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Traffic Controlling System

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Abstract: In the present era, the population of people living in cities and the number of vehicles on the road is growing by the day. The necessity to govern lanes, thruways, and streets has become a significant concern as the urban population and, as a result, the number of vehicles has grown. Today's traffic framework places minimal emphasis on real-time traffic conditions, resulting in inefficient traffic management systems. Therefore, to overcome such limitations or drawbacks of the present system, the current research proposes a smart and efficient traffic management system that can analyze real-time traffic and take appropriate action. This is achieved by the application of an image processing technique, that would capture the real-time pictures of the paths to compare with the reference image of the path. The evaluation matrix is created to decide the amount of time each light must be on. In addition, an evaluation matrix is created. The purpose of the evaluation matrix is to determine how long each light must be turned on. The MATLAB 7.8 was used to perform the study.

I. INTRODUCTION

The flow of people and things from one area to another is referred to as traffic. Except for foot mobility, which requires just human force, all movement necessitates the use of a vehicle of some kind that can transport people, cargo, or both. Road, rail, aviation, and maritime vehicle types, also known as modes of transportation, can be widely classified. The desire to move people and things from one site to another drives traffic evolution. As a result, people decide to transport themselves or others from one site to another in order to participate in activities at the second location or to relocate commodities to a location where their worth is higher. Because traffic flows are essentially governed and determined by rules of human behavior, they vary fundamentally from other disciplines of engineering and the physical sciences. While physical characteristics are important in the operation of all modes, the desire to shift locations drives the demand or need to travel that leads to traffic [1].

One of the most difficult aspects of traffic control is accommodating traffic in a safe and effective manner. Efficiency can be conceived of as a measure of movement levels in relation to a transportation system's aims and the funds necessary to operate it. Another important purpose for traffic control is safety, which involves managing traffic to decrease or eliminate accidents. The multiple objectives, on the other hand, frequently clash or, at the very least, compete. The present study only focuses on road traffic systems. In road traffic, Intersections with traffic lights (green, amber, and red indications) will frequently include a separate lane with an illuminated green arrow to allow left turns with no opposing traffic. This frequently leads to extended non-green periods at the crossing, resulting in higher delays and decreased efficiency and mobility. The task of traffic control will always be to balance the often competing aims of safety and mobility [2].

Any transportation system's safe and effective operation relies heavily on traffic control. A traffic management system’s component includes detailed operational procedures, rules and legislation, and physical devices (such as signs, markings, and lights). The operator, whether a motorist or a pedestrian in a roadway system, is at the heart of any system. While traffic control may appear to be a need to control or influence a large number of vehicles at first glance, it is important to remember that traffic is made up of a large number of individual operators who must all make consistent decisions in order for the systems to function safely and efficiently [3].

The layout of streets to suit a variety of travel needs in a region is referred to as road traffic control at its widest level. Highways or expressways move high-speed traffic across cities; arterial streets transport traffic inside and between cities; and local streets give low-speed transit but access to a variety of local locations. The base upon which traffic control problems develop is a hierarchy of streets that perform at varying speeds and allow different levels of access. Inadequate road planning, which results in an insufficient number of roadways to suit travel needs, is a typical cause of long delays and numerous accidents [4].

Traffic congestion has become a big problem in modern life, and it is becoming a stumbling block by the day. The main causes of increased automotive overload are not only an increase in the number of vehicles but also a lack of infrastructure and unreasonably wide distribution of improvements. The main cause of automobile overload is a large number of vehicles present in most metropolitan urban settlements, which arose because of population growth and the expansion of municipal limits. To address this problem, government officials should strongly encourage people to use open transportation, such as buses or small vehicles such as bicycles, or boost personal vehicle taxes to keep the number of personal automobiles in check.

In several Asian countries, such as Vietnam, local government experts have approved laws restricting the number of vehicles that can be owned by a family. The procedures stated above are effective, however, they are not entirely recommended. Inadequate infrastructure, particularly at road intersections, can't handle the traffic, which is also a major factor [5].

