AN INTELLIGENT TRAFFIC CONTROL SYSTEM USING MORPHOLOGICAL OPERATIONS

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Abstract: Because of an increase in the number of cars on the road in India, there is now a significant problem with traffic congestion at intersections. There is an immediate need for adaptive traffic signals that are able to perform real-time monitoring of traffic density due to the fact that the density of cars is steadily rising day by day. The purpose of this work is to present a system that employs image processing for the purpose of effectively managing traffic at a junction by obtaining photographs of the traffic at the junction. At a traffic signal, a methodical approach that includes the collecting of images, the analysis of images, and the development of an algorithm to alter the length of the traffic light according to the density of cars on various routes is used. A given picture has its number of items tallied, and the route with the most things in its path is given precedence.

Keywords: Congestion in traffic, picture processing, converting RGB to grayscale, image scaling and enhancement, edge detection, image matching, and temporal allocation.

1. Introduction

Congestion on the roads causes speeds to gradually decrease, which in turn extends travel times, raises fuel consumption and other operating expenses, and contributes to a rise in the amount of pollutants in the environment, which in turn contributes to global warming. As a result of a growth in the number of cars on the road and an increase in the number of people who need to travel for business and holiday, congestion on the roads has developed into a significant issue in recent days. It has the potential to make people stressed out and causes them to be delayed in traffic. Additionally, it lengthens the time it takes for individuals to get to their destination. Those who utilize public transportation, who are often people with lesser incomes, are the ones

who are forced to pay higher prices as a result of congestion, thus drivers aren't the only ones who have to deal with the negative effects of traffic congestion.

Another significant effect of traffic congestion is that emergency vehicles, such as ambulances and fire trucks, are unable to get at their destinations within the allotted amount of time. Because to traffic bottlenecks, people could have difficulty completing their crucial task on time. It's possible that this may result in both personal and professional setbacks. The nonstop honking of horns and general air of annoyance brought on by traffic jams both have the potential to have an effect on a person's state of mind. The government has considered a number of solutions to the issue of traffic congestion, including the imposition of parking limits and the establishment of regulations on traffic signals. The current systems for controlling traffic lights are time-based rather than reliant on the number of vehicles currently on the road. It requires human handling, which results in congestion and a lengthier amount of time spent waiting. This pause in waiting time contributes to the formation of traffic congestion as well as an increase in the production of smoke.

Therefore, the most effective way to alleviate traffic congestion is by using an image-processing-based traffic signal management system. 2. Regulation of the Traffic Lights Traffic lights are signals that are used to govern the passage of cars on the road. Their primary purpose is to keep drivers safe. Controlling the flow of traffic on the road and avoiding congestion are both possible when this traffic light is properly monitored and operated. There are three different signals that make up the traffic light at the intersection: red, yellow, and green. People are forced to wait in line until they get the all-clear signal before moving forward. Because of the congestion, waiting times are lengthened if the red signal is delayed.

Nearly every intersection in metropolitan centers and other locations that are prone to accidents and traffic congestion has a CCTV camera installed. This would make traffic maintenance easier and assist the police catch those who break the rules. We are able to compute the population density of the cars on the road with the assistance of these CCTV cameras. Image processing refers to the operation of applying certain mathematical and logical procedures to digital photographs via the use of a computer. This method regulates the signals that are shown on the road's traffic lights in order to reduce the amount of congestion that is not essential.

2. Existing Method

The traffic lights that are utilized in India are pre-timed, which means that the amount of time that each lane spends with a green signal is predetermined. When there are four lanes of traffic, the green light will only be issued to one lane at a time. Because of this, the traffic light enables cars travelling in any of the lanes to do so in the correct order. Therefore, the traffic may go forward in either a direct path or make a turn of ninety degrees, as seen in Figure 1. Therefore, even if there is the least amount of traffic in a particular lane, it still has to wait needlessly for a considerable amount of time, and when it finally gets the green signal, it needlessly causes other lanes to wait for even longer durations of time.

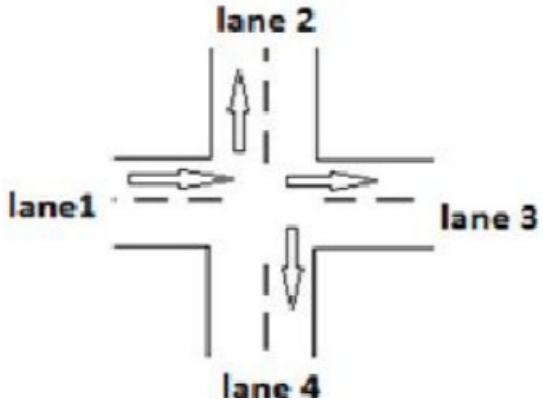

Figure 1. Lane Diagram.

