MANTECH Publications

Recent Trends in Computer Science and Software Technology
Volume 7, Issue 3, September-December 2022

Applying Internet of Things with Computer Vision for Designing Effective Systems for Traffic Management

***Ramesh Vysakh* [1], *Hari Sankar. K. M* [2]**
Student[1], Professor[2]
Department of Computer Science Engineering
Amal Jyothi College of Engineering
Corresponding Author's Email: *-rameshvysakh854@gmail.com*

Abstract

The creation of a concept for an intelligent traffic control system based on computer vision and the Internet of Things is the aim of this project. Computer vision may be used to pick and prioritise routes with heavy traffic, as well as to design a traffic counting system at crossroads. By taking pictures of the drivers and recording licence plate information, it will also aid with traffic enforcement. Software for recognising letters and numbers will be used to record the registration number and save it in a database. The connection between the sensors in emergency vehicles and the traffic signal system will provide precedence to emergency vehicles. Utilizing IOT, a sort of V2X communication, might be used to accomplish this.

Keywords: -*Intelligent Traffic Management System, IOT. Computer Vision, Lane Prioritization.*

INTRODUCTION

Even the wealthiest nations face a major and escalating traffic management burden. Modern traffic lights do not control traffic by lane density and are outdated since they rely on time-dependent mechanisms. The proposed framework is an intelligent traffic management system that combines vision-based traffic monitoring with IoT sensors to manage traffic as efficiently as feasible. Using vision-based traffic monitoring and IoT-based sensors, we want to create an artificially intelligent system that is just as good as a traffic cop and manages traffic in a typically efficient manner. Using a sophisticated video camera and computer vision, we can count the number of vehicles on either side of the signal, and we can then use a straightforward algorithm to favour the lane with the greatest density of traffic. In order to estimate the traffic density on each side of a traffic signal, the video from the cameras will be uploaded to the cloud and analysed using computer vision algorithms. All traffic lights will receive traffic time information from the cloud after the research is finished. When the traffic light goes red, the cameras transmit any video frame, even those that show a breach of a traffic law; when this is done, computer vision may be used to store the offender's licence plate. Traffic signals will be connected with IoT sensors, and each emergency vehicle will utilise V2X communication to submit a request to the closest traffic signal in the event of an emergency.

This request will be sent to the cloud for processing, and the cloud will then send the traffic signal timing data once more. The emergency vehicle will be able to pass first since the cloud will prioritise the traffic signal. As a result, the information for each traffic light may be handled by the central server, which reduces traffic at each signal. By lowering traffic at each place, this lowers overall traffic.

The structure of this study is as follows: a brief introduction, pertinent prior research, and the suggested design. The design issue may be broken down into two parts: implementing IoT sensors for emergency situations and creating a vision-based algorithm.

Related Work

There has already been a significant amount of research in the realm of images. The problem of picture detection has been extensively studied in the past. Frame difference techniques and backdrop reduction can both be used to detect vehicles. [1] use the commonly used frame difference approach to recognise moving things with a stationary camera. Using this method, moving objects in videos will be found.

In order to determine the geometry of the object, which may subsequently be identified as a vehicle, the method changes the static camera's image to grayscale, subtracts it, and then converts the subtracted image to a binary image. This methodology is not employed in our method since it would not function well in a real-time context due to the calculation time for item classification based on a data set, which is frequently longer.

The technique of static subtraction is often used to identify moving objects. A reference frame, which is a stream of fixed-frame-rate frames, is removed from a video.

This reference frame encompasses the backdrop picture. However, the background may alter based on the external circumstances, leading to the identification of several wrong things. To prevent this, a collection of pictures with the backdrop are averaged.

$$B(x,y,t) = \frac{1}{N}\sum_{i=1}^{N} V(x,y,t-i)$$

Where N is the number of images, x and y denote the pixel of the image and t denotes the time of the image at time t, i denotes the initial image time. After calculating B(x, y, t) we can calculate

$$|V(x,y,t) - B(x,y,t)| > \mathrm{Th}$$

the place where the threshold is. Objects moving more quickly demand a higher threshold. The background subtraction method has an error rate of 17.59–17.742% for both grayscale and colour video, according to [2]. Car categories may be determined using the generated binary picture. [3] classifies pictures using algorithms based on Haar data. This idea might help us quickly classify the binary picture of the automobile.

To find characteristics of absolute intensity, utilise Haar classifiers. The training data set yields a probability for each feature, which can subsequently be utilised to categorise the binary picture.

The future of traffic control is V2X and V2I communication, allowing The future of traffic management will involve connectivity between automobiles, infrastructure, and other vehicles.

