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Image Processing Based Traffic Control System using OPENCV

Nitesh Kumar [1], Sampath Kumar S [2]

Student[1], Assistant Professor[2], Department of Master of Computer Applications JNN College Of Engineering, Shivamogga

nitishraj91088@gmail.com, sampathkumar@jnnce.ac.in

Abstract

This paper describes the development and execution of the smart traffic light management system with a microcontroller. In Pugh's case, this seems to have been a working Software model that was employed demonstrate the feasibility of a smart traffic system. It intended to adjust the traffic light because of traffic intensity on each side of the junction. Still, infrared sensors and cameras can be effective tools where they are actually reasonably applicable – in the hardware. Regarding the number of cars, image processing is utilized to estimate this number and the timings are calculated based on the proportionality of the data at a ratio of vehicle density. In this research, it is the morphological algorithm and the gaussian algorithm that were used in this research contextual analysis was not used. It also means quicker dispersion of traffic jam in terms of the number of the carriageway space available in most used highway in comparison to the least used highway.

Keywords: *Traffic Density Estimation, Vehicle Detection, Image Segmentation, Image Processing.*

1.Introduction

Most Dynamic traffic signal systems currently installed in cities today are the fixed-time or systematic systems that do not allow adaptation to the actual traffic conditions and thus result in spending a considerable amount of fuel and time. Why should a person allocate time in signalling to green light on an empty lane and make the cars on the busy lane delay for the signal to turn green? The systematic traffic system would not usually change its traffic strategy due to the environment. Time is also highly significant in the constantly changing world we live in today. There are still many countries using fixed-time or programmable traffic control systems even if they know that traffic intelligent is developing. However, the fuel that is consumed by fixed time along with programmable traffic management systems causes pollution in today's world.

This study aims to lessen driver irritation by decreasing unnecessary stops at traffic lights when there are no oncoming cars. It focuses on building a prototype with vehicle detection algorithms. Intelligent traffic control systems use technologies including infrared, radar, ultrasonic, and inductive-loop detectors also video processors to dynamically alter signal cycles based on Real-time traffic volume. These systems also have advanced features including database synchronization automated number plate recognition, collision avoidance, red light runner detection, and speed limit violations to increase the overall efficacy of traffic control.

Furthermore, it was identified that there exists considerable amount of work done on intelligent traffic control models. In this study, traffic density has been calculated by analysing image taken from video camera. The technique that we used to pass on high quality photos for later utilization is open for your personal use. Finally, we proposed the previous notion with good video samples to examine our idea. To achieve the objective of this research, this paper designed a density-based traffic system software prototype. Due to optimizing the time for each cycle to avoid a large gap between cycles, waiting time at traffic signals decreased. The method was used to compare each of them and identify the beneficial and non-beneficial outcomes that can be expected.

The primary Mission of the research is to build a self-adjusting traffic light system utilizing image processing. The efficiency of every vehicle utilizing the same time slot is decreased when uneven and irregular traffic is present in various lanes. This leads to slower moving traffic, longer travel times, and increased congestion. developing a camera and image processing module system that will enable the traffic management system to assign lane time based on traffic volume in other lanes. We have to drop the traffic light system's well-organized set cycle in order to address its shortcomings and start implementing in the ever-changing environment.

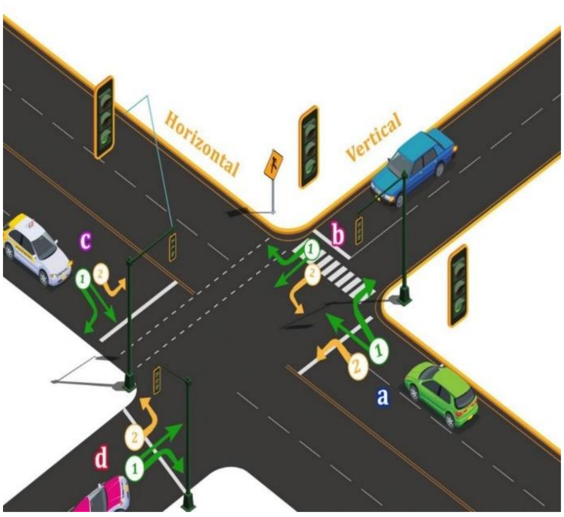

Fig 1.1: Traffic control applied in 4 lanes.

2.Literature Survey

Sathuluri et al. [1], present a concept of an intelligent traffic controlling and monitoring system that uses image analysis and Arduino technology. This study, shown in the 2016 International Conference on Control, Instrumentation, Communication, and Computation Technologies, demonstrates how managers might harness the use of image processing along with Arduino.

