Machine Learning Based Smart Traffic Control System

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***Abstract*- Sometimes there is a situation in which lots of vehicles on the roads get stop moving. There will be late arrival by students & employees on their work, drivers become frustrated, occurring of road accidents due to constant stopping & moving of traffic. This situation is considered as a traffic congestion problem which is very critical & it need to be controlled as it is a worldwide problem. India has a network of over 6,215,797 kilometers of road. The country which has the second largest road network in the world is India. The major cause of road accidents is lot of registered vehicles, overpopulation, less number of available roads as required and inadequate parking facilities. Despite of implementation of strict traffic rules, even-odd system, express highways, widening of roads problem continues. In this research a system has been proposed to develop a smart transportation system. The task is to collect dataset of traffic density at different intervals in each direction at each round about. According to the collected dataset, system will determine duration of green & red lights for all directions at each round about. The system will work based on the knowledge of traffic density, there will be large duration of green lights for the lane which has the more traffic density. Counting the number of vehicles & detecting the type of vehicle helps in making a smooth transportation system.**

Keywords- RFID, GSM, YOLO, HOG, MC, R-CNN

I. INTRODUCTION

Road safety is a critical issue. There is a need of smooth transportation system to avoid personal, economical & environment losses from the country. There is a lack of concern behind reasons that leads to uncontrolled transportation system. The main factor is number of vehicles which is more than required. Also wrong parking or inadequate parking facilities, presence of animals on the roads, construction of roads, etc. Many solutions have been proposed but problem continues. However, this problem can not be eliminated completely but it can be controlled to some extent. The purpose of this research is to balance the traffic in each direction by using supervised learning model. System will identify the traffic pattern at regular intervals during the day. This pattern data is collected regularly for some days by using sensors & supervised learning algorithm. Based on this data system will examine the direction & the time during which traffic reaches its peak point and adjust the duration of green light accordingly. With this there will be very less difference between the traffic density in four directions. As a result there will be smooth flow of traffic in all directions & less possibility of noise & air pollution. Secondly based on vehicle detection scheme, highest priority vehicle will be moved first.

II. LITERATURE SURVEY

A. *Survey was conducted by Ref.[1]*
Problem Statement: Provides information of road & traffic conditions among drivers

Proposed Methodology:
RFID (Radio Frequency Identification) scheme is used. Transmission & receiving system is used. Transmitters are installed on one side of road and broadcast information of their locations provided using commercial Frequency Modulation. Drivers can adjust to the specified broadcast frequency.

Disadvantages:
A. It cannot always work with real time conditions.
B. Microcontroller may not be so powerful.
C. Installing the transmitter units across large city is costly
D. Inefficient for areas with no or less congestion problems.

B. Survey was conducted by Ref.[2]
Problem Statement: Proposed System represents the traffic strength of a road graphically using traffic judgements. By measuring the traffic lined up on a

particular roads the signal timings are adjusted to let that particular way clear out and then the next populated one. System consists of an emergency override that allows traffic authorities to remotely let go a particular signal in case an ambulance or important vehicle arrives on that way.

Proposed Methodology: Traffic signal timings are managed based on density of traffic on its corresponding road. System is detecting traffic through roadside CCTV cameras. System is using CNN algorithm for the process of image & video recognition and for classification problems. System working depends on creation of HOG in which a histogram is created for each image dependent on the angel of picture. Each image is split into 8*8 cells and a bar graph of gradients is calculated for every 8*8 cells.

Disadvantages:
System is using hoard highlight descriptor for vehicle discovery which works on 64*128 fix of picture. But on traffic a picture may be of any size 100*200, 128*256, 101*205. So it will not be able to detect all the vehicles on road which can result in inaccurate results.

C. Survey was conducted by Ref.[3]

Problem System: System is adjusting the traffic by detecting the number of cars in all the lanes and types of cars. System is taking decision for which light to be on a corresponding lane by identifying the normal cars and emergency cars. If an ambulance is detected by a system then the red light at that lane get changed to green light. System is also taking into account the density of traffic so if system will automatically change the red light to green light if the lane is empty or less traffic.

Proposed Methodology: System is based on the relationship between a server computer and an open source microcontroller. Server receives car videos through attached cameras. MC controller controls all operations of electronic circuit. Video cameras are used for inputting real time videos to the server. Image processing starts with car identification, feature extraction, matching with available data set images & detecting ambulance cars. Depending on existence of emergency cars system will change red light to green light. Traffic lights communicate through wireless mode to give priority to emergency cars.

