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DENSITY BASED SMART TRAFFIC CONTROL SYSTEM USING CANNY EDGE DETECTION

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ABSTRACT

The need for state-of-the-art equipment and technology to enhance traffic management is become more pressing as the problem of urban traffic congestion deteriorates. empirical evidence has shown that the traditional methods, such as timers and human control, are inadequate in effectively tackling this problem. The present study introduces a traffic control system that employs digital image processing and intelligent edge identification to enable real-time measurement of vehicle density. In contrast to earlier systems, this high-performance traffic control system offers a significant improvement in response time, automation, vehicle management, reliability, and overall efficiency. Furthermore, the whole process, including picture collection, edge recognition, and green signal allocation, is documented with suitable schematics and validated by hardware implementation using four illustrative images of different traffic situations.

I. INTRODUCTION

An undeniable challenge confronting modern major cities globally is the problem of traffic congestion. A recent study conducted by the World Bank reveals that the average speed of vehicles in Dhaka has decreased from 21 km/h to 7 km/h throughout the last decade [1]. Analysis carried out in urban areas suggests that traffic congestion hampers the growth of county gross product or the increase of employment in metropolitan regions, therefore reducing regional competitiveness and causing economic activity to be redistributed [2].The existing traffic system is experiencing more congested conditions as a result of the introduction of additional vehicles. Efficient use of the current infrastructure requires the immediate implementation of a novel traffic management system using cutting-edge technologies. Although the construction of new roads, flyovers, elevated expressways, etc. requires extensive deliberation, financial resources, and time, it is more prudent to prioritize the optimization of existing infrastructure. Previous studies proposed many techniques, such as induction loops and infrared light sensors, for gathering traffic data. Nevertheless, each approach had limitations. Employing closed-circuit television (CCTV) footage placed along the traffic signal, image processing has demonstrated encouraging outcomes in recent years for the capture of real-time traffic

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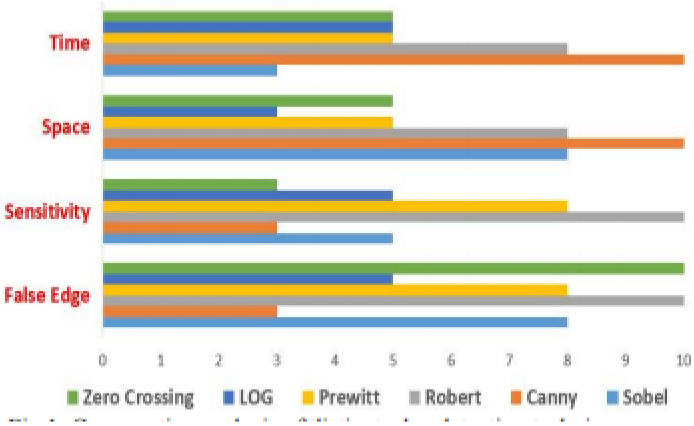
information. Several techniques have been proposed to get traffic data. While some algorithms are designed to calculate the quantity of automobiles [4-6], others are designed to maintain a count of the entire number of pixels [3].Results of using these methods to get traffic data are promising. However, in cases where the distance between cars is extremely little, two vehicles in close proximity to each other might be considered as a single unit. Furthermore, the calculations of the number of vehicles may exclude rickshaws and autorickshaws, which are prevalent modes of transportation, especially in South Asian nations. Moreover, the presence of intangible entities such as cars, pathways, or people presents limitations in the process of pixel counting. Several studies have proposed the allocation of time only based on traffic density. Nevertheless, people occupying lanes with lower traffic may have negative consequences as a consequence of this situation. Effective extraction of traffic information from CCTV footage requires the use of edge detection technologies. This technique may be used to extract the essential information from the rest of the image. Numerous techniques exist for the detection of edges. Differences exist among them in terms of noise reduction, detection sensitivity, accuracy, and other factors. Prominent operators among them are Prewitt [7], cunning [8], Sobel [9], Roberts, and LOG. The Canny edge detector has been seen to provide improved accuracy in object recognition with higher entropy, PSNR (Peak Signal to Noise Ratio), MSE (Mean Square Error), and execution time when compared to Sobel, Roberts, Prewitt, Zero crossing, and LOG parameters [10–12].Presented below is a comparative analysis of several edge detection techniques.



