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Density Based Traffic Management using Image Processing and Accident Monitoring

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Abstract: Traffic problems nowadays are increasing because of the growing number of vehicles and the limited resources provided by current infrastructure. Also, road accidents are the major cause of deaths in India. This is some serious matter at hands and measures need to be taken to save the lives of the victim, by providing proper medical aid on time. We propose a system for controlling the traffic light by image processing and an accident detection and rescue process. This system will detect vehicles through images captured by a camera installed alongside the traffic light. These images are processed using Image processing techniques to obtain the density of vehicles in each lane and also detects the presence of an ambulance, this data is sent to the microcontroller. Based on this data, the microcontroller sets the LED's such that the lane with more density is allowed to the pass the traffic signal. If an ambulance is detected in any lane, then priority is given to that particular lane. Also, the spot is continuously monitored for accidents. If any accident occurs, the microcontroller detects this using the vibration sensor. Immediately the microcontroller sends a message containing the location of that spot, to the nearest health care center, thus initiating an immediate rescue process.

Index Terms **- Traffic management, Image processing, Object detection, CNN, YOLO.**

I. INTRODUCTION

With rapid urbanization cities face problems of congestion. Congestion occurs when demand for road space exceeds supply. Besides space being the limited resource most of the time the reason for congestion is the poor allocation of resources and lack of management. Hence, not only to save resources but also to use available means/resources wisely, it is necessary assess the existing traffic management and suggest measures to improve the same. The advent of technology has also increased demand of vehicles for transportation. The increase in the number of automobiles has increased traffic and thus increasing the rate of accidents. People rely on vehicles for their commute from one place to another. Due to large number of vehicles on the road, the risk of accidents is large. People lose their lives because of poor emergency facilities. Prevention of accidents is not possible, but taking immediate safety measures is possible.

Some of other traffic controlling system in which electronic wireless sensors are used to detect the traffic and generate the indicating signal. This system has focused to reduce the traffic without affecting the transportation and it has given a new picture to take the automatic decision for changing the red, green and amber lights based on the number of vehicles counted in a particular picture.

II. OBJECTIVE

Traffic management and accidents are some of the biggest crisis in the present day. Our main objective is to overcome this crisis by monitoring the number of vehicles in each lane and clearing the lane based on the density of vehicles. Another objective is to take immediate action to help the accident victims by sending a message and thus requesting immediate help from the nearest hospitals. We also aim to clear the traffic lane for ambulances and thus help the patients reach hospitals as quick as possible without any delay due to traffic and be able to get the immediate treatment and required care.

III. MOTIVATION

With the increase in automobiles, both traffic and accidents increases. Traffic management plays the major role in today's world. Thus to achieve this, we need to take up necessary measures to manage traffic and reduce the rate of accident. Making way for the ambulance is also important in order to provide required medical assistance. Thus, we propose a model for traffic management and accident monitoring to overcome the above issues. The use of Image Processing and Embedded technology has proved to be very beneficial in present Traffic Light Controller and that will minimize waiting time of vehicle and also manage traffic load. We can make use of new technologies such as Segmentation of images along with embedded technology, where traffic light will be intelligently managed based on the total traffic on all adjacent roads. Thus optimization of traffic light switching increases road. Capacity, traffic flow and can prevent traffic congestion.

IV. LITERATURE REVIEW

Paper [1], this paper proposes a vision-based vehicle detection and counting system. In the proposed vehicle detection and counting system, the highway road surface in the image is first extracted and divided into a remote area and a proximal area by a newly proposed segmentation method; the method is crucial for improving vehicle detection. Then, the above two areas are placed into the YOLOv3 network to detect the type and location of the vehicle. Finally, the vehicle trajectories are obtained by the ORB algorithm, which can be used to judge the driving direction of the vehicle and obtain the number of different vehicles.

In Paper [2], an automated system based on processing of real time videos is proposed for detection of vehicles and recording count of them. The System consists of various stages which includes Object Car Detection and Signal variation based on density. Captured video will be converted into frames and which will be pre-processed for object detection using Haar-Cascade than detected object count will be used to obtain the density and manipulate the signal accordingly.

