GoEasy: Monitoring and Control

Gresha Bhatia, PhD
Deputy HOD, CMPN Dept.
HAMC, Collector Colony
Chembur, Mumbai 400074

Rinku Sahu
Student, CMPN Dept.
HAMC, Collector Colony
Chembur, Mumbai 400074

Pavan Satpute
Student, CMPN Dept.
HAMC, Collector Colony
Chembur, Mumbai 400074

Manali Gupta
Student, CMPN Dept.
HAMC, Collector Colony
Chembur, Mumbai 400074

Shruti Kangane
Student, CMPN Dept.
HAMC, Collector Colony
Chembur, Mumbai 400074

ABSTRACT
World is facing an exponential growth of population, which leads to urbanization, industrialization, motorization, resulting in increased traffic congestion. The development of new roads is generally not always possible, even in such cases reaching a traffic bottleneck is always a threat. Problem is magnified in major cities. This takes us to find a new and optimized solution to this problem, which is aided by the new information technology, real time solutions and communication networks. Congestion reduces efficiency and commutations experience and increases travel time, air pollution and fuel consumption. In order to overcome such a problem, the Intelligent Traffic Management System holds a good point.

This paper, Go Easy, is about Intelligent Traffic Management System(ITMS), which aims to automate the traffic control management by accessing traffic conditions across cities and then regulating the traffic flow by analyzing real time situations in different areas, general traffic patterns at various nodes.

This paper proposes idea of an efficient and fully automated way of managing traffic by an Intelligent traffic management System, with focus on easy flow of traffic and minimizing the waiting period of vehicles in congestion.

General Terms
Smart system, Intelligent system, Artificial Intelligence, Image processing.

Keywords
intelligent traffic management system, IMS, ITMS, YOLO, Traffic waiting time, Traffic signal, Smart system, Smart city.

1. INTRODUCTION
World population is on an ever increasing sphere. It is estimated to reach 8 billion people 2023 [1]. It took over 200,000 years of human history for the world's population to reach 1 billion, and only 200 years more to reach 7 billion [2]. This shows the growth rate. Humans are social animals and are bound by mobility and migration. People migrate towards cities making it a heavily dense cluster of people making mobility an issue. More and more vehicles populate roads causing tedious traffic congestion and deadly accidents, making traffic control a serious issue. This demands a solution of a proper systematic system which is not only capable of handling large masses of people on wheels safely and efficiently distributing traffic but also make sure that it is environment and commuter friendly. These kinds of projects are very popular in developed countries. When it comes to developing countries like India, Intelligent Traffic Management System, ITMS is in the primary stage of development. Each nation, whether developed or developing, when implements the intelligent technologies the surface transportation system will be safest, economical and environment friendly. This paper thus focuses on presenting an intelligent software solution for traffic congestion with the aim to give commuters easy drive experience.

Paper begins with the introduction followed by a literature survey related to the problem statement. The next session 4 and 5 explain the purpose solution and methodology used. This is followed by section experimental design, results and evaluation measures. paper ends with the conclusive view of the paper.

2. LITERATURE SURVEY
A number of authors have published research paper on this topic, such is the paper authored by Priyankar Roychowdhury and Sarjo Das, where they present a system that manages the road traffic in a city automatically by combination of algorithms, equipment and communication networks without involvement of human personnel in decision making according to various kinds of situations of road traffic that arise in a city [3] . The approach of this paper is traffic signaling at a crossing point by measuring traffic density in each road. Also, vehicles that will violate signals at crossing points can be tracked by this system [3]. Sometimes, situations like road congestion and exceeding the maximum traffic capacity of a road can arise and this system can also take decisions automatically accordingly [3]. Vehicles can never cross the speed limit under this system.

The paper is written considering left-hand traffic rules [3]. Paper, “Traffic Management and Violation Detection Systems”, presented by Gagan Preet Kaur, Gagan Prakash, Shaivee and Dimple Juneja reviews existing traffic violation detection and management systems and a comparative analysis of existing systems have been presented with the aim to improve the existing structure in future [4].

