S-TVDS: Smart Traffic Violation Detection System for Indian Traffic Scenario

Aman Kumar, Shakti Kundu, Santosh Kumar, Umesh Kumar Tiwari, Jasmeet Kalra

Abstract: ***The world's second-largest road network is in India, which is directly and similarly proportional to the causes of road rules violations, accidents, and a large per-year death ratio. Now in semi-structured cities, it becomes the biggest challenge to make people abide by traffic rules. Much different automation has been proposed to automate and to make it happens in India. Many researchers are also trying to solve this with computing technology advancement. As from the recent past, AI & ML not only making things smarter but also have proven to a valuable technological human assistant of dealing with such issues with intelligence. In this paper, we proposed a smart traffic violation detection system as a solution for the same issues in the Indian scenario. The advanced and intelligent form of visual computing will assist in detection as well as pruning actions /alerts accordingly with classification of types of violations.***

Index Terms: traffic violation detection, smart traffic violation detection & alert system, AI traffic monitoring, smart traffic management, smart traffic alert system

I. INTRODUCTION

Road safety is the biggest concern from the Indian traffic scenario; even the traffic regulatory, rule-books are also numerous in numbers and heavy in volume, which are obviously sufficient and viable enough to be followed. But the accident ratio is equally proportional due to rules violation. In the report of 2010 of Road Transport Ministry [1], which is related to road accidents in India were close to 5 lakh, more than 1.3 lakh deaths caused, and with 5.2 lakh inflicted injuries. In 2018 report of the same scenario was worse, which clearly stating. According to the report of world record statistics (2018), India ranked 1st in the total number of road accidental deaths followed by China and the United States. On this same issue of accidental-related deaths, India sharing 11% proportion as per the WHO Global Report on Road Safety 2018.

The road traffic is getting exponential growth, so the road incidents. The manual human guard watch to let people abide by rules and regulations is getting unpractical too. Many automation to help or assist humanity is being proposed and in usage. But still, the city traffic scenarios are getting worst so a smart traffic violation detection & alert system needs to be there, even for small to big violating incidents.

The smart violation detection and alert system will assist the human guard without getting tired.

Revised Manuscript Received on March 20, 2019.

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Vision computing has also been a matter of curiosity and challenge among researchers and AI practitioners to make AI vision as efficient as a human being. Machine learning, especially deep learning, has proven as a great methodology to make it happened up to an extent. If we want to make a machine as efficient as a human being, which is the prime target of Artificial Intelligence methodology, then the machine must have eyes to look and feel the situation in real-time. The new form of visual computing as stated above is a key to the same. Hence Deep-Learning based AI vision computing environment really making this happened in present time.

In this reference, to make a road traffic violation detection & alert system smarter, challenge-free, and to assist human-based traffic control system in a similar fashion with similar feel like a human being, smart vision computing-based system is being used in this paper which would be cost-effective too. The system model helps to help them in type-of violation detection as well as recognition and real-time alerts based on interest-class detection and situation. The system development is based on different open source technologies which are the reason for its cost-effectiveness.

The remainder of this paper is organized as follows; section II the literature review of the recent years' development of the automated systems with the same or similar target, section III is all about the system modeling in Indian local traffic scenario, the section IV demonstrates the implementation and the accomplished simulation & results that we have done and got till now, finally the section V is the conclusion including future perspective and scope.

II. LITERATURE SURVEY

Many efforts have been made and still going on by different researchers and automation techies to solve the traffic violation, which is one of the biggest challenge in Indian traffic scenarios where the cities & associated roads planning are not up-to the mark and still will take much time. In this section we are reviewing those recent, real-time experimental and practical kinds of solutions that have been made till now.

An initiative by Delhi Police in the National Capital Region (NCR) with support of Maruti Suzuki India aims to promote the road safety campaign in NCR region. The objective behind this initiative is to highlight the country's traffic regulations in a transparent manner. The objective of this scheme is to reduce accidents and fatalities. The focus of the proposed system was on its automated behavior and transparency.

