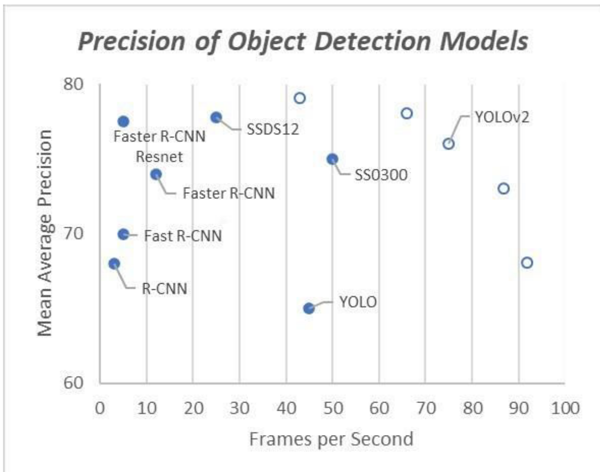
B. SORT Function

SORT is a 2D video stream object tracking method that works in real time. It can follow numerous objects in real-time video frames. SORT is an online algorithm that can detect many objects just by looking at the current and previous frames of a video stream. SORT is a critical component of visual multi-object tracking frameworks that use raw data and state estimate algorithms. While this basic tracker doesn't handle occlusion or re-entering objects, its goal is to act as a starting point and testbed for future trackers. In the beginning, SORT was described in an arXiv technical report. On the MOT benchmark, SORT was ranked as the best open-source multiple object tracker at the time of its original publication.

V. RESULTS

Our goal was to differentiate whether an object is a car or not immediately, and the YOLO performs better compared to other real-time object detectors. YOLO is compared with various detectors, and comparisons are shown in figure below.

A graph that shows the comparison between different algorithmic models, and clearly states that YOLO wins:



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VI. CONCLUSION

The goal of this project is to develop a vehicle control system through machine learning to control traffic flow. This new system facilitates traffic flow at intersections, resulting in reduced congestion, less CO2 emissions, etc. We have evaluated and compared our model YOLO with other existing models on various grounds as far as YOLOv3 is a good detector. It's fast and accurate also. But by using YOLO, we have solved our purpose to identify objects on the roads. Some Adaptive Traffic Light Systems were not so good and could not work with Indian traffic conditions. Our model has more limit than any other by playing equally on the streets of India and solving the problems people face.

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