Concerns Regarding Currently Employed Methods: When it comes to controlling traffic, one of the most popular methods or tactics is the use of a time-based traffic management system. However, the success of this strategy is more dependent on the passage of time than on the amount of material. Because of this, the cars are required to have a variable amount of waiting time due to the delay. In a time-based traffic management system, the cars are required to wait even when there is no other traffic on the route, which may further add to congestion or a traffic jam. The employment of sensors allows for the detection of cars and the subsequent regulation of traffic. The issue of traffic congestion may be dealt with in a more efficient manner by using a traffic light management system that is based on the image processing technology.

3. Proposed system

The cyclic time of the traffic light signals is determined by a method that is used for the control of traffic lights and is based on image processing. This method measures the traffic density on the road and, based on those measurements, determines the times at which the traffic light signals will cycle. Because of the employment of a camera of high quality in this method for the intelligent management of traffic lights, this not only solved the issue of pricey sensors but also eliminated the problem.

The following is a list of the steps that are involved:

• Image acquisition, during which an image of a traffic-free road as well as an image of a road with traffic on it are acquired; the image of a traffic-free road is preserved as a reference image.

• Conversion of both of the photos from RGB to grayscale

• Image enhancement

• Image matching via the use of morphological edge detection, which compares the edges of the reference image to those of the image with traffic on the road

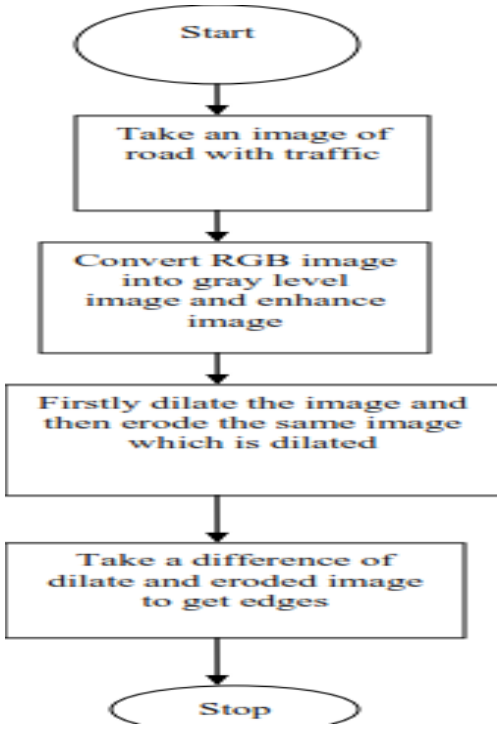

Figure 2. Flow Chart of Proposed System

Image acquisition: An image is obtained by using a webcam to record the scene. After that, it is moved over to the computer by means of a USB connection. MATLAB is used for both the initial picture capture as well as any further processing.

Figure 3: Image Acquisition Flow Diagram

Image processing: This picture was taken using a camera that was installed at the intersection of the two roads. It is able to take pictures of all of the roads that converge at the intersection where it is located. On top of the DC motor is where the camera is attached. The motor is in charge of taking pictures from all different directions at predetermined intervals of time. It is intentional that the speed of rotation of the camera be larger than the time it takes for the camera to capture an image when the shutter button is pressed. In order to proceed with the processing, the picture that was captured is transformed to greyscale. After that, the grayscale picture is changed into a binary image, which only has two colors—black and white. The picture you see here is referred to as the threshold image. The picture is thresholded in order to drastically reduce the amount of information it contains in order to make further processing more straightforward. After that, the threshold picture is enhanced so that additional image processing may take place.

Image Enhancement: During this step, the images are modified in such a manner that the final results are more suited for the processing that comes after them. When this is done, the picture that was acquired is changed into a greyscale image.

Edge detection: Edge detection is the process of finding and localising abrupt discontinuities in a picture. This technique is referred to as "edge detection." The rapid fluctuations in pixel intensities that make up the discontinuities are what define the borders of the individual objects in a picture. It eliminates unnecessary information from a picture while preserving the essential

structural components of an image. A technology called edge detection is put to use in this system that has been presented. It is first necessary to locate the borders of each picture, and then the total number of items may be determined.