The system includes 100 high resolution cameras and sophisticated 3D radar units to track the presence of vehicles and other entities. Moreover, to capture multiple offences such as Red Light Violations, Speed Violations, Stop Line Violation and Wrong Side Violation; an automatic camera having feature of license plate recognition had been proposed [2].

The first step of proposed system is the detection of violations in real time. The automated cameras capture video and images which results in fruitful benefit to security personnel and traffic management operators. With the relevant findings, they can quickly access the activity and can respond with comprehensive situations and above all they are exempted from having to collect evidence on-site [3].

The two smart detectors such as red light violation and automatic number plate recognition, playing a vital role in today's scenario. Overview camera which comprise of red light violation detection system and automatic camera consists of number plate recognition system. The system starts capturing the red light violation as soon as traffic signal turns red and considered as an input for further proceedings. The new system comes with user friendly interface that provides important facts such as image of the number plate; image of the vehicle; speed violation detection; date, time and location of offense [4].

Another initiative regarding smart traffic signal system establishment came into existence in Hyderabad in 2014. The new smart system has number of features which help in detecting a motorist who commit violation. The automated camera and smart sensors will detect photos, video footage that will be transmitted to their data center for further proceedings. Based on these facts and information, a case filed against the default motorist and e-Challan will be issued [5].

Another smart traffic violation detection system was proposed in Bhubaneswar where two parameters were taken into consideration, namely, red light violation and speed violation. In the first case, proposed system captures image of the vehicle who found violating the traffic rules. Once the traffic signal turns red, the proposed system starts capturing the violation (if any).Whereas in another case, the proposed smart system monitored the speed of the vehicle as well as capture photo of its number plate. These above two discussed initiatives will help the cops to trace those violators easily who are in the category of habitual offenders [6].

Some of the smart violation detection systems already implemented in cities like Gurugram, Noida, Greater Noida, Ghaziabad, Faridabad, Bengaluru and Chennai. Thus making a positive impact as a result of less fatal accidents and reduced traffic congestion.For further proceedings, radar based three dimensional automated camera were installed which are capable enough in detecting the violations as well as to monitor those defaulters who were jumping the red light. Under the smart city program, Chennai city is also following the similar practice by installing automated and smart cameras. This project is being implemented to catch those cases that are coming under the scenario of violations such as over-speed, jump signals and illegal parking of vehicle [7].

One of the renowned organization Devfolio [8] proposed smart traffic system in which camera was considered as primary equipment to monitor the various activities of traffic. Over-speeding is one of the important issues and has taken a shape of high risks now-a-days. The aim of this organization is to monitor on rule breakers and protect from road accidents through their automated systems. With the help of smart automated camera equipments; they will trace the violated vehicles and report to the concerned authorities to take strict actions against defaulters. Moreover, they will trace over-speeding vehicles with the help of expert system based learning algorithms.

An overview automated camera is one of the best utility in smart traffic violation detection system. It shows the entire view of violation. The proposed system is having state of the art, user friendly interface for smooth operations. The overall results in the form of capturing and delivering report were active and suitable for tracers to avoid violations and other disruptive activities [9].

Many other like- Radar Speed Signs (RSS), Red light violation Detection System (RLVDS), Speed Violation Detection System (SVDS), and Public Addressing System (PAS) are also the smart automation efforts to impose e-challan to make them abide by [10].

In [11], author describes a design, experimental realization outcome of a participatory urban traffic monitoring system. To model the road traffic conditions operating buses is given as search vehicles and farm-out the sensing jobs to public bus riders using their commodity mobile phones instead of GPS traces.

In [12], author proposed a parallel computing based real-time violation detection algorithm for places like roadways and parking. An optimization scheme is also employed to further enhance the performance of parallel implementation.

Chauhan et al. in [13], used CNN based modeling for object detection by training on different and multiple vehicle classes over the dataset of Delhi roads traffic and obtained significant classification count accuracy.

Prouzeau et al. in [14], proposed and named wall display: an synergistic model for traffic monitoring to visualization, interaction, traffic modeling, to realize potential impact of performed traffic modeling settings on global or local.