Disadvantages:
System is priority based but emergency cars can be ambulance, fire brigade, police car So if they are at the same time then which vehicle will be the first to go.
If a lane is more populated then the system allow it to go first what if other lanes has less traffic they have to wait longer.

III. PROPOSED WORK

Dataset of traffic density is created at each round about. The data is collected at some regular intervals of time from all directions. This can be done manually or by using sensors. After processing the created dataset, patterns will be recognized for each direction. This pattern will give information about the amount of traffic at some point of time in each direction. Now after analysis duration of red & green light will vary for each direction. The direction in which traffic is more will have the green light for longer duration and red light for short duration. In this way traffic will be balanced in each direction. Proposed system will work based on counting the numbers of vehicles in each direction and determine the type of vehicle so that emergency vehicle will be the first to move on. To count the number of vehicles Piezoelectric sensor will be used and for the identification of vehicle type fast R-CNN technique will be used which will give more accurate results.
The figure below shows the amount of traffic at each direction at each round about before applying ML system.

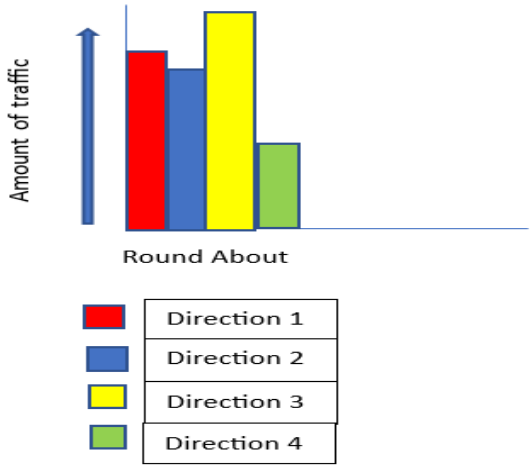

Fig 3a: Amount of traffic

First proposed system will count the number of vehicles in each direction to check which lane has the highest traffic so that duration of traffic light signals will be adjusted accordingly. Secondly using piezoelectric sensors the type of vehicle will be recognized. With this most priority vehicle will move first. The figure below shows the implementation of piezoelectric sensor on roads.

Fig 3b: Piezoelectric Sensor on roads

Now the trained ML system will take decision based on input data feeded into the system. The system below shows the concept of proposed system.

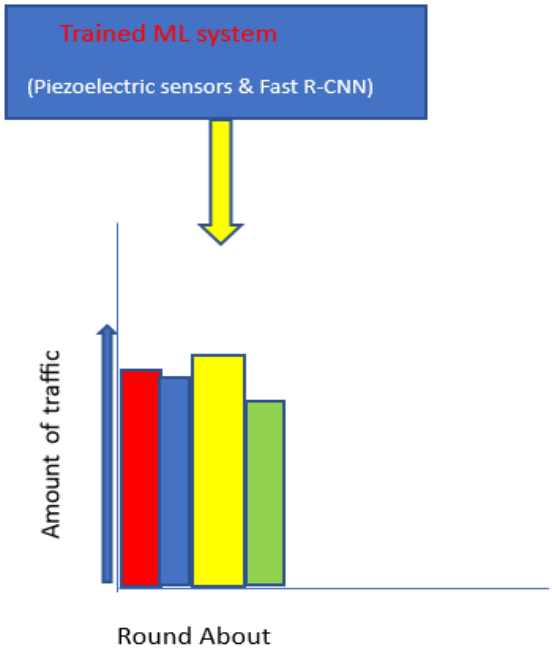

Fig 3c: Balanced Traffic Control System

3.1 Fast Region with Convolutional Neural Network

To detect different types of vehicles fast regions with CNN technique will be used. According to this phenomenon, users can have the appearance of single, end to end network. The figure below shows the architecture of fast region with CNN technique.

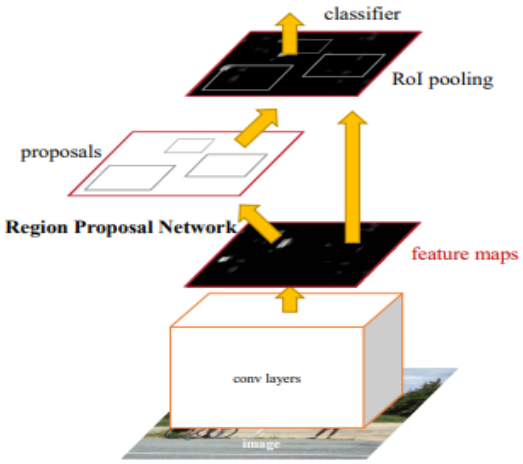

Fig 3.1.1: Fast R-CNN architecture

The Fast R-CNN architecture a Fully Connected Layer, having a fixed size follows the RoI pooling. RoI windows are of different sizes, so a pooling technique needs to be applied to them.

