ADAPTIVE TRAFFIC SIGNAL CONTROL FOR EFFICIENT VEHICLE MOVEMENT

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Abstract: Nowadays, we see that Traffic has become a major issue in our country and in many places. We need smart traffic management systems, so that we can avoid huge lines of vehicles and save our time. Traffic light control system was made to control and track the movement and flow of vehicles through the road junctions from all directions. Thus, we get smooth motion of cars, bikes, etc. on transportation routes.

However, synchronization of many traffic light systems at adjacent intersections becomes complicated and thus leads to more traffic. At adjacent junctions, more parameters are involved to track traffic. The mutual interference between adjacent traffic light systems and pedestrian crossing and cars flow with time and accidents are not implemented in existing system. This causes congestion and traffic jam.

We propose a system based on ARM and integrated Camera which evaluates traffic density using Image Processing. Moreover, a portable device controller device has been designed to solve the problem of emergency vehicles stuck in overcrowded roads.

Keywords: Smart traffic management system, traffic control automation, image processing, image segmentation, congestion detection,

I. INTRODUCTION

This paper proposes a system that measures traffic density by processing images captured by a camera and using a microcontroller (STM32F7 ARM Cortex processor) to manage the traffic light. It also uses STM32 Image Processing library to perform various image processing operations such as image segmentation, analyse the images and send signals to the microcontroller.

The system consists of three main components: a camera, a microcontroller, and a traffic light system. The camera captures images of each lane at a junction and sends them to the microcontroller. The microcontroller uses digital signal processing features onboard the chip to perform image processing and detect congestion on the respective roads. The microcontroller then decides appropriate timings for individual traffic signals.

This system improves traffic flow and reduce congestion by adjusting the traffic light duration according to real-time traffic conditions. The system is cost-effective, easy to implement, and adaptable to different scenarios.

1.1 Aim

To make use of advanced Technology to make daily life issues more easier by designing intelligent traffic control system. Traffic issues are major concern and we aim to build intelligent system to reduce this issue to some extent by managing waiting time for vehicles and smooth flow of cars, buses, etc and thus avoid traffic congestions.

1.2 Objective

The objective behind the project is to regulate the traffic flow by means of implementing sensors at all major traffic signals and to reduce the stoppage time. Reduce the traffic jams in order to have less traffic congestion, optimize traffic flow, pro-actively handle traffic conditions, reduce aggregate fuel wastage while waiting on traffic signals.

II. RELATED WORK

1. The model-based tracking, as proposed by Koller [1] uses a parameterized vehicle model for an intra-frame matching strategy. Initially, an image segmentation component identifies potential moving vehicles by identifying the moving features in the image.

2. The next approach is also known as region-based tracking [2] used a technique to identify connected regions in the image associated with each vehicle and tracks them. The strategy commonly uses a background subtraction technique. This approach, however, fails in congested traffic conditions when vehicles partially occlude each other, this makes the technique detect the vehicles as one large blob in the foreground image reducing the accuracy.

3. The Kalman filter-based approach [3] helps the background estimate to evolve as the lighting, time or weather of the day changes. Another approach based on Active-Contour tracking uses tracking of active contour models. This technique has a reduced computational complexity.

4. The next approach tracks sub-features in the image which can be of distinguishable importance [4]. The advantages of this approach are that even when partial occlusion occurs some of the features of the moving object are distinguishable.

5. Research work [5] and [6] used a Haar-like feature detector with good accuracy for the detection of vehicles. A Haar-like feature takes into consideration adjacent rectangular regions, sums up the pixel intensities in each region and takes the difference between these sums. This will be used to classify sections of the image.

6. Another approach uses a fuzzy logic system started by Zadeh [7]. Also, there are techniques for using Artificial Neural networks wherein decisions are made based upon the accumulated previous knowledge.