Image matching: The process of edge-based matching refers to the procedure in which two representatives (edges) of the same object are combined into a single whole. When comparing and analysing two images, any edge or its representation on one image is judged in relation to all of the edges on the other image.

- Matching between 10 and 50 percent, with the green light staying on for a full minute.
- Matching between fifty and seventy percent, with the green light on for a full thirty seconds
- Matching between 70 and 90% of the time, with the green light staying on for 20 seconds.
- Matching between 90 and 100 percent, with the red light on for a full minute and a half

4. Results of the Simulation

This section provides a description of the simulation results that have been evaluated using a variety of traffic images. Every single one of the experiments was carried out in the MATLAB 2016a version.

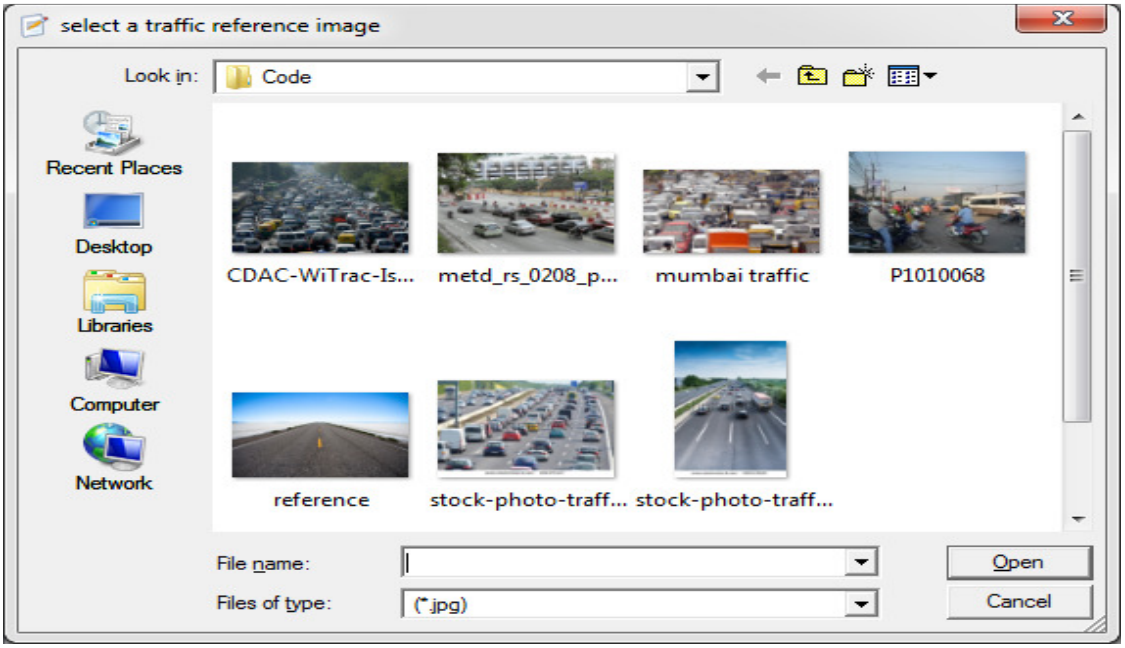

Figure 4. Select a reference image

Figure 4 shows the selection process of reference image. Here, reference is a colour image, which is anempty road, no traffic, and no vehicles.