In this post, we'll use V2X communication to tell an approaching traffic light to prioritise that lane so an emergency vehicle may pass first by sending that information from the emergency vehicle. IEEE 802.11p uses 5.96 GHz of bandwidth to connect infrastructure and vehicles. [4] How to use DSRC devices for V2X communication is covered in this document. Additionally included are roadside units (RSU) and onboard units (OBU).

The DSRC unit may transform UDP packets from the OBU into non-IP packets and send them to all RSUs within the coverage region. The cloud server programme then receives the packet from the RSU, analyses it, and overrides the traffic signal timing algorithm. Any violators' licence plates are recorded by cameras when the traffic light turns red. Similar background removal techniques may be used for this, using simply the intersection region as the reference picture.

Any car in the area will have its picture taken, and the image will be processed in the cloud to identify the licence plate and be stored in a database. A letter and number recognition module called [5] was developed on the DSP platform. Use the support vector machine method instead of nearest neighbour classifiers to categorise characters [5].

Vision Based Approach

As previously said, we will identify moving automobiles using background removal and frame differencing and categorise them as cars more quickly utilising the binary image created from these techniques. This might be used to determine how many cars are in a certain lane.

Thirteen automobiles, one LUV, and one HUV are included in the calculation. By placing a box of the differentiated item and a green dot in the middle of the red box, you can use the frame differencing strategy to increase the count when the red line and green box are crossed.