7. Finally, there are also hybrid systems as developed by Patel et al. for urban traffic control applications.

8. In their research work, Pena-Gonzalez et.al [8] invented a scheme to track vehicles in real time and thereby classify them by involving a vision-based system. An HD-RGB camera is placed on the road to acquire data. At the same time, clustering and classification algorithms are used to process information. Their method yielded an efficiency score of over 95% in test cases. Also, the system achieves 30 fps in image processing with a resolution of 1280x720.

9. Another method was applied by Bhaskar et. al [9] for-Image Processing based vehicle tracking and identification. Blob Detection methods and Gaussian mixture model are used to develop a unique algorithm which is able to track vehicle and recognize vehicle data at real-time. The proposed algorithm was a view to doing improvements. Although it is a highly efficient method, it is not enough to control the high volume of traffic congestion.

10. In the [10], [11], Ali et. al and Kanungo et. al presented an alternative approach to intelligent traffic control switching algorithm. Traffic recognition was achieved using cascade classifier for vehicle recognition utilizing Open CV and Visual Studio. A comparison is drawn between conventional traffic management and their proposed scheme.

III. METHODOLOGY

The designed method employed for the intelligent traffic control system for this case study was the use of Split Cycle and Offset Optimization Technique. This technique used was use for the signal timing optimization and also to make a series of frequent adjustment for signal timing to minimize the modeled vehicle delays of the case study. The method is developed to meet the need of today`s traffic management. Visual basic was the developed program used for designing the intelligent control system of the case study and its design analysis as a functional designed method for the specification that identifies whether a new replacement system is required. This is done so as to ensure proper accuracy, efficiency and effectiveness which is the basic of a traffic control system.

3.1 Block Diagram

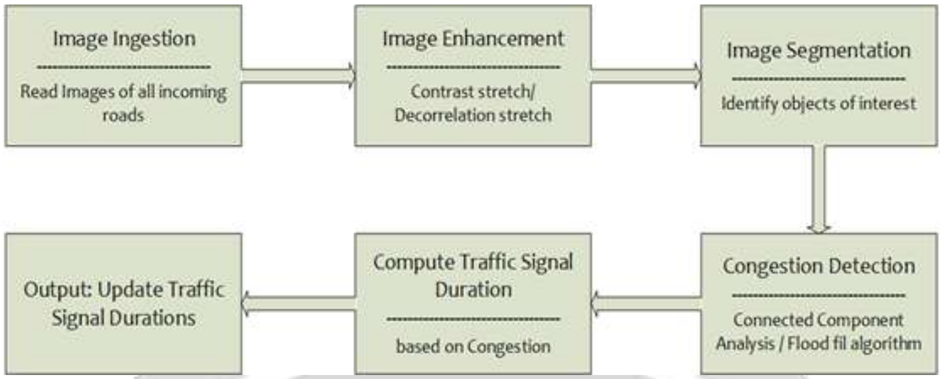

Figure 1. Complete Workflow of System

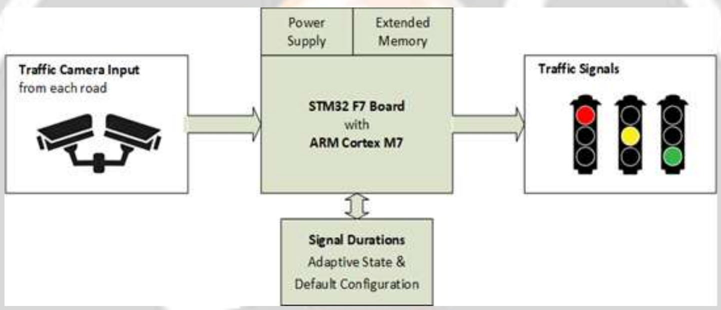

Figure 2: Block Diagram of System

3.2 Working

Following is the working of the Traffic Signal System as discussed below:

a. *Input to the system:* Images from the road using Image processing of the vehicle count present. Camera takes the input of images.

b. *Output of the system:* Update the traffic signal timings based on the image processing.