The infrared-based intelligent traffic system is presented by Islam et al. [2], in their article published in 2012. Proposing a distinct approach to image processing, this paper was submitted at the 2012 Conference in Informatics, Electronics & Vision (ICIEV) where the authors recommend using infrared technology to address traffic issues.

Dangi, Parab, Pawar, and Rathod [3], also contributed to the development of an image analysing based intelligent traffic controller in their undergraduate project. Available in the Undergraduate Academic Research Journal, their work focuses on the use of image analysing to develop a traffic controlling system that can learn to adapt to existing traffic trends.

In their research study, Frank, Al Aamri, and Zayegh [4], propose an IoT-based Smart Traffic Density Controlling System with the intervention of Image Processing. Their study, presented at the MEC International Conference in Big Data and Smart City (ICBDSC) 2019, concentrates on IoT with image analyzing techniques to improve the management of traffic density.

Anand et al. [5], present an advanced traffic control system using deep learning and image processing. This study, featured in the International Conference on Computing, Analytics, and Security Trends (CAST), showcases the application of convolutional neural networks (CNN) for real-time traffic monitoring and management.

Nguyen et al. [6], explore the use of machine learning algorithms in traffic signal control systems. Presented at the IEEE International

Conference on Intelligent Transportation Systems (ITSC), this research highlights how supervised learning techniques can enhance traffic signal efficiency based on traffic density analysis.

Almeida et al. [7], discuss a framework for vehicle detection and classification using image processing and machine learning. Published in the IEEE Transactions on Intelligent Transportation Systems, this study elaborates on the integration of HOG (Histogram of Oriented Gradients) features and SVM (Support Vector Machines) for accurate vehicle recognition.

Li et al. [8], propose a method for real-time traffic flow analysis using YOLO (You Only Look Once) object detection algorithm. This paper, presented at the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), demonstrates the effectiveness of YOLO in detecting multiple vehicle types and enhancing traffic control measures.

Jain et al. [9], investigate the application of background subtraction techniques for traffic monitoring. In their paper presented at the International Conference on Advances in Computing, Communications, and Informatics (ICACCI), they explain how adaptive background models can be used to detect and track vehicles in varying traffic conditions.

Wang et al. [10], utilize deep learning approaches for real-time traffic congestion forecasting. Published in the Journal of Artificial Intelligence Research, this study emphasizes the role of recurrent neural networks (RNN) and long short-term memory (LSTM) networks in predicting traffic patterns and improving traffic signal timing.

3.Proposed System

The red-light camera and traffic light controlling system were both part of the sophisticated traffic light controlling system. A computer was alerted to the intersection and was able to acquire video of all four lanes. The computer system uses the PYTHON and OPENCV algorithms to analyse each frame of the short video clip in order to determine the densities of the four lanes at the intersection. The number of identified vehicles in each lane and on all sides is recorded by the computer system. Based on these details and the proportionate traffic density, the algorithm calculates when the green light should turn on.

For video image analyzing methods, there are a variety of methods or techniques that must be followed and used. In the process of processing an image or a video, we frequently want to identify the objects displayed to perform additional analysis on them, such counting or sizing them. Identifying objects in photos requires an understanding of edges, or the lines that signify a transition from one group of related pixels in the image to another group that is distinct.

The following image analysing techniques were used in our investigation: morphological analysis algorithms and Gaussian blur.

3.1 Gaussian Blur Algorithm: The Gaussian Blur filter uses a Gaussian function to find the appropriate adjustments for each pixel in the image. This function also helps to explain the normal distribution in statistics. The image is filtered and smoothed using a Gaussian method to eliminate noise. The equation $g(m, n) = G\sigma(m, n) * f(m, n)$ (1) represents the action.

where $G(m, n)$ is the Gaussian filter defined by $G\sigma = 1 \sqrt{} 2\pi\sigma2 \exp -m2 + n2\ 2\sigma2$ (2) and $f(m, n)$ is the picture.

3.2 Morphological Algorithm: Binary picture In this circumstances a new binary picture is produced from the binary image that had undergone a morphological operation called as a morphological method wherein every pixel of the new picture contains a non-zero value only if the test that was conducted at that specified location in the initial picture is successful.

3.3 Relative Traffic Density: When it came to the green light, timing of about 5 to 30 seconds was being considered. Ratio was performed to compare traffic density and thus it set the exact time with regard to second to be given to each lane. Let I for total number of cars in each lane and 120 seconds as the base time is used.