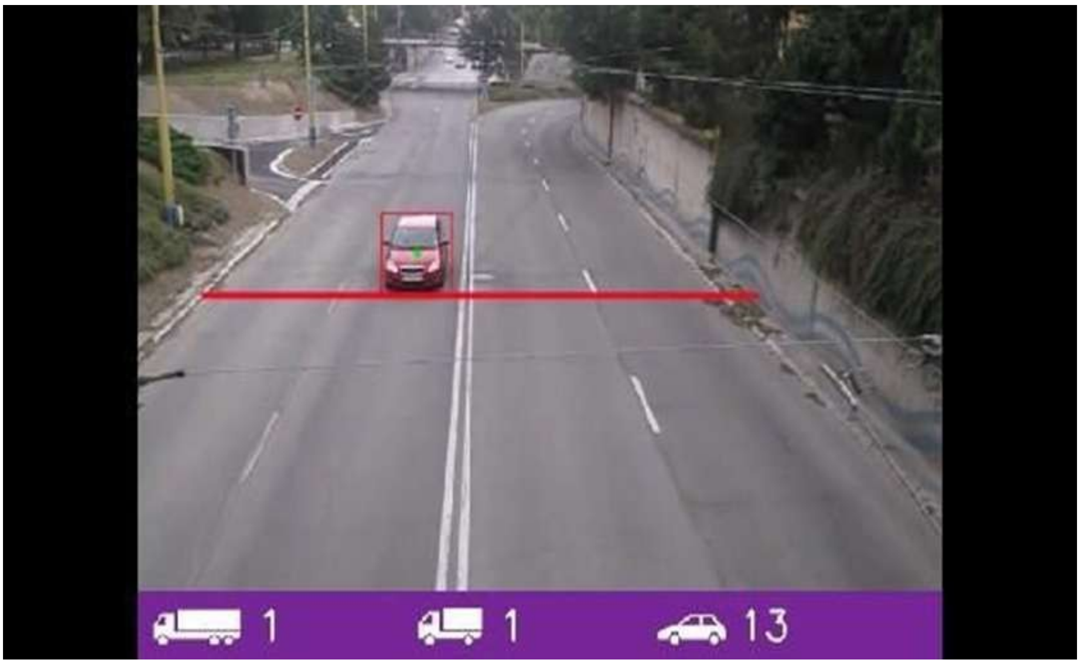

Figure 1

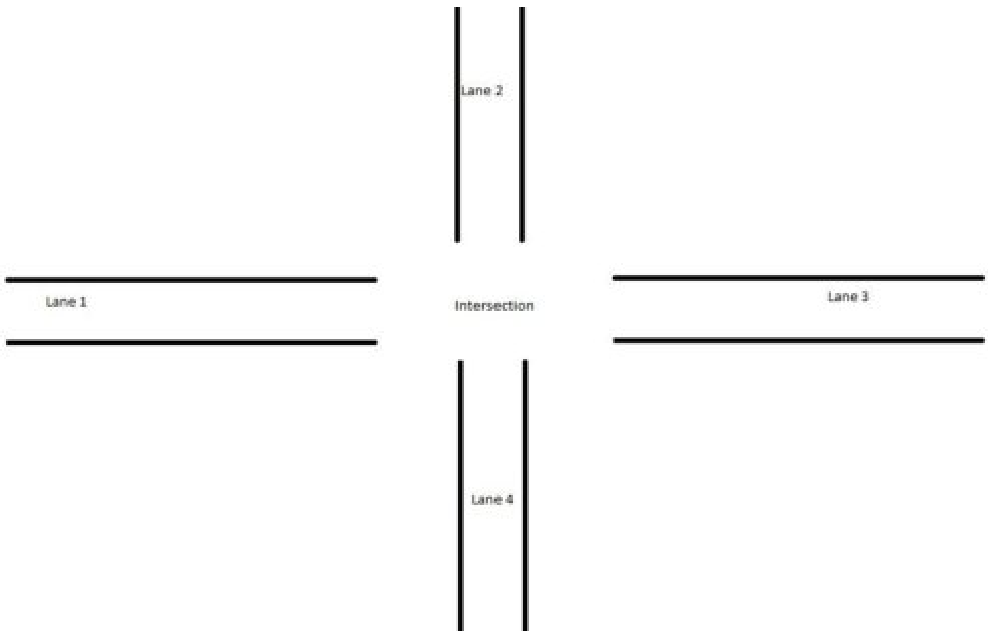

Figure 2

Consider a junction with four lanes, each with ln1, ln2, ln3, and ln4 of traffic density.

The maximum amount of green time is specified by MAX ALLOW. such that a green light may be given to several lanes, preventing traffic congestion from restricting movement to one direction.

Assume lane 1 has a green signal, and lanes 2, 3, and 4 have a red signal.

When the algorithm has established the traffic density, the data will be sent to the cloud, and green time will be allotted based on the density. Assume lane 2 has a 40 vehicle density. As a result, the cloud will be instructed by the backend computation to deliver a number to lane 2, such as 45 seconds (green time). Any lane's red time can be set with MAX ALLOW to be less than the maximum red value. As a result of this,

3(green_time+ wait_time)<= MAX_STOP (redtime) MAX_ALLOW<= (MAX_STOP – wait_time)/3

Let the waiting time

- Red time of lane 3 = green_time + wait_time
- Red time of lane 4 = 2*(green_time + wait_time)
- Red time of lane 1 = 3*(green_time + wait_time)

Similar computation will happen for lane 3 and lane 4.

Consider that lane 2 is green and lane 1-4 is red. Now, each of these lanes will check the junction image for infractions (background subtraction). The camera takes a photo and sends it to the cloud for analysis if another object is found. Support vector machines are utilised in the backend to analyse the image and find the licence plate using alphabetic and numeric classification. The recovered image is stored in a database along with a classified number for the transportation department to process further.

IOT Based Approach

V2X communication is the main use of IoT. In the vision-based method, emergency vehicles are usually disregarded in order to minimise the necessity for V2X communication. Any emergency vehicle need to be able to go to the following stop sign. The traffic signal then transmits information to the cloud, which overrides the algorithm and gives the lane the emergency vehicle is approaching priority. The approach vector information and the location of the emergency vehicle may be included in the UDP packet sent through the V2X connection when there are several traffic lights nearby to help identify which traffic light junction is being approached. The algorithm will perform an emergency function when the traffic light has been targeted by the backend programme.

Here there may be 2 cases.

Case 1: The direction the emergency vehicle is travelling in is that of the current green lane. Assume, as shown in Figure 1, that a rescue vehicle is coming from the already-green lane 1. The algorithm will activate an emergency function in response to a request from a rescue vehicle. As a consequence, the green timer in lane 1 and the clocks in lanes 2, 3, and 4 will stop decrementing, enabling an emergency vehicle to pass first. The system will turn lane 1's light yellow once the car has passed, check the volume of traffic in lane 2, and start assigning green time to lane 2 and red time to lanes 1, 3, and 4.

Case 2: From a red lane, the emergency car approaches. Assume that lane 2 is green and the emergency vehicle is approaching from lane 1, which is red. In this example, the emergency feature of the algorithm is activated as soon as an emergency request is received, resulting in the green light in lane 2 going yellow for a brief amount of time before turning red and the green light in lane 1 turning green. The clocks in lanes 3 and 4 will be stopped, and the red timer in lane 2 will also be stopped. When the car passes, Lane

1 will remain green. After that, it will change yellow to indicate a wait period, and the process will restart by allocating time to Lane 2.