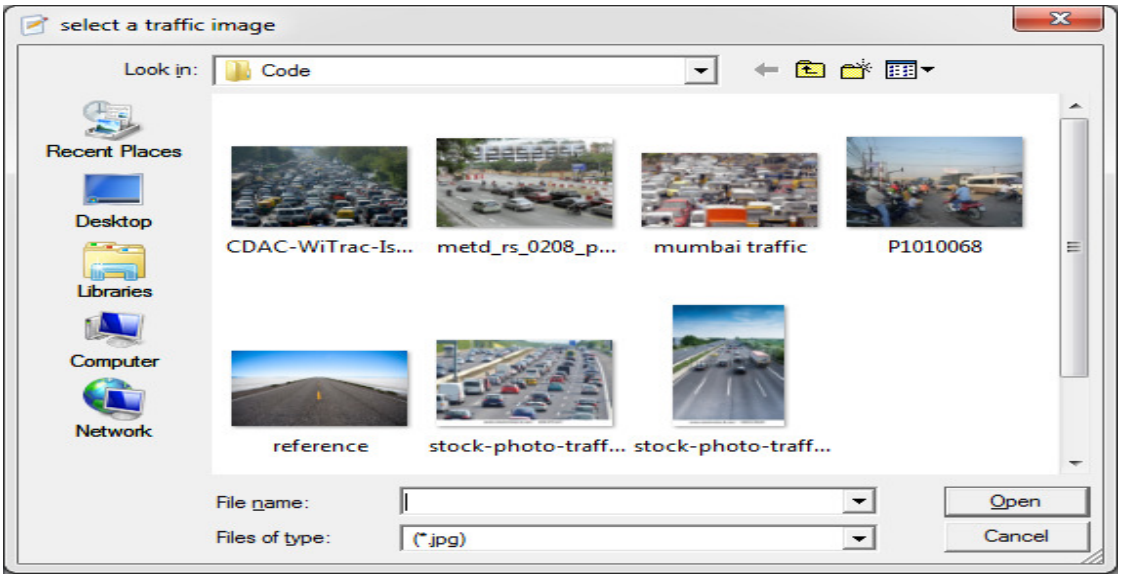

Figure 5. Select a traffic image

Figure 5 shows the selection process of traffic (road)image. Here, source image is a colour image, which can be either high traffic, low traffic, and no traffic.

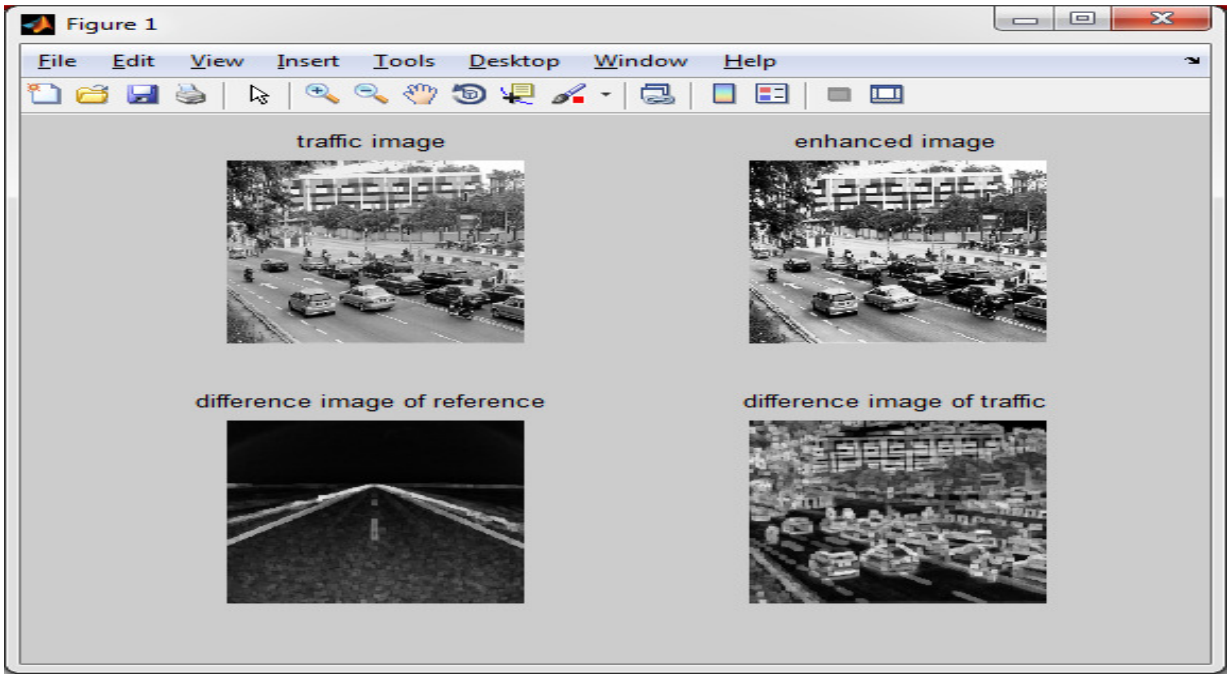

Figure 6. Enhanced and difference images after morphing.

Figure 6 shows the enhanced versions of traffic image and reference image. Figure 6 (a) shows the traffic image, Figure 6 (b) shows the traffic enhanced image,Figure 6 (c) shows the difference image of reference, and Figure 6 (d) shows the difference image of traffic.