Work in paper ”Automated Traffic Violation Detection and Challan Generation System” authored by Harwinder Singh, Vikas Goel cites that traffic accidents can be controlled largely if traffic norms are followed strictly. This paper presents a system which is embedded inside the vehicle to provide surveillance of traffic violations. Driver is penalized for his offences at the nearest checkpoint, so the system enforces people to obey traffic regulations [5]. Existing systems have incorporated additional devices like RFID tag and reader. Other solutions are vehicle specific and do not include overall traffic in a particular area.

3. PROBLEM DEFINITION

In major cities, traffic is a huge problem which will ever increase. This leads to long lanes of vehicles waiting at signals.

The traffic lights on signal are generally of fixed time for various lanes irrespective of the traffic density on a particular route. This leads to same time allocation to lanes with few vehicles & with many vehicles, which leads to high waiting time on dense routes. If the above is not the case then the traffic time is controlled by personnel from the Control room or by the traffic constable present at the signal. Our aim is to solve this problem with a fully automated system with no manual interference required from the traffic control room. This paper proposes a software based traffic applied control and management approach. This approach shifts away from a global roadside traffic management to a more vehicle-based and user-specific network-based traffic management.

4. PROPOSED SYSTEM

GoEasy, ITMS technology is defined as the application that is applied to road transportation to achieve smooth and seamless flow of traffic across the city region. It aims of achieving efficient management of traffic signals light at a particular junction considering the traffic at other intersecting junctions. It creates a virtual network that communicates to release traffic in various directions such that there is minimal congestion and waiting time and easy flow.

GoEasy aims to give a multidimensional controller system that communicates with other nodes, connected traffic network which provides better safety, mobility and traffic environment. It aims at solving the peak hour problem in major cities and thus manages traffic congestion.

The overall function of ITMS is to provide decision making system, give real time solutions to congestion, work as a virtual controller by communicating between traffic signals and synchronizing time between them, aided by the real time data processing (image processing) and thereby improving overall operations of the system.

Intelligence traffic management system offers scope of integration with various systems and can be used as an application in various scenarios and emergencies.

For a system to deliver quality & useful results, the input given should have width and depth and with that a highly efficient and strong processing system. Intelligent traffic management systems rely on a wide range of technologies like data acquisition, processing, back-end software, artificial intelligence, object detection and classification, etc.

In this paper, we propose a communicative software solution to efficiently control the time of signal light of traffic signals considering others. Below is the block diagram.

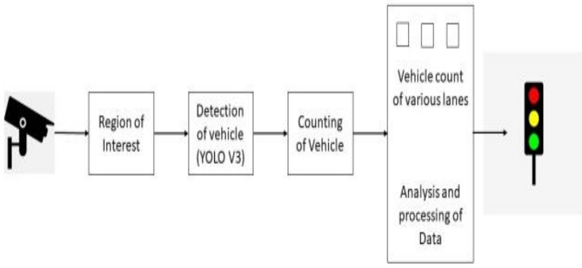

Figure 1: Block diagram

5. METHODOLOGY

The proposed system is a software based system which analyzes real time situations on the site (road) using image processing technology. It will use the camera installed at the traffic signal to get the images /videos from the site, as represented in the above fiig. Another approach to this could be getting traffic density of a location using Google traffic map APIs.

Detection
Considering image processing technology, object detection tool, YOLO V3 can be used to know the density. Pre-trained model or trained model on traffic images can be used. The output of the detection system .i.e the knowledge about density of various lanes can be given to algorithms which will calculate the time for which the signal will be green and of which lane.

Management
The algorithm would analyze traffic from various lanes on a traffic signal and then judicially give the time allotment to each signal. Algorithms can also consider the traffic at various traffic signals nearby. It can also incorporate artificial intelligence.

- Data collection:

Detecting the number of vehicles using cameras by YOLO (real time object detection) or extracting data of traffic congestion from google maps.

- Processing:

Stores data into a database and performs comparison. analysis of data is performed to find accurate traffic density.

- Training:

The data of traffic density from different traffic lanes is given to the algorithm. It will allow the flow of vehicles in lanes which would contain the highest traffic and the system will also monitors the traffic pattern. Irregular crossing of vehicles sensed by the system using image processing can be fined.