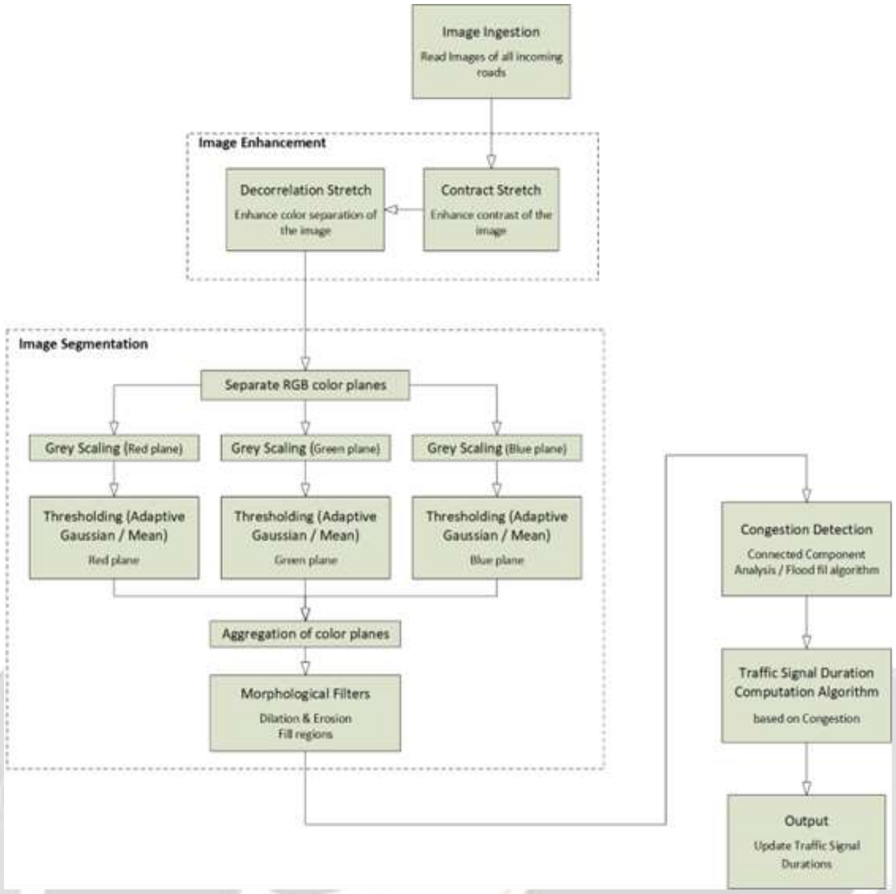

Figure 3: Workflow of entire Traffic control System

The working of this system is as follows:

1. Camera inserted near poles/roads, vehicles on the roads are captured through images and sent to ARM Cortex M7 board.

2. After the input is taken it is sent to ARM, we will enhance the image through Image Enhancement by contrast and color separation of the captured image.

3. After Enhancing the image, we will do Image Segmentation. Here, we will segregate the colors into R, G, B through Grey Scaling. We will calculate the Mean separately for each color plane and then aggregate or sum up all the color plane values.

4. We will pass the output of the aggregated color planes through Morphological Filters for sharpening the images. If we find some congestion in the image results, we will detect the congestion through Flood fill Algorithm.

5. Based on the congestion results, we will compute the signal duration based on the congestion values. Greater the value of congestion, we will have the traffic signal timing for this signal earlier.

The output of the algorithm will be sent to the traffic signal and the duration will be set respectively based on the value of congestion.

3.3 Flowchart/Algorithm

Figure 4, demonstrates the flowchart used for building this project. This flowchart helps us understand the functional workflow of the project, where steps and validations needed are checked and thus necessary next inputs and output are decided. Based on the image signal input and congestion, we will decide the traffic signal timings.