In [15] Marti et al., proposed a multi-agent system based traffic monitoring and management system that works in two mode of operations, coordinately – where all agents would work towards solution and the locally mode where some essential will work only.

In [16], author focused on causes of urban traffic congestions and intelligent transportation. Big data analytics is used on IoT based collected data for traffic prediction modeling, with real-time monitoring and further analysis for integrated supervision.

In [17], author analyzed Traffic Light Control (TLC) complexity on a single isolated junction having making an allowance it from the perspective of supervised learning by explicitly splitting the dilemma into two parts: demand estimation and traffic light control itself.

The Experiments is demonstrated by Shallow Neural Network (SNN) models to show viability of estimation and well traffic control on a single junction.

Hence, as per the survey indicates that many HD cameras and other sensing devices have already been installed for making surveillance round the clock. Now there is a need to utilize that hardware smartly by equipping them with AI & ML technological usage. In view of the same our effort is to make things smarter to detect, to predict, to report, to store, to analyze the different violations & alarming them correctly for further proceedings and actions.

III. SYSTEM MODELING

This section will demonstrate the system model of S-TVDS and functioning. To make it understandable and simple, the model is beings demonstrated in two different ways, first- the overview model of the system and, second – the flow model for functioning demonstration.

A. System Modeling- Overview

The simplest way to understand the system is the upper lay-out diagram of the system as given below for S-TVDS lay-out diagram in Fig 1.1.

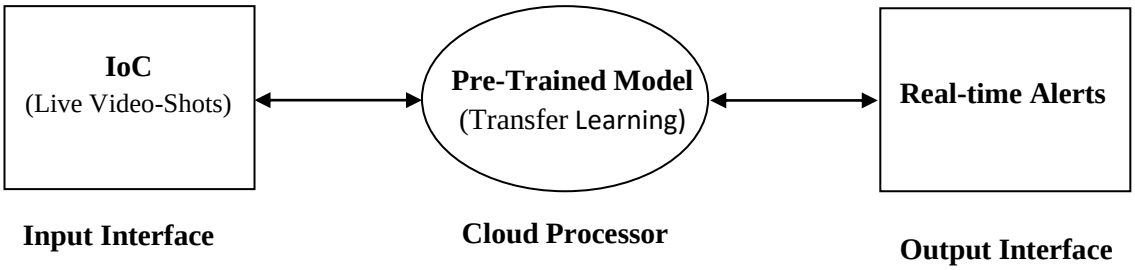

Fig 1.1 S-TVDS Overview Model

As the standard system S-TVDS (Smart- Traffic Violation Detection System) is also contains three main layers as describes below.

Input Interface – The input unit of the system will feed inside, and constituted by a web of Internet of Cameras (IoC), the term IoC that coined here is a dedicated and specified things from the T of IoT i.e. IP Cameras. The traffic signal lights will also work or will be equipped with high definition cameras to feed live video chunks to the next phase. The feeding process will be automated as well as manual stop.

Cloud Processor- The cloud processor which contains a pre-trained deep learning model will always be live to take input in and to detect anomaly as decided by the trained classes. This will process to major things from the input, first- the statistics maintenance and, second – the prediction alert feed forwarding to next phase.

Output Interface- The final phase of the model will send alerts to the nearby guard, or traffic police station, or to other specified with predicted class and degree of violation.

B. System Model – Workflow

The below Fig 1.2 will demonstrate the current implantation workflow diagram; this work is a piece of series of complete smart traffic automation & solution. This work is mainly concerned with violation of traffic rules' detection in Indian local traffic scenario.