Traffic Density=i/ (total number of cars) *120

If the value is lesser than five seconds, the lowest green signal is displayed; if the value is more than thirty seconds, the maximum green signal is displayed. If the value comes in between, then that interval of seconds is considered. Pre-processing is a technique for converting an RGB image to a grayscale image. It is accomplished with the help of luminance converter shown in the below equation.

IS=0.2896*IR+0.5870*IG+0.1140*IB

The grey level image is denoted by IS. The red, green, and blue luminance's are indicated using the letters IR, IG, and IB.

An enhanced image provides greater contrast and more detail than an unaltered photograph. Among the methods for improving the image are filters that use morphological operators like dilate, erosion, and structuring element approaches. The borders of things are shown by an image's edges. These edges are only pixels where a potential brightness shift can happen and where the behaviour of image methods of a nearby pixel is computed. Various morphological methods are used to identify objects.

We require exact information regarding the car numbers and the circumstances to stay away from the traffic problem in particular. To determine traffic density, related pixels must be searched algorithmically. The contours algorithm is used. The main ideas that follow explain the work that was completed.

The flow diagram for the proposed system as shown in the below figure; Fig 2. Thus, collecting data from four lanes to initiate the process of characterizing the flow, automobiles, tracking, and detection and the time indicating where it is necessary to switch to the adjacent lane by allocating the needed amount of time depending on the traffic density, I have described the working approach.

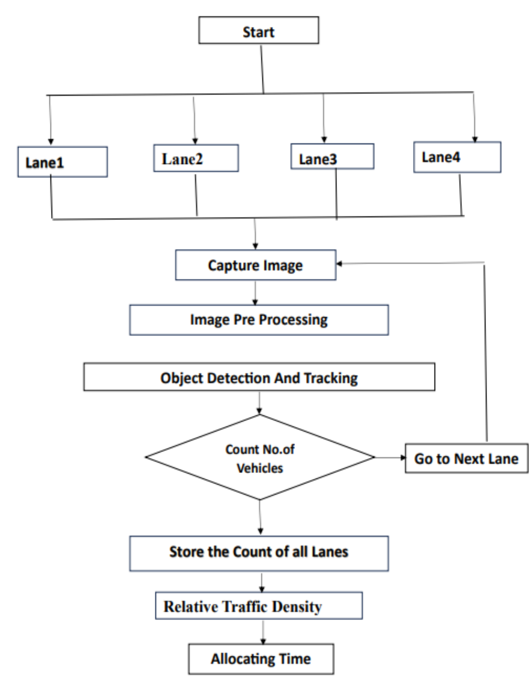

Fig 3.1. Flow diagram of the proposed system

Start: The system initialization begins here. It sets up the necessary configurations and parameters for the traffic control system.

Lane Monitoring: The system monitors multiple lanes (Lane1, Lane2, Lane3, and Lane4). Each lane is processed individually to determine the traffic density.

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Capture Image: For each lane, the system captures an image of the current traffic situation. This image serves as the input for further processing.

Image Pre-processing: The captured image undergoes pre-processing steps, which might include resizing, noise reduction, and color space conversion. These steps enhance the quality of the image for better object detection.

Object Detection and Tracking: The system uses image processing techniques to detect and track vehicles within the captured image. This involves identifying the contours of the vehicles and tracking their movements.

Count Number of Vehicles: After detecting the vehicles, the system counts the number of vehicles present in the lane. This count is crucial for estimating the traffic density.

Go to Next Lane: Once the vehicle count for the current lane is obtained, the system moves to the next lane and repeats the process of image capture, pre-processing, vehicle detection, and counting.

Store the Count of All Lanes: The vehicle counts from all lanes are stored in the system. This data is used to compare the traffic density across different lanes.

Relative Traffic Density: The system calculates the relative traffic density for each lane based on the stored vehicle counts. This helps in understanding which lanes are more congested compared to others.

Allocating Time: Based on the relative traffic density, the system allocates green light time for each lane. Lanes with higher traffic density are given longer green light durations to help alleviate congestion.