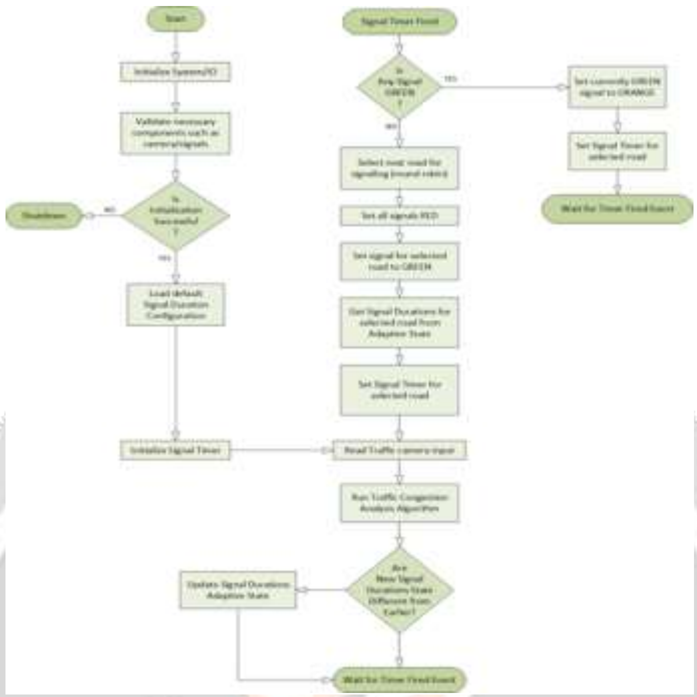

Figure 4: Flowchart of Code

IV. RESULT

As part of development, we simulated the basic modules of the proposed traffic signal controller.

Figure 4, 5 and 6 shows schematics of hardware designed for this traffic management system.

Simulation established effective use of advanced image processing techniques to accurately detect traffic congestion and its use for effectively resolving traffic congestion problems.

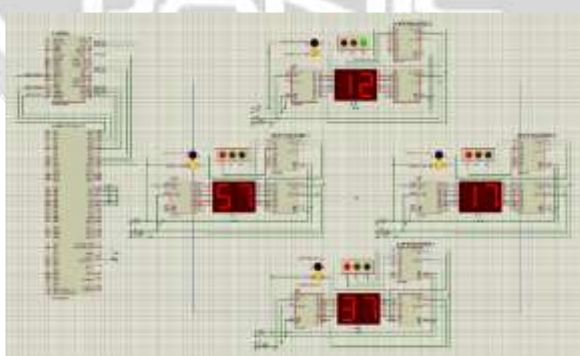

Figure 5: Snapshot of running simulation model.

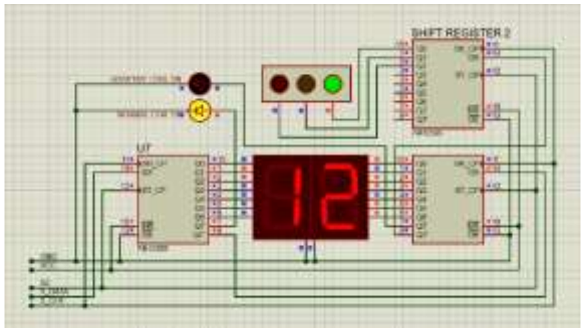

Figure 6: Signal module of simulation model

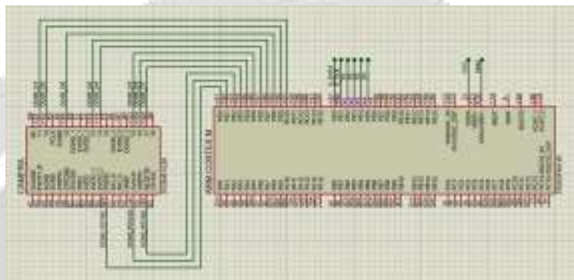

Figure 7: Signal controller module, and traffic congestion detection module.

V. CONCLUSION

Image processing is an effective technique for measuring traffic density and controlling traffic lights. Traffic congestion can be reduced by using image processing to control traffic lights. This method detects vehicles by analyzing images captured by a camera near the traffic light. It can adjust the state of the traffic light according to the traffic density and avoid wasting time on empty roads. It is more reliable and cost-effective than using sensors or timers. It uses real traffic images to estimate vehicle presence and visualize practicality.

VI. REFERENCES

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