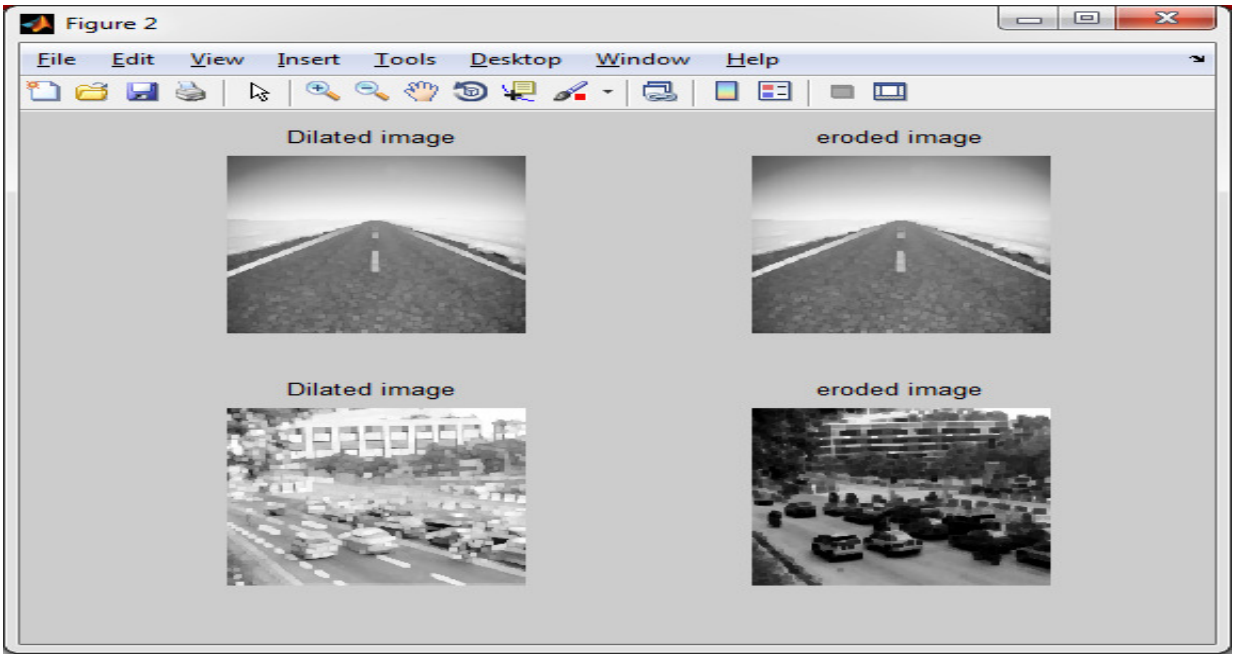

Figure 7. Morphological processed images.

Figure 7 shows the morphological versions of traffic image and reference image. Figure 7 (a) shows the dilated version of no-traffic image, Figure 7 (b) shows the erode version of no-trafficimage, Figure 7 (c) shows the dilated version of traffic image, and Figure 7 (d) shows the erode version of traffic image.

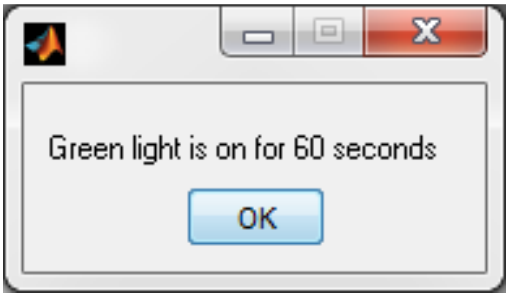

Figure 8. message box to display number of seconds.

Figure 8 shows the output response, which resulted in outcome as green light on for 60 seconds. Table 1 shows the performance of proposed method, where proposed method resulted in accuracy, sensitivity, specificity, precision, recall, F1-score as compared to existing method.

Table 1: Performance comparison

Metric	Existing Method	Proposed method
Accuracy (%)	89.23	98.273
sensitivity	78.347	99.23
specificity	76.56	99.09
precision	82.44	99.28
recall	80.34	99.45
F1-score	92.35	99.374
Loss	97.345	12.34
False acceptance ratio	93.49	25.44
False rejection ratio	98.34	72.3

5.Conclusion

According to the findings of the research, image processing is an effective method for controlling the transition between states of the traffic signal. It demonstrates that it is possible to lessen the congestion in the roads and prevent the squandering of time caused by a green light on an empty road. Because it analyses real-world traffic photos, it also has a more reliable detection rate for the presence of vehicles. Because it is able to visualize the reality, it performs significantly better than other systems that are dependent on the detection of the metal content of the vehicles. The system as a whole is excellent, but it still has some room for development in order to obtain an accuracy rate of 92%.

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