In Paper [3], video surveillance data is used for classification of road traffic using Convolution Neural Network. Convolution Neural Network requires minimal preprocessing when compared to other classification algorithms and is known for its accuracy. The video is classified based on rating of the traffic of its content. The Convolution Neural Network is first trained and then it is evaluated and updated using validation set. Once the model is completely trained it is tested with the testing set. This trained model is capable of processing the live streaming video and classifies each of the frames and gives the rating of the traffic for each lane, which can be helpful for traffic management.

Paper [4] proposes a video-based vehicle counting method in a highway traffic video captured using handheld cameras. The processing of a video is achieved in three stages such as object detection by means of YOLO (You Only Look Once), tracking with correlation filter, and counting. YOLO attained remarkable outcome in the object detection area, and correlation filters achieved greater accuracy and competitive speed in tracking. Thus, builds multiple objects tracking with correlation filters using the bounding boxes generated by the YOLO framework.

Paper [5] aims to improve the response time of the emergency response department to be informed on vehicle accidents. The primary impact of this work was to reduce the waiting period for accident victims to receive medical assistance and be rescued from a catastrophic vehicle accident. The conceptual idea of achieving this was by accommodating sensors and a microcontroller. The system was developed using a vibration sensor to determine the collision impact of an accident. When an accident occurs, the instantaneous coordinates will be transmitted to the emergency response department via a GSM module. With that, necessary emergency response units can be deployed to the accident location. The outcome of this project utilizes a vibration sensor at collision impact frequency of more than or equal to 90 Hz.

V. BLOCK DIAGRAM

The proposed block diagram(**Fig.1**) consists of a camera for capturing the images of each lane, a processor(laptop) for processing the captured images using Image Processing technique, a vibration sensor used to detect vehicle accidents, LED's to control traffic, a Wi-Fi module(ESP8266) to send information and a microcontroller(STM32).

VI. METHODOLOGY

The model aims to provide a solution for current traffic issue by managing traffic signal on the basis of real time scenario. The images of each lane captured by the camera is sent to the processor. The processor then processes these images using Image processing techniques to obtain the density of vehicles in each lane.

Here a pre-trained model YOLO is used to perform the basic task of object detection, and correspondingly the count of the vehicles is stored in order to process further request of signal processing. Now the captured image will be passed to the model for vehicle detection purpose followed by vehicle counting process. This whole process of capturing image and detection will be repeated for all four sides of the road using one single camera. The captured image is then passed to a filter where the region is defined in terms of height and width, only vehicles present in that predefined region are detected and counted. This regions size remains constant for all image being captured. Open-CV is the library that plays important role in object detection, also as and when the object gets detected it forms a rectangular box around the object, so that one can even visually verify that
the object detected as vehicle is actually a vehicle only.

The model also detects if an ambulance is present, this data with the density of vehicles is sent to the microcontroller. Based on this data, the microcontroller sets the LED's such that the lane with high density of vehicles is allowed to pass the traffic signal. Also, the spot is continuously monitored for accidents. If any accident occurs, the microcontroller detects this using the vibration sensor. Immediately the microcontroller sends an message containing the location of the spot which is preset, to the nearest health care center.

VII. OBJECT DETECTION

7.1 Convolutional **Neural Network (CNN):**

CNN is mainly used for image recognition and image classifications. In CNN image classification takes an input image, process it and classify it under certain categories. CNN is an another type of neural network that can be used to enable machines to visualize things and perform tasks such as image classification, image recognition and object detection etc. Image classification is the task of taking an input image and outputting a class (car, bike, truck, etc) or a probability of classes that best describes the image. CNN is specialized type of neural Network model designed for working with image data.

A computer should differentiate between all the images it is given. For that computer perform image classification by looking for low-level feature such as edges and curves then building up to more abstract concept through a series of convolution layer. In CNN the input image pass through a series of convolution layer and, pooling (down sampling) layer and fully connected layer and finally produce the output which can be simple class or probability of classes at best describes the image.

Convolutional layer performs an operation called a convolution, hence the neural is called convolutional neural network. It extracts features for the input image. Convolution is a linear operation that involves the multiple of a set of weights with the input.

Figure 2 shows the neural network with many convolution layer. Initially give the different input images to neural network, each image is classified into 2 hidden layers. In the first hidden layer convert all RGB image to Gray scale image and in second layer Gray scale image matches with the expected image.