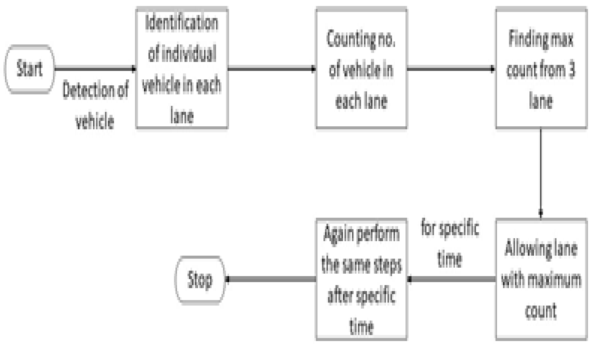

Figure 2: Work flow

6. EXPERIMENTAL DESIGN

6.1 Datasets

Data collected from cameras and google maps can be used as dataset. The dataset is also available for free at https://catalog.data.gov/dataset, www.europeandataportal.eu, etc. which can be used for experimentation and evaluation.

6.2 Evaluation Measures

Measures such as prediction error, Computational cost, Accuracy, Time delay can be used for calculating the accuracy of the traffic management system.

6.3 Software and Hardware Requirements

YOLO Object Detection with OpenCV and Python will be exploited for the development and experimentation of the project. Tools such as Anaconda Python, and libraries such as Tensorflow will be utilized for this process. Training will be conducted on NVIDIA GPUs for training the model.

6.4 Management Module

This module comprises the algorithm developed to manage the time for which lane is allowed and which lane is allowed. It checks the density of vehicles on the roads and then evaluates which lane is to be allowed. It also takes into consideration that all lanes are given a chance and there is no starvation. It does not allow the same lane to be allowed twice in a row. The minimum time for which the signal is on is 3.20 minutes. This time is calculated by performing at least four analysis and detection rounds. Initial time is fixed at 3.20 minutes since the model needs time to load at each processing call.

Running detection models for at least twice on each lane alternatively increases the chances of predicting the correct lane (based on count of that lane a few seconds earlier) at the time of allowing signal.

7. RESULTS

7.1 YOLO Object detection

Object detection is a task in computer vision that involves identifying the presence, location, and type of one or more objects in a given photograph [6]. You only look once (YOLO) is a state-of-the-art, real-time object detection system [7]. Biggest advantage of yolo is its speed (45 frames per second) and its network that understands generalized object representation [8]. This model is used for detection in our system. Size of .h5 (weight file) file in the model is 256 MB and thus requires approx. 16 sec to load. Detecting vehicles is done by implementation of the YOLOv3 Model. Given an image of resolution 900 X 540 Figure 3 (below) following the result, Figure 4 is obtained. Figure 5 shows object detection applied on a lane cut out by region of interest (ROI).

Figure 3: Input image to detection module

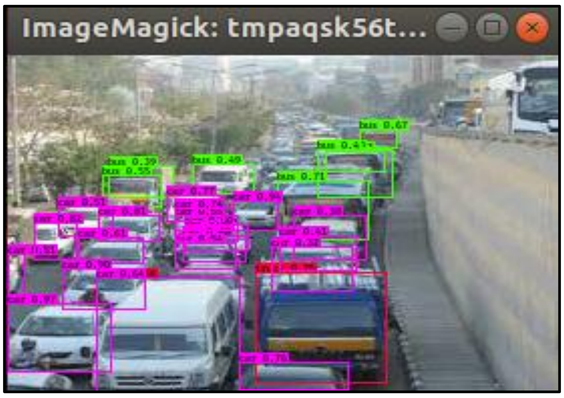

Figure 4: Output image of detection module

Time required: 180 second

Count produced by model: 28

Actual count: 45

%accuracy: 62.22%

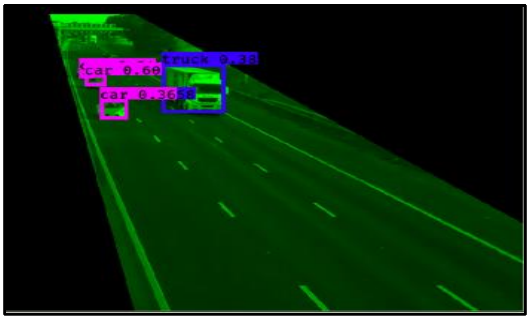

Figure 5: Object detection on ROI

7.4 Management Module

In system, input data that is images captured by the camera at traffic signal is passed to the trained yolo detection model, whose output is shown in above figures. This model detects vehicles on the road. Count of vehicles on each lane of the road is calculated with above given accuracy and then passed to the algorithm. We consider a three lane road as shown in the figure below. Algorithm then compares density of vehicles on each lane and allows appropriate lane for a particular time period based on the density of vehicles. Below diagram shows signal status at particular time. It shows that lane 1 is allowed to pass while other two lanes are stopped.