Even if open transportation services are accessible, they are often of poor quality, particularly in developing nations. Furthermore, the parkway and streets are inadequate and insufficient to meet the basic requirement of increasing the number of vehicles. Rather than chiseling away at roadways to accommodate growing traffic, several techniques have been devised to lessen traffic on streets, such as the use of embedded controllers. However, until the last decade, the traffic control system at the signal junction was ineffective. The standard traffic control systems are briefed in the next section. In the later part of the article, the study of an efficient control system of traffic congestion is addressed using the image processing technique. Moreover, the application of edge detection technique is also made in the present study [6].

II. TRAFFIC CONTROL SYSTEM

A. Manual Controlling System

The name itself suggests the meaning of the term “Manual controlling” i.e., controlling traffic necessitates the use of human resources. Depending on the nation, traffic officers are assigned to a specific area or city to maintain traffic management. To control traffic, traffic officers will carry a signboard, a sign light, and a whistle. To control traffic, they will be required to wear certain uniforms.

B. Automatic Controlling System

Timers and electrical sensors are used to regulate the automatic traffic light. A consistent numerical number is fed into the timer for each phase of a traffic light. As the timer value changes, the lights automatically turn on and off. The availability of the car and signals on each phase will be captured using electrical sensors, and the lights will automatically turn ON and OFF depending on the signal [7]. More manpower is required in the manual regulating system. It is very difficult to manually manage traffic in all areas of a city or town since there is the scarcity of traffic officers. As a result, the requirement of effective traffic control is mandatory. Automatic traffic light control, on the other hand, employs a timer for each phase. Another approach for detecting vehicles and producing signals is to use electronic sensors. However, a green light on an empty road wastes time in this method. When using electrical sensors to control traffic, there was also traffic congestion [8].

III. IMAGE PROCESSING TECHNIQUE

Image processing is a technique for enhancing raw photos acquired from cameras/sensors aboard space probes, planes, and satellites, as well as pictures captured in everyday life, for a variety of purposes. During the previous four to five decades, many approaches in Image Processing have been created. The majority of the techniques were created to improve photographs captured by unmanned space probes, spacecraft, and military surveillance aircraft. The important aspects of the technique are explained in this section.

A. Acquisition of Image

An image is a two-dimensional function f(x,y) in general (x and y are plane coordinates). The amplitude of a picture at any point, say f, is referred to as the image's intensity. It's also known as the picture's grayscale at that point. To create a digital image, we must convert these x and y data to finite discrete numbers. A fundus image from the gaze and drive databases is used as the input image. The retinal image is taken for processing and to evaluate the person's condition. We must transform the analog image to a digital image to process it on a computer. Each digital image is made up of finite elements, each of which is referred to as a pixel [9].

A sensor captured the image in this case. The sensor here is a photodiode. The silicon substance is used to make the sensor. Light is proportional to the sensor's output voltage waveform. With a single sensor and displacement in both plane directions, we can obtain a 2-D image. The setup here is for high-precision scanning, with the film negative mounted on a rotating disk. This mechanical rotation results in displacement only in one direction. Because it provides motion in a perpendicular direction, a sensor positioned on a lead screw is employed. We can effectively regulate mechanical motion and generate high-resolution photographs using this technique. To give an image in both directions, the sensors are organized as strips. The strip displays the image in one direction, while motion handles the perpendicular direction. In airborne imaging, this technology is quite effective. During the flight, the arrangement is fastened to aircraft. One-dimensional imaging sensor strips that respond to different bands of the electromagnetic spectrum are perpendicularly mounted to generate a 2-D image [10].

B. Formation of Image

The criteria for producing an image f(x,y) are proportional to the energy radiated by a physical source as image values. Therefore, f(x,y) must be finite and non-zero. The condition in the mathematical form can be represented as $0 < f(x,y) < \infty$.

C. Image Generated by Reflection

There are two components to the function f(x,y).

1) The illumination components, or the quantity of source illumination incident on the scene being observed, are denoted by i(x,y).
2) The amount of light reflected by the elements in the picture, also known as reflectance components, is indicated by the letter r(x,y).

The image can be generated by the product of the intensity i.e.,

$$f(x,y)=i(x,y)r(x,y) \quad (1)$$

$$0< i(x,y) < \infty \quad (2)$$

$$0< r(x,y) <1 \quad (3)$$

The nature of i(x,y) is defined by illumination, while the nature of r(x,y) is determined by the imaged object's characteristics [11].