7.2 YOLO — You Only Look Once:

YOLO or You Only Look Once is an object detection algorithm much is different from the region-based algorithms which seen above. In YOLO a single convolutional network predicts the bounding boxes and the class probabilities for these boxes as shown in **fig.3**.

YOLO works by taking an image and split it into an SxS grid, within each of the grid we take m bounding boxes. For each of the bounding box, the network gives an output a class probability and offset values for the bounding box. The bounding boxes have the class probability above a threshold value is selected and used to locate the object within the image. Non-Maxima suppression is used to remove multiple detections.

YOLO is orders of magnitude faster (45 frames per second) than any other object detection algorithms. The limitation of YOLO algorithm is that it struggles with the small objects within the image.

Output:

The count of vehicles in an is obtained successfully. The snapshot of the output is as shown **fig.4**. The image in the left is the output of the object detection using the YOLO model, where the vehicles detected are bounded by bounding boxes and labeled with their class names and confidences.

VIII. HARDWARE IMPLEMENTATION

The counts of vehicles in each lane are sent to the microcontroller, based on the lane with maximum count or if any ambulance id detected, the microcontroller sets the traffic LEDs accordingly. The vibration sensor and Wi-Fi modules are interfaced to the microcontroller. At any time if the value from the vibration sensor is higher than the threshold meaning that an accident has occurred, the microcontroller sends a message to the nearest health center with its GPS location using the Wi-Fi module.

IX. ADVANTAGES

- It avoids problems that usually arise with present traffic control systems.
- This Segmentation technique deals with a multi-vehicle, multi-lane, multi road junction area.
- Power issues can be resolved with the use of renewable sources

X. LIMITATIONS

- System failure may occur due to tampering
- System failure may also take place in the absence of power to the entire unit attached to the vehicle.

XI.FUTURE SCOPE

To make the system fully automatic and in future, multi-view tracking can be implemented using multiple cameras. Multi view tracking has the obvious advantage over single view tracking because of wide coverage range with different viewing angles for the objects to be tracked. For Night time visual tracking, night vision mode can be installed as an inbuilt feature in the CCTV camera.

XII.CONCLUSION

This system aims to fix the problem of traffic which most of the cities in urban as well as rural areas are facing with the help of this project wherein the focus would be to minimize the vehicular congestion. The trained model can be used for efficient traffic flow without creating much chaos on the road. The model may take comparatively more training time but the response time will be less and thus flow of traffic is smooth on the road.

This system also provides accident monitoring to take immediate action to help the accident victims by sending a message and thus requesting immediate help from the nearest hospitals. Also, it continuously monitors to clear the traffic lane for ambulances and thus help the patients reach hospitals as quick as possible without any delay due to traffic and be able to get the immediate treatment and required care.

