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Traffic Signal Control Based on Vehicle Detection Algorithm & IOT

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***Abstract*—** The fast development of road infrastructure, the volume of vehicle on the road network increases which leads to traffic Congestion. The same scenario exists in the Bangalore of India. Traffic congestions are amongst the top list of the problems faced in other Indian cities such as Mumbai,Delhi,Pune etc. This is mainly caused due to the rapid up rise in the number of vehicles in a short span of time. To overcome such impact of traffic congestions, it is required to develop an IoT and Vehicle detection-based algorithm traffic control system. The proposed system would be based on the measurement of the actual traffic density on the road. This would be achieved using a real time video and image processing techniques with machine learning algorithms. Propose a fast vehicle flow detection algorithm based on a learnt background dictionary. The proposed detection algorithm detects vehicles by background dictionary and has a robust and best performance in real-time. Combining the virtual region and the virtual detection line, the proposed detection algorithm is robust in accuracy.The theme is to control the traffic by determining the traffic density on each side of the road and enabling a controlling option of the traffic signal to the user through a software application and Raspberry Pi3

***Keywords*—IOT(Internet Of Things), Image processing, machine Learning, sensors, web application server**

I. INTRODUCTION

Increasing number of populations and vehicles hence, leading to rapidusage of vehicles therefore increasing the traffic level indifferent areas [1]. Traffic congestion is the main cause forslower speed, chaos, longer waiting time, accidents and frustration.Therefore, in order to help to overcome such issue, we proposethe initiation of Density based Traffic Light using RaspberryPi to control traffic through signal control. One major causeidentified is traffic congestion in peak hours. The traffic congestion trendneeds to be monitored closely to ensure the development ofinfrastructure are carried out effectively without any delay. In addition to that,traffic congestion has been associated with longer waitingtime, delays in travel time and may cause traffic violation etc.In fact, the routine Traffic light signals are set at certaintiming and are not able to recognize road density at all.With thedevelopment of technology, the systems are turning smartsand more intelligent. The possibilities to remote controllingand monitoring is not a difficult task compared to couple of years back. With the faster internet connectivity, the advanced systems are developed to transmit data at a very high speed[2]. This communication has acted as a back bone for somebreath-taking technological development which were released in the market recently. IOT and video frames Images processing model gives an opportunity to be one ofthe possible solutions to overcome such problem of trafficcongestion, by utilizing Raspberry Pi with Image processingcapability.Start by review of literature. Based on this develop a system using IoT to monitor and controltraffic is signal based on density using image processing and Machine learning. The systemis implemented and simulated for monitoring traffic density,auto signaling mode, and manual signaling mode.Thevirtual detection line is used and combined into the virtualregions to detect the vehicles.propose a robust vehicle flow detectionalgorithm based on a learnt background dictionary method.Theproposed detection algorithm detects vehicles by backgrounddictionary and has a fast performance in real-time.Combining the virtual region and the virtual detection line,the proposed detection algorithm is robust with high accuracy.Compared with an improved Gaussian model algorithm, theproposed detection algorithm is effective and robust in realtimeand with high accuracy.

II. RELATED WORK

Many researches try to find solutions for transportation and traffic management using different approaches using sensors, machine learning techniques, wireless sensor networks and digital image processing with advanced algorithms.In [3] an array of IR sensors is deployed to count thenumber of vehicles on each lane of the road and recordthe statistics on the cloud using Bluetooth connection or wifi connection, trafficdensity information is fed to clustering algorithms basedon KNN algorithm to determine expected required timing oftraffic lights.Using short-range communication technology such as Bluetoothrequires that the access points close to the sensor arrayto achieve data transfer and thus increase the complexity of thesystem, in addition using clustering algorithm based on KNN or any other machine learning or statistical algorithmleads to increased overhead in

the cloud computing system,which may result a delay in decision-making and modificationof traffic lights timing, which will reflect negatively on traffic.Another proposal for IoT based Traffic Signaling systemusing ultrasonic sensors has been developed in [4] whereultrasonic sensors deployed at every 100 meters of road.

III. METHODOLOGY

The methodology used in this paper is the V Model approach, in order to track the system timeline and dependenciesextensively. The reason for opting this methodology is thenecessity for the process to be completed in step by stepphases. This method is structured, systematic, progresses onan individual and separate phase and simple to understand.The requirement and design once are made, the entire flow ofwork needs to follow the process one after another. Itgives aproper tracking as design of the system is made according tothe analysis and it is checked before moving to the next stepof coding. Once the coding is completed, the system testingis considered to ensure the design. On the confirmation of the same, the next step of acceptance of the task as shown in fig 1