The RoI pooling layer technique is the main idea behind Fast R-CNN and the reason that it outperforms R-CNN in accuracy and speed respectively**.** SPP is a pooling layer method that aggregates information between a convolutional and a fully connected layer and cuts out the fixed-size limitations of the network. Therefore, the disadvantage of the fixed image size needs is overpassed.

RoI pooling layers divide a rectangular window into set of sub-windows, and afterward perform max-pooling in each sub-window. The RoI pooling layer performs a max pooling operation in any proposed RoI of an image individually**.**

The figure below shows an example of fast R-CNN technique:

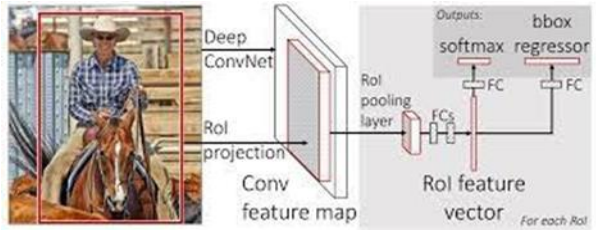

Fig 3.1.2: Fast R-CNN example

First, from selective search algorithm we generate the region proposal. The generation of approx. *2000* region proposal will takes place using this algorithm. These region proposals (RoI projections) combines with input image passed into a CNN network. The convolution feature map has been generated as output. Then a Region of Interest (RoI)

pooling layer for each object proposal, extracts the feature vector of fixed length for each feature map. Every feature vector is then passed into twin layers of softmax classifier and Bbox regression for classification of region proposal and improve the position of the bounding box of that object.

Using this technique, we don't need to pass 2000 region proposals for every image in the CNN model. Instead, the convNet operation is done only once for each image and feature map is generated from it. No need for feature caching. That also decreases disk memory requirement while training. Fast R-CNN also improves mAP as compare to R-CNN.

3.2 Piezoelectric sensors

Piezoelectricity is the charge created across certain materials when a mechanical stress is applied. Piezoelectric pressure sensors exploit this effect by measuring the voltage across a piezoelectric element generated by the applied pressure. They are very robust and are used in a wide range of industrial applications.

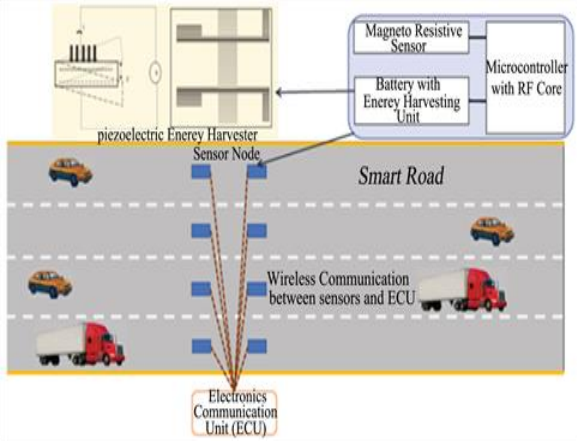

Fig 3.2.1: Working of Piezoelectric Sensor

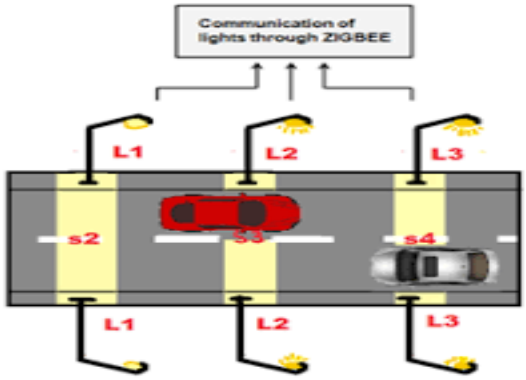

Fig 3.2.1: Street light system based on Piezoelectric Sensor Network

3.3 PYTHON PROGRAMMING LANGUAGE

For the proposal implementation, python programming language will be used. It is used as it provides a precise & reliable code. Coding using python will be easy to learn & use.

PyBrain a modular machine learning library provides easy-to-use algorithms for use in machine learning problems. Solutions to the problems require a proper structure and tested environment, which is available in the Python frameworks and libraries. There is a presence of third-party modules. It is open source, versatile, easy to read, learn and write. Python has user-friendly data structures. It is dynamically typed language.

Python provide more functionality with less coding. It is highly efficient(Python's clean object-oriented design provides enhanced process control, and the language is equipped with excellent text processing and integration capabilities, as well as its own unit testing framework, which makes it more efficient.)