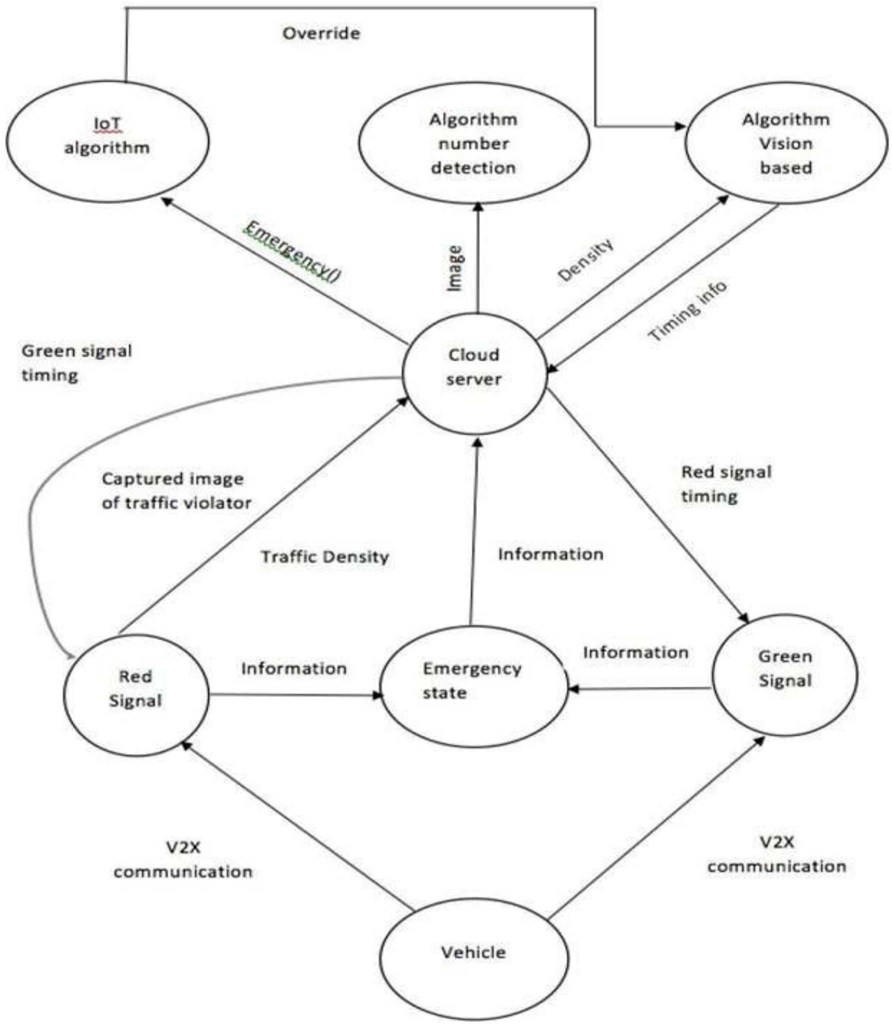

Figure 3

NORMALIZATION

RowNumber	TrafficRange	TimeAllocated(Seconds)
1	1-3	5.7
2	4-6	11.4
3	7-9	17.1
4	10-12	22.8
5	13-15	28.5
6	16-18	33.2
7	19-..	38.3

Signals should receive green lights in a consistent manner. A minimum quantity of traffic should be accessible for flow, and the maximum wait time should be set to prevent a sharp increase in traffic density. With a 5-second wait time, the maximum wait time should be between 1.5 and 2 minutes.

So, MAX_STOP = 2mins, so MAX_ALLOW becomes 38.3 seconds. also say a row of traffic (3 lane road) takes about 5 seconds to cross the intersection. Now max traffic count can be 21 (7 rows of traffic).

As a result, the countdown should stop when it reaches 21. The computations may alter depending on the circumstances. This figure is correct for a typical city situation. Normalization table values for different density of traffic.

CONCLUSION

An artificially intelligent system that can manage traffic better than a traffic conductor is made possible by the integration of IOT sensor-based and vision-based approaches. Due to the low error rate of both methods, it is possible to regulate the majority of traffic in an equitable and efficient manner, which lessens traffic congestion at crossings during peak hours. The collecting of traffic fines may be automated in future system upgrades. The data may also be regulated so that total traffic is reduced by taking into consideration the traffic density of traffic lights before and after the particular signal light since the traffic density information is stored on a central computer.

REFERENCES

1. N. Singla,"Motion Detection Based on Frame Difference Method", International Journal of Information & Computation Technology,Volume 4,Number 15, 2014.

2. Clemens Arth, Florian Limberger, Horst Bischof, "Real-Time License Plate Recognition on an Embedded DSP-Platform", IEEE, 2007

3. T. Intachak, W. Kaewapichai, "Real Time Illumination Feedback System for Adaptive Background Subtraction Workin in Traffic Video Monitoring", International Symposium on Inteligent Signal Processing and Communication System (ISPACS), 2011

4. XutinDuan, Yue Yang, DaxinTian, Yunpeng Wang, Tao Li, "A V2X Communication System and Its Performance Evaluation Test Bed", Innovation Center of Modern Urban Traffic Technologies, 2012

5. Youpan Hu, Qing He, XiaobinZhuang, Haibin Wang, Baopu Li, Zhenfu Wen, Bin Leng, Guan Guan, Dongjie Chen, "Algorithm for Vison-Based Vehicle Detection and Classification", International Conference on Robotics and Biomimetrics (ROIO), 2013