The complete workflow based on progress implementation can be briefly described by following given steps-

STEP1: The Input Interface

IoC (Internet of Cameras) will feed video-shots inside the modeled system

STEP2: Frames Extraction & Scaling

i) The input video will be converted into frames according to 24 f/s

ii) Extracted frames will be processed over a cloud, to clean, to resize and for final scaled input

STEP3: Pre-Trained Model (Transfer Learning)

The fames of concentration will be testified against a pre-trained CNN back-boned and Customized Deep Learning Model to predict specified class

STEP4: Classification (Class Labeling)

The model will predict a class of traffic violation from the decided classes- as per supervised learning network

STEP5: Alerts, Storage and Dashboard maintenance

i) The alerts according to the predicted class will be sent to nearest concerned one in real time for quick action

ii) Alerts and results will be recorded to suitable database in pre-processed format for further analytics

iii) Particular alert will also go to the dashboard as new feed for updating in single view dashboard

STEP6: Self- Evaluation (Auto –Training)

The auto tuned module of periodic self-training of the model be executed by system to self train and evaluate

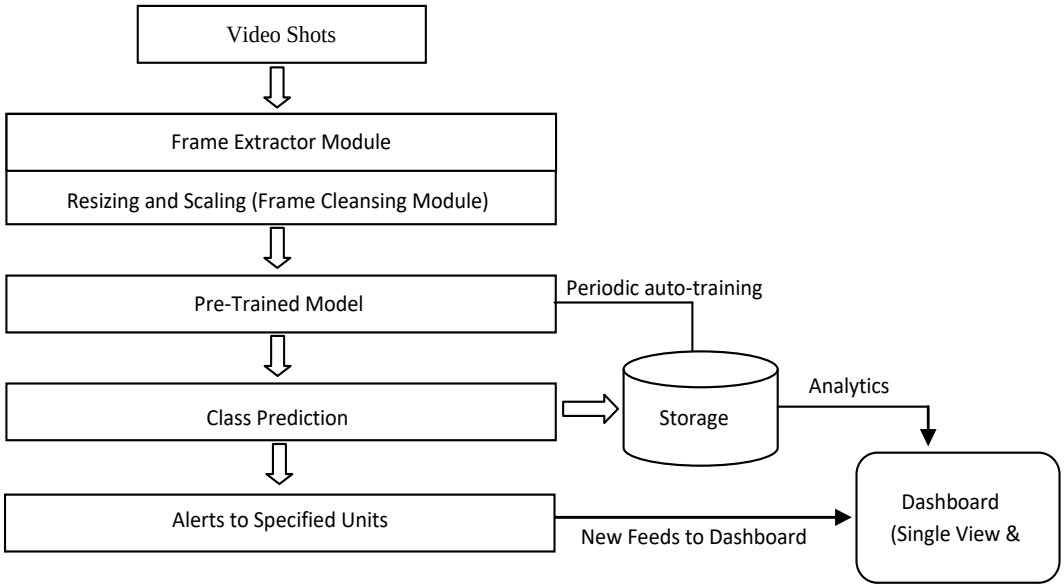

Fig 1.2 S-TVDS Workflow Diagram

IV. SIMULATION AND RESULTS

The complete simulation and modeling is based on open source tools like python, opencv and tensorflow 2.0 to train & test the core of system i.e. model. That we will save and used later as transfer learning.

A. The Experimental Setup

The current implementation is completely based with 2D CNN backbone neural net and we named it with fusionConvNET (FCN), with the following specification – The fusionConvNET is a simple CNN neural net with experimental settings. It initially contains 3 convolution layers, first- Conv2D(32, kernel_size=4, activation=tf.nn.relu) with a kernel size of 4 and relu activation function, second- Conv2D(64, kernel_size=2, activation=tf.nn.relu) with a kernel size 2 and relu activation, third- Conv2D(128, kernel_size=2, activation=tf.nn.relu) again kernel size 2 and relu activation. All alternate max pooling layers are like MaxPool2D(2, strides=2) with kernel size of 2 and strides of 2. The final fully connected layer is like Dense(1024) having 1024 neurons. The Dropout(rate=….) we are varying from .35 to .50 which is only going to be applied if there is a training otherwise no drop-out. The final output layer till now limited with three classes (1- No Helmet, 2- Peoples are hanging on a Auto, and 3- Wrong Side Drive).