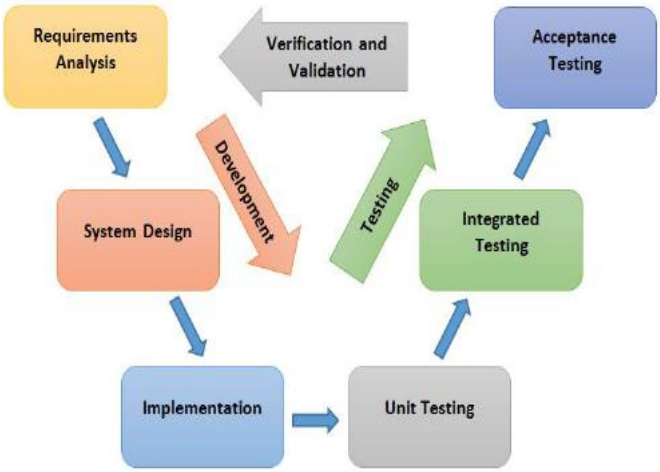

FIG1 V-MODEL METHODOLOGY

The requirement phase involves monitoring traffic density,Manual signaling mode and auto signaling mode. The system
design phase involves traffic controller hardware, Server (M2X IoT platform), software development of java application. The implementation phase involves developing application code for Raspberry Pi3 image processing, GPIO controlling, communication with server. Java application for communication with server. The unit testing phase involves developing the test cases to test each functionality of hardware, vehicle flow detection algorithm in video detect vehicles by lanes. Namely, the vehicle flow detection algorithm sets a fixed region as a virtual region,detects vehicles in the virtual region.The system integration testing phase involves testing communication between application and server, Raspberry Pi and server, testing interface of controller and relay module, testing image processing and control relay based on traffic density. The Acceptance test phase involves testing Auto signaling mode takes care of traffic signal based on traffic density. Manual control mode to control traffic signal through the App, and automatic update traffic density. Vehicles on road drives along a lane, so the vehicle flow detection algorithm in video detect vehicles by lanes. Namely, the vehicle flow detection algorithm sets a fixed region as a virtual regiondetects vehicles in the virtual as shown in Figure 4. Figure 4 (a) shows the detectedphoto in traffic video. Figure 4 (b) shows three lanes in thetraffic video. We set a virtual region in each lane and accountthe vehicle flows in each lane. Vehicle Counting Algorithm Based on Virtual Region and lanes The proposed vehicle counting algorithm combines the virtual region and the virtual detection line, as shown in Figure 2. The virtual detection line can distinguish whether there are two vehicles in the virtual region, as shown in Figure4 (b). When the area of the moving object in the virtual region is larger than one third of area of the virtual region, the moving object is considered as a vehicle, there are four cases according to previous and current.Machine learning algorithms can be used to detect the density of the algorithms to improvise the detection, so that signals can be controlled more efficiently. In sound detection sensors are used to detect the emergency vehicles like Ambulance, Fire truck and any other emergency vehicle to make the signal clear and allow them to pass through.

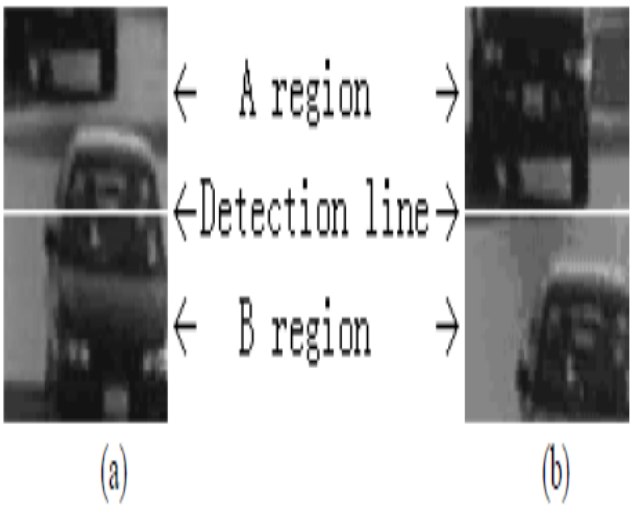

Figure 2

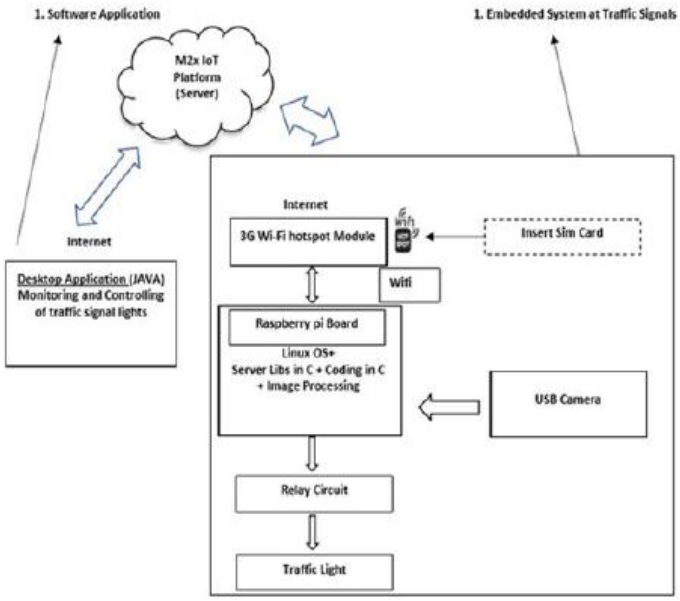

Fig. 3. System block diagram

The detail of the vehicle detection algorithm: The proposed vehicle detection algorithm includes three main components: the background dictionary initializing, the vehicle detection and dictionary updating.