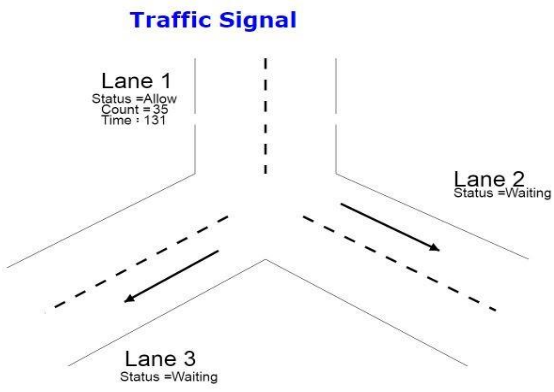

Figure 6: UI screen showing control status at signal

8. EVALUATION MEASURES

- YOLOv3 Detection Model

The COCO dataset is an excellent object detection dataset with 80 classes, 80,000 training images and 40,000 validation images.

Table 1: AP result for the YOLOv3 detector

	backbone	AP	AP50	AP75	APS	APM	APL
Two-stage methods							
Faster R-CNN+++ [5]	ResNet-101-C4	34.9	55.7	37.4	15.6	38.7	50.9
Faster R-CNN w FPN [8]	ResNet-101-FPN	36.2	59.1	39	18.2	39	48.2
Faster R-CNN by G-RMI [6]	Inception-ResNet-v2 [21]	34.7	55.5	36.7	13.5	38.1	52
Faster R-CNN w TDM [20]	Inception-ResNet-v2-TDM	36.8	57.7	39.2	16.2	39.8	52.1
One-stage methods							
YOLOv2 [15]	DarkNet-19 [15]	21.6	44	19.2	5	22.4	35.5
SSD513 [11, 3]	ResNet-101-SSD	31.2	50.4	33.3	10.2	34.5	49.8
DSSD513 [3]	ResNet-101-DSSD	33.2	53.3	35.2	13	35.4	51.1
RetinaNet [9]	ResNet-101-FPN	39.1	59.1	42.3	21.8	42.7	50.2
RetinaNet [9]	ResNeXt-101-FPN	40.8	61.1	44.1	24.1	44.2	51.2
YOLOv3 608 × 608	Darknet-53	33	57.9	34.4	18.3	35.4	41.9

[9] source of table : YOLOv3: An Incremental Improvement Joseph Redmon, AliFarhadi https://pjreddie.com/publications/

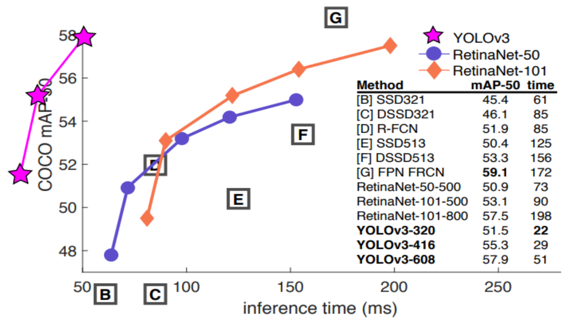

Figure 7: Various detection tool comparison

[9] source of figure : YOLOv3: An Incremental Improvement Joseph Redmon,Ali Farhadi https://pjreddie.com/publications/

9. CONCLUSION

The paper presents a review of an ITMS which tries to develop a system suitable for developing countries to manage traffic. The paper aims to develop a time-based signaling system which will help to manage traffic effectively and reduce waiting time. The proposed system aims at effective management of the traffic system and thus reduces the major problem of transportation in metropolitan regions. This paper presents an overview, proposed solution and implementation model of our system. We present the system with the motto More Efficiency, More Convenience.

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