XIII. Figures

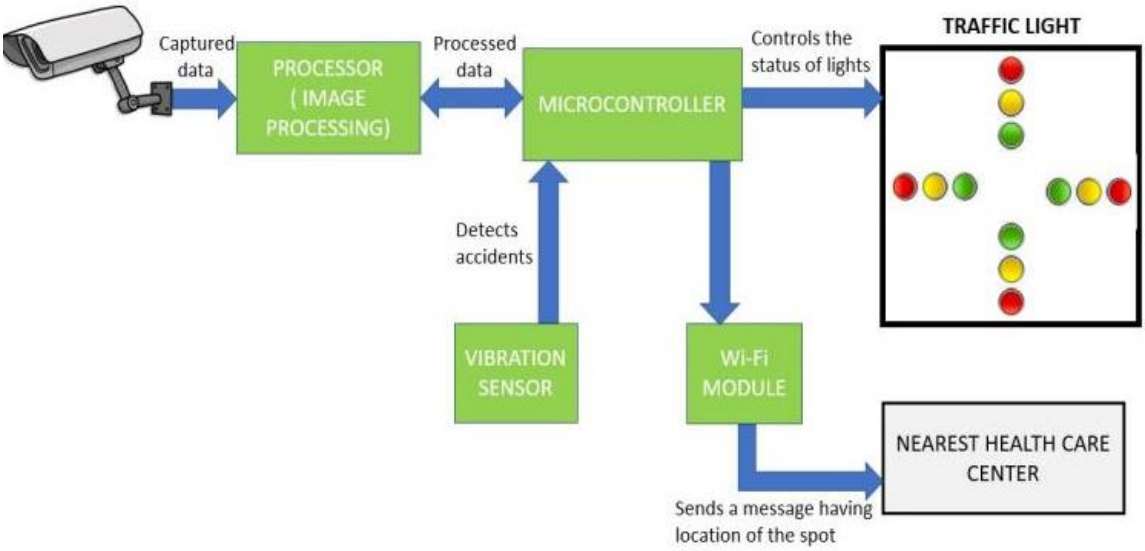

Figure 1

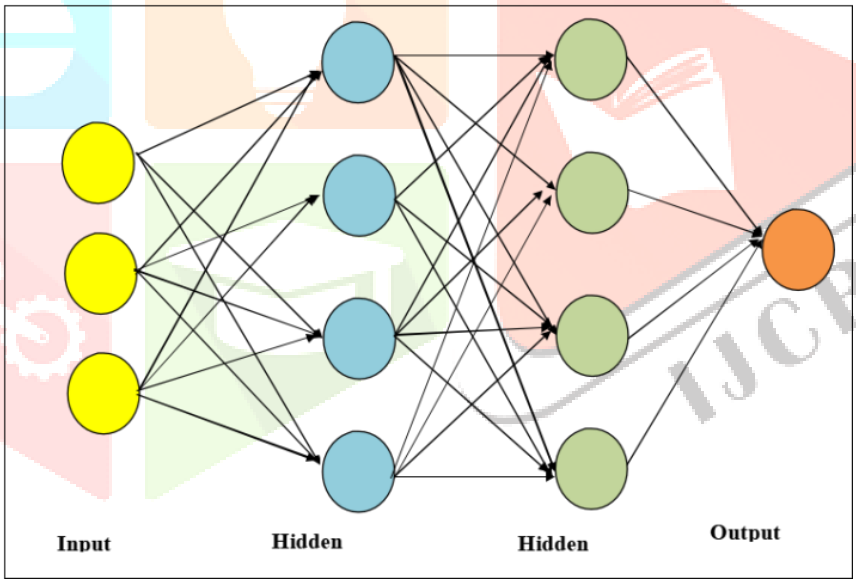

Figure 2

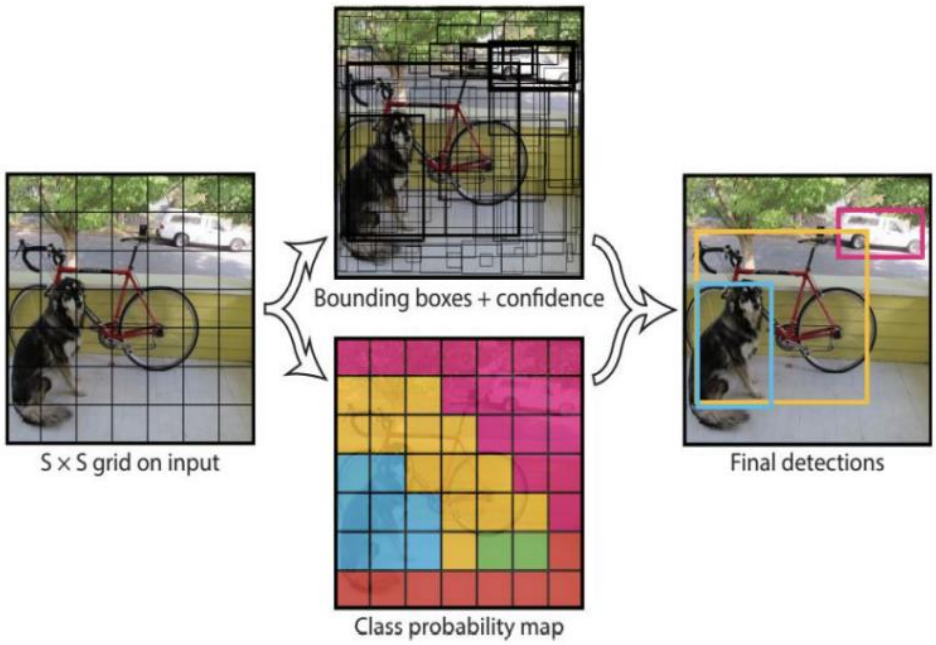

Figure 3

Figure 4

XIV. REFERENCES

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