*a) The background dictionary initializing:*The core process for the background dictionary initializing is to model a background image. In a Gaussian Model, the first frame of a video is usually regarded as the background. However, the object always appears in the first frame. To solve this problem, the average image of the first N frames is selected as the background. This method can remove the moving object. However, there is still error between the average background and real background. In this work, a novel method of initializing background dictionary is proposed to obtain a robust background dictionary. Based onthe initialized background image, the background dictionarycan be established by dividing the background image intoimage patches.

*b) Vehicle detection:*The virtual region is divided into image patches that havesame sizes as the background dictionary. Then, these patchesare distinguished as background or vehicle. The proposed object detection is outlined as follows: Step 1: divide an image frame f into m image patches. Step 2: For each image patch, the similarity between theimage patch and all of the atoms in background dictionary iscomputed as:

$$S_i = e^{-\frac{\|p-d^i\|_2^2}{h^2}}$$

where $S=\{S_i, S_2, \ldots, S_k\}$ is the similarity, p is the image patch, d_i is an atom in background dictionary, h is the parameters to control the descent rate of the similarity .The highest similarity is selected as:

$$S_{\max} = \max\{S_i \mid 1 \le i \le k\},$$

where k is the number of the atoms in background dictionary.

Step 4: Based on the computed similarities, a patch is
distinguished as the background or a moving object:

$$b = \begin{cases} 1, & S_{\max} \ge T \\ 0, & else \end{cases},$$

(a) A video (b) Three lanes in the video

Figure 4. A video and the lanes

Figure 5. The virtual regions in the second lane

VI. RESULTS AND DISCUSSION

IoT to monitor and control traffic is signal based on density using image processing found to be best of all the available systems in the market and conventional traffic signal maintenance. Conventional models fail to detect the density of the road and adjust the timings of the signal accordingly and it also it does not identify the emergency vehicles like Ambulance, fire station vehicles or any other VVIP and emergency vehicles in the route or road Since it uses both IOT and real time Image processing techniques, in market there are lot of sensor-based models are available but they are controlling signals for the long time compared to IOT and Image processing model

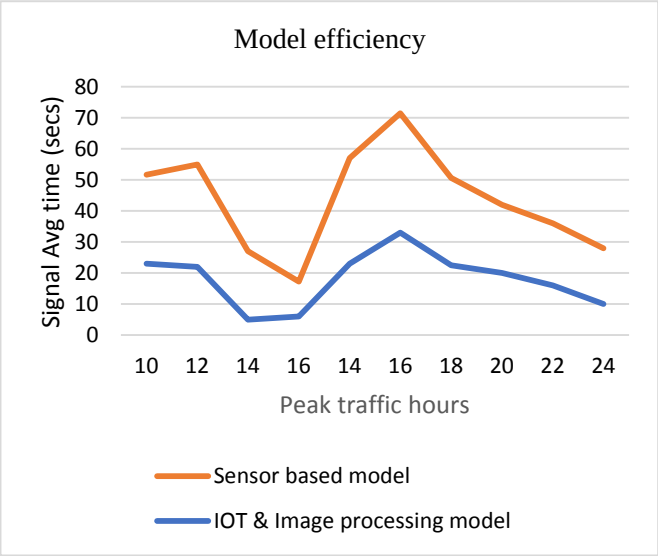

Figure 6. Model Efficiency

V. CONCLUSION AND FUTURE SCOPE

The proposed method focused on overcoming the traffic congestion scenarios experienced. The system would primary focus on the image captured using the camera. The capturedimage would be cross-verified with a preset image loaded inthe server to identify the density. Based on the density, thetraffic movements are trigger for the junctions. This reducesthe overall waiting time and results in a smoother trafficflow. The system would function automatically based on thecollection of density image send from the location to theserver.Future Recommendation: Many upgrades on the systemare foreseen with more customization that could be adaptedfor various applications where remote monitoring and controllingare required. The system can have more integrationlike incident detection and failure notification etc. With thedevelopment in advanced technology the platform can be usedto integration various devices like parking machines, VariableMessage Signs, Traffic Count Stations, and City SurveillanceCamera etc. giving a better control and monitoring on variousdevices remotely. This would lead the city to be have aninfrastructure which is smart, and technology driven.

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