India has the second-largest population globally and the fastest growing economy. Its urban areas are facing significant difficulties with traffic congestion. Financial and geographical constraints hinder the pace of infrastructure growth compared to the growth in the number of automobiles [1]. Furthermore, the traffic in India is disorderly and not organized according to lanes. It necessitates traffic management techniques that are distinct from those used in affluent countries. The adverse

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impacts of congestion may be reduced by the use of sophisticated traffic flow management. Given their cost-effectiveness, wireless networks have gained popularity in road transportation in recent years [2]. The use of technologies such as RFID, GSM, and ZigBee may provide cost-effective options for traffic management. Radio Frequency Identification (RFID) is a wireless technology that transfers data between an RFID tag and RFID reader by using radio frequency electromagnetic energy. Although many RFID systems have a restricted operational range in inches or millimeters, others may reach distances of up to 100 meters (300 feet). A GSM modem is a specific wireless communication device that operates in a manner similar to a mobile phone, by accepting a SIM card and necessitating a membership to a mobile operator. Operating modems requires the use of AT commands. The instructions provided are based on the Hayes commands used by the Hayes smart modems. ZigBee devices have low power consumption and may be employed in many work setups to perform predefined job functions. ISM bands in which it operates include 868 MHz in Europe, 915 MHz in the USA and Australia, and 2.4 GHz in the rest of the world. The data transmission rates in the 868 MHz frequency range are 20 kilobits per second, whereas the 2.4 GHz frequency band achieves data transmission speeds of 250 kilobits per second [3], [4]. The ZigBee system utilizes 11 channels while operating on the 868/915 MHz radio frequency, and 16 channels when operating on the 2.4 GHz radio frequency. Furthermore, it utilizes slotted CSMA/CA and CSMA/CA, which are two channel configurations [5].

Investigation

Congestion of traffic is a significant problem in developing countries such as India. The significant rise in the number of cars in cities may be attributed to the expansion of the middle class and urban population [6]. An inherent issue in metropolitan regions is the presence of traffic congestion, which eventually results in sluggish traffic and thus increases journey durations. According to reference [7], a green wave system was implemented to allow emergency vehicles to pass by converting all red lights along their path to green. This granted the desired vehicle a complete green signal. A "green wave" refers to the synchronization of traffic lights precisely during the green period. When a vehicle is equipped with a "green wave," it will consistently get green signals while driving on the freeway. In addition to the green wave path, the system will track a stolen vehicle as it passes through a traffic light. A key advantage of the method is that the car's GPS does not need any more power. An inherent limitation of green waves is that their disruption may lead to traffic problems, exacerbated by the synchronization of the waves. Under such circumstances, the queue of vehicles in a green wave extends until it reaches an excessive length, at which juncture some vehicles are unable to reach the

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green lights in a timely manner and must come to a halt. This phenomenon is referred to as over-saturation [12], [13]. Reference [8] discusses the use of RFID traffic management to address common problems encountered with traditional traffic control systems, specifically related to image processing and beam interruption techniques. This RFID technology is effective in areas characterized by several lanes, a large number of cars, and many road junctions. The system provides an efficient time management solution that computes a real-time dynamic schedule for the sequential passage of each traffic column. The system operates in real-time, replicating the autonomous decision-making process of a traffic officer currently on duty. The calculations and judgments rely on the automobile count in each column and the route, which are proprietary information. An inherent limitation of this study is its failure to consider the protocols governing communication between the traffic signal controller and the emergency vehicle. A concept for an automatic lane clearing system for ambulances using GPS and RFID technology was proposed in reference [9]. The objective of this endeavor is to facilitate the automated clearance of the