IV. FUTURE SCOPE

In summary, our proposed system is balancing the traffic in each direction according to the traffic density information collected at regular intervals of the day based on learning with supervision. In future suggestion is to consider learning technique with no supervision. Machine learning model should be trained so that it will take decision based on the input given to system. The duration of green & red light must be change dynamically based on the input. This can be implemented using faster region with convolutional neural network.

3.4 Learning with Supervision

Learning with supervision allow to build an artificial system which can identify the mapping between input & output and based on the given inputs outputs can be predicted. It is more resource intensive as it needed labelled data. It works based on previous experiences. It is used to solve regression & classification problems.

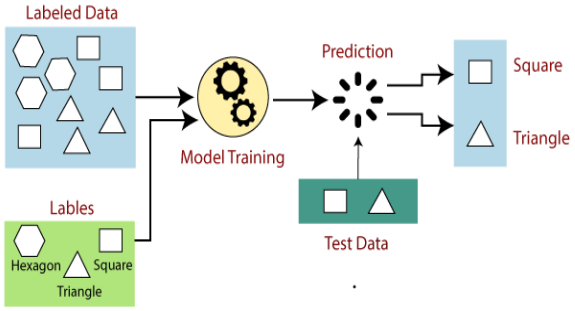

Fig 3.4.1 Working of Supervised learning

According to given example suppose our machine learning model has trained with the knowledge of each shape. If the shape has four equal sides then it is square, if the shape has three sides then it will be triangle, if the shape has six equal sides then it will be hexagon. After training, the task of the model is to identify the shape. When the machine finds a new shape, it classifies the shape on the bases of a number of sides and predicts the output.

3.4.1 Types of problems for Learning with Supervision

There are two types of problems which can be solved by supervised learning:

1. Classification Problem:

It is used when the output variable is categorical as we have two classes YES-NO, TRUE-FALSE, etc. It can be solved using random forest, decision trees, logistic regression and support vector machines.

2. Regression Problem:

It is used when there is a relationship between input variable & output variable and to predict continuous variables. It can be solved using linear regression, regression trees, nonlinear regression, Bayesian regression and polynomial regression.

REFERENCE

[1]. Assil Ksiksi, Saeed Al Shehhi, Rashad Ramzan Department of Electrical Engineering UAE University Al Ain, United Arab Emirates, 2015 “Intelligent Traffic Alert System for Smart Cities” IEEE International Conference on Smart City/SocialCom/SustainCom together with DataCom 2015 and SC2 2015,pp. 165-169.

[2]. Jhondale S.S., Shingote Vijaya R., Badhe, January 2020, Machine learning based automatic traffic control system, JETIR, Volume 7, Issue 1, ISSN: 2349-5162, pg. 297-300.

[3]. Najmadin Boskany, October 2020, Intelligent Traffic Congestion Control System using Machine Learning and Wireless Network, UHD Journal of Science and Technology , DOI:10.21928/ uhdjst.v4n2y2020, pp.123-131.

[4]. S R Samal1, P Gireesh Kumar2, J Cyril Santhosh3, and M Santhakumar4, ScTACE 2020, “Analysis of Traffic Congestion Impacts of Urban Road Network under Indian Condition” IOP Conf. Series: Materials Science and Engineering doi:10.1088/1757-899X/1006/1/012002,pp.1-7.

[5]. Dr.A. Ravi1, R.Nandhini2, K.Bhuvaneshwari3 , J.Divya4, K.Janani5, April 2021, Traffic Management System using Machine Learning Algorithm, IJIRT, Volume 7, Issue 11, ISSN: 2349-6002, pp. 303-308.

[6]. Aditya Krishna K.V.S, Abhishek K, Allam Swaraj, Shantala Devi Patil, Gopala Krishna Shyam, May 2019. “Smart Traffic Analysis using Machine Learning” IJEAT, ISSN: 2249–8958, Volume-8, Issue-5S,pp.199-202.

[7]. Prof . Sunayana Jadhav#1 , Siddharth Vaghela, Shubham Tawde, Rashmi Bharambe, Stuti Mangalvedhe, K.J Somaiya College of Engineering, Department of Information Technology, Vidyavihar. Mumbai, June-2020, “Traffic Signal Management using Machine Learning Algorithm”, IJERT, ISSN: 2278-0181,Vol. 9 Issue 06,pp.384-387.

[8].https://www.mygreatlearning.com/blog/machine-learning-tutorial/

[9].https://www.javatpoint.com/machine-learning-random-forest-algorithm

[10]. https://en.wikipedia.org/wiki/Supervised_learning