D. RGB to Gray-scale Conversion

Color is perceived by humans through cones, which are wavelength-sensitive sensory cells. Cones are divided into three types, each with different sensitivity to electromagnetic radiation (light) of various wavelengths. Greenlight is most responsive in one cone, red light in the other, and blue light in the third. We can make practically any observable hue by generating a limited combination of these three colors (red, green, and blue) and thereby stimulating the three types of cones at will. This is why color images are frequently saved as three different image matrices: one for storing the amount of red (R) in each pixel, one for storing the amount of green (G), and one for recording the amount of blue (B). RGB images are color images that are stored in a specific format [12].

However, in grayscale photos, it is not differentiated that how much of each color it does emit; instead, it emits the same amount in each channel. We will be able to distinguish the total amount of radiated light for each pixel; small amounts of light produce dark pixels, while large amounts of light produce bright pixels. When transforming an RGB image to grayscale, we must consider the RGB values for each pixel and output a single number that reflects that pixel's brightness. One method is to aggregate the contribution: (R+B+C)/3. However, because the green component generally dominates perceived brightness, a different, more "human-oriented" way is to use a weighted average, such as 0.3R + 0.59G + 0.11B. Figure 1 shows the conversion of RGB image to Grayscale image [13].

Figure 1: Conversion of RGB image to Grayscale

E. Image Enhancement

The practice of modifying digital photographs such that the results are more suited for display or further study is known as image enhancement. You can, for example, remove noise, making it easier to detect the main traits. The algorithms in the image enhancements used are Contrast-limited adaptive histogram equalization (CLAHE), Decorrelation stretch, Histogram equalization, Linear contrast adjustment, Median filtering, Unsharp mask filtering, and Noise-removal Wiener filtering [13].

F. Edge Detection

Edge detection refers to a set of mathematical approaches for recognizing points in a digital image where the brightness of the image abruptly changes or, more technically, where there are discontinuities or noise. The sharp changes in image brightness are usually grouped into a collection of curved line segments called edges. Step detection is the problem of recognizing discontinuities in a 1D signal, and change detection is the difficulty of finding signal discontinuities over time. In image processing, machine vision, and computer vision, an edge detection is a fundamental tool, especially in the fields of feature reveal and feature extraction. Figure 2 depicts the edge detection image from MATLAB [14].

Figure 2: Edge detection image

By default, edge in MATLAB employs the Sobel method to detect edges, although the following table lists all of the edge-finding methods that are supported by various functions.

G. Matching of Image

The method of pairing two representatives of the same object is known as edge-based matching. Any edge or representation on one image is compared to and evaluated against all edges on the other image. The Canny operator was used to detect the edges of the reference and real-time images. After that, these edge-detected photos are matched, and the traffic light durations can be set accordingly [12].

IV. METHODOLOGY AND RESULT

Figure 3 demonstrates the flow chart of the work. All the terms termed in the flowchart such as Reference image, RGB to Gray conversion, image resizing, image enhancement, edge detection, image matching, and timing allocation are explained in section 3. The USB-based camera and a general-purpose Personal Computer (PC) were used as the hardware requirement. Whereas, for software, MATLAB 7.8 (version) was utilized. The interfacing was done using the parallel port of the PC.

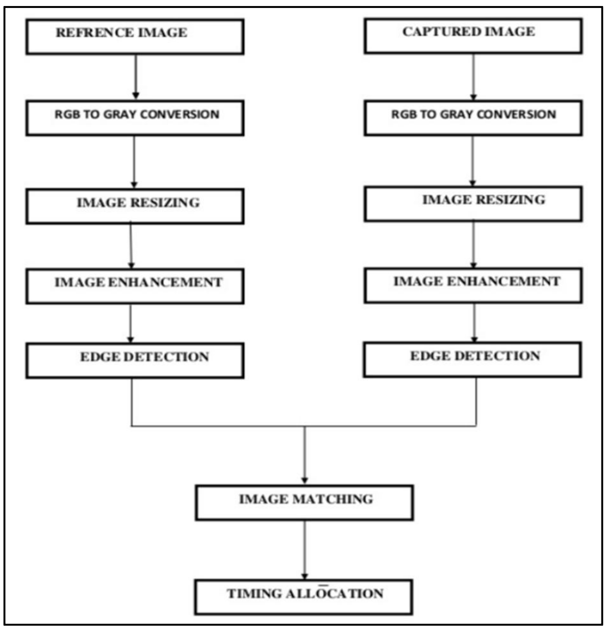

Figure 3: Flow Chart

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A. Evaluation Matrix

The evaluation matrix was created. The mathematical representation of the evaluation matrix is depicted by equation 4 percentage matching (%) = (Number of pixels matched/total no of pixels) *100 (4)