The classes in dataset of 10000 are approximately equally distributed to balance training dataset. Currently we simulated with three classes but trying to cover all traffic violations as classes/labels. Initially during object detection yolov3 on coco dataset is used to train model to identify the primary concerned object. The main focus and the dependent success factors are data collection and denoising.

B. Experimental parameters settings and Results

The training parameter's setting is the heart of any deep learning model, here we use following parameters with given specifications to tune our model in its best state.

```
num_classes = 3
learning_rate = 0.0001
training_steps = 2000
batch_size = 200
display_step = 100
```

After settings the first epoch results of training are demonstrated in Fig 2.1 is the processed class one prediction during testing, Fig 2.2 the accuracy and Fig 2.3 the loss.

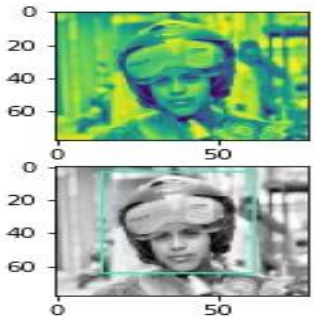

Fig 2.1 Class 1 (Without Helmet) Processing, we manually split classes, size 78*78

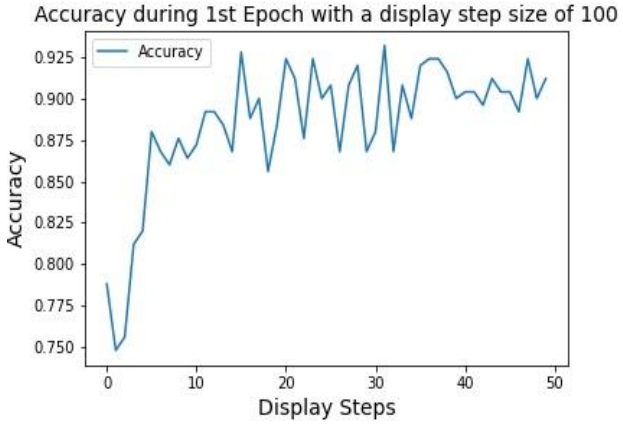

Fig 2.2 Accuracy graph over 100 step size during epoch 01

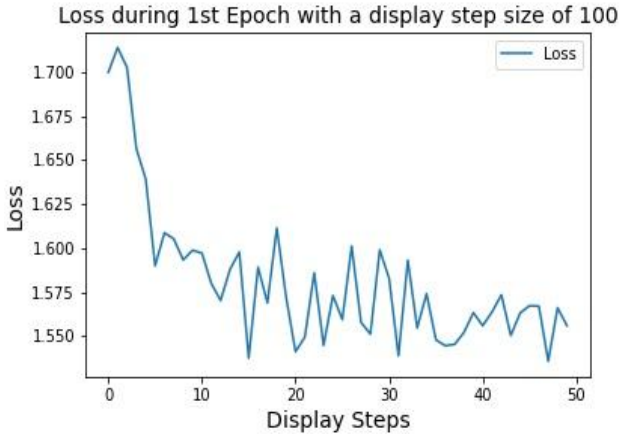

Fig 2.3 Loss graph over 100 step size during epoch 01

The experimental results clearly demonstrating trends in accuracy and loss i.e. increment and decrement accordingly. The final testing till now ends up with a Test Accuracy: 0.93400 i.e. 93.5 % (approx).

V. CONCLUSIONS AND FUTURE WORK

Indian traffic is highly unorganized as far as the local city traffic is concerned. Monitoring, Modeling, and Management of traffic violations have always been a curious topic for researchers to discover new solutions. In name of smart automation different systems have been proposed and implemented, but those were mostly related and end with a wall display monitoring or automatic periodic light switching as far as India is concerned. In name of smart cities, the visual capturing units are extended up-to HD, but still manual monitoring. This paper is a piece of a series of smart traffic automation system. The given model will use the existing HD capturing units and will classify the predefined class of violation with the help of vision computing (deep learning). The prototype & experimental setup demonstrated with a satisfactory accuracy of classification and custom real-time alerts based on processing. This work will lead us to be smarter in recognition of the owner or current driver to make them abide by-laws.

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