4.Results and Discussion

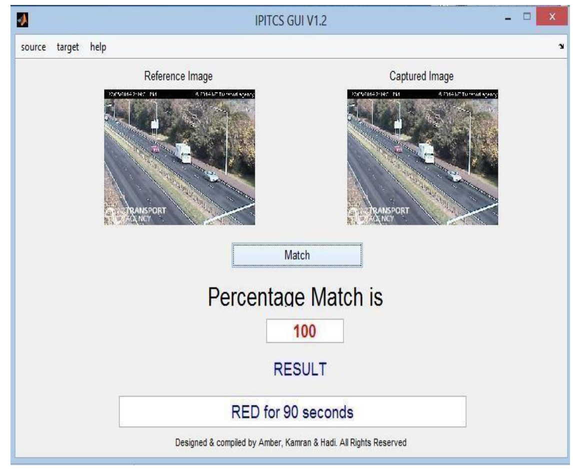

Fig 4.1: Matching between 90-100%

The picture is the output of a traffic control system that uses image processing. When a reference image and a captured image match 100% of the time, it means that the system has identified the scenario that it was designed to Consequently, while the system reacts, the traffic signal turns red for ninety seconds.

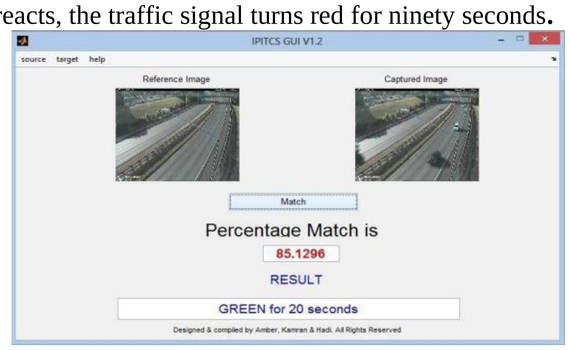

Fig 4.2: Matching between 70-90%

A partial match in an image processing-based traffic control system is indicated by a 70% to 90% match between the reference and collected images. This might trigger the system to execute a series of intermediate actions, such as adjusting the green light's timing or changing the traffic signal to yellow.

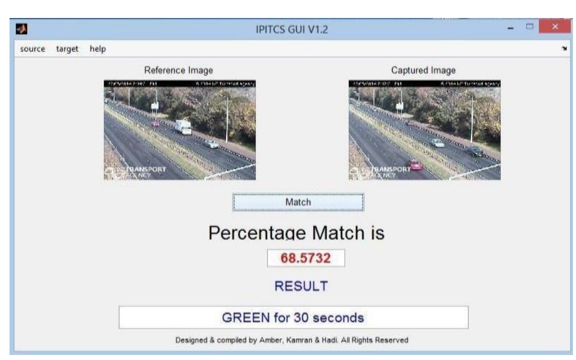

Fig 4.3: Matching between 50-70%

An image processing-based traffic management system is considered substantially similar if there is a 50% to 70% match between the reference and collected images. Safety precautions include anticipating the yellow light change or temporarily extending the current light phase may be necessary to maintain safe traffic management in response.

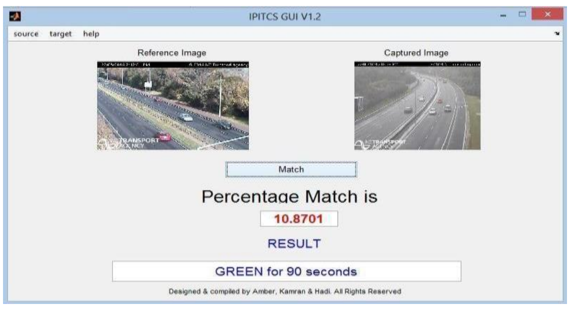

Fig 4.5: Matching less than 30%

A match of less than 30% between the reference and collected images in an image processing-based traffic control system denotes a low similarity. Due to the observed scenario's lack of considerable similarity to the reference scenario, the present traffic light phase is normally maintained.

5. Conclusion

Given the rapid population growth of our modern day, the use of vehicles has increased significantly. Heavy traffic is to blame. New communication strategies, such intelligent traffic regulation and monitoring systems based on image processing, are required to solve this problem. From the aforementioned hypothesis, we may therefore conclude that density-based traffic signal regulation can lead to smooth traffic flow and significant time, fuel, and pollution savings. It can also prevent excessive traffic congestion. This project may have a number of add-ons, such the ability to obtain internet data on cars at certain intersections, detect rule violations, and much more. Humans, the city, and the ecosystem all benefit from this. In actuality, time-based traffic light regulation is currently in use in India, which results in significant fuel loss and traffic congestion. We expect that these tactics will be implemented as soon as it is achievable to do so in order to solve the shortcomings of the current methodology. Its dependability and realism will increase with further research and use of various machine learning and image processing techniques.

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