B. Time Allocation

The time allocation considered is as follows:

1) If the matching is between 0-30% - Green Light is on for 90 seconds
2) If the matching is between 30-50% - Green Light is on for 60 seconds If
3) the matching is between 50-70% - Green Light is on for 30 seconds
4) If the matching is between 70-90% - Green Light is on for 20 seconds
5) If the matching is between 90-100% - Green Light is on for 60 seconds

C. Reference Image and Captured Image

Figure 4 (A) depicts the gray image of the reference image, whereas figure 4 (B) demonstrates the image after edge detection. Moreover, figure 5 (A) represents the gray image of the captured image, whereas figure 5 (B) shows the image after edge detection.

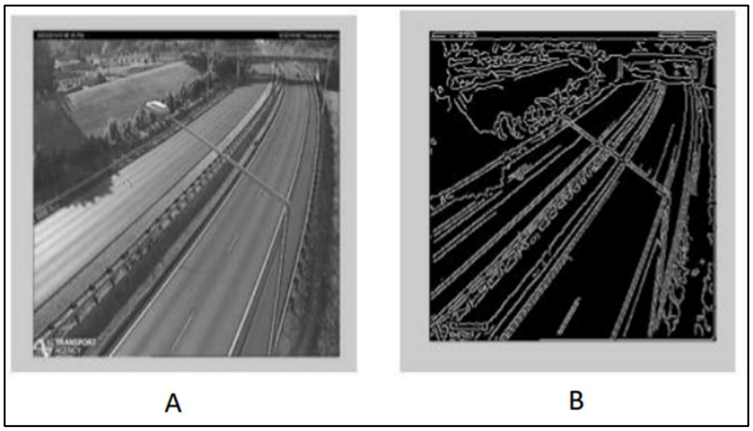

Figure 4: A: Gray image of the reference image, B: Image after Edge detection

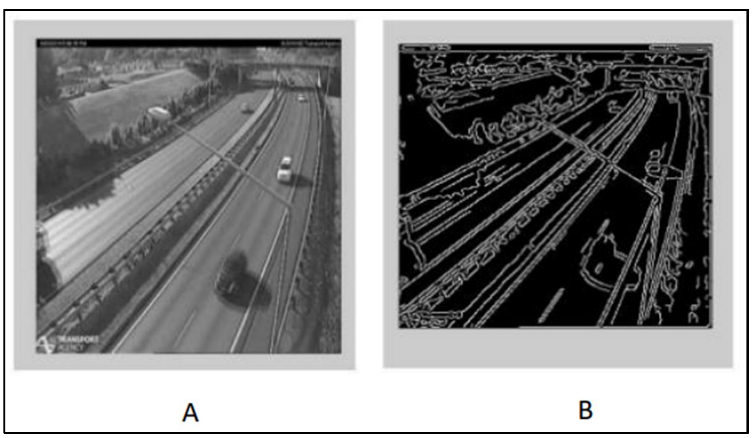

Figure 5: A: Gray image of the captured image, B: Image after Edge detection

V. CONCLUSION

The present study over traffic control utilizing image processing system employs image processing techniques to usher in a new era of traffic management that decreases traffic congestion and delays for people. This technology eliminates the need for humans to control and maintain traffic. It detects traffic using effective edge detection methods and hence addresses all of the previous techniques' drawbacks and limitations. It gives users an alternative to the prior ways, which wasted time due to a green light on an empty road. The project eliminates the need for additional hardware such as sensors, making it very inexpensive. The fluctuation in signal timing, which is managed correctly by the traffic density using Image Matching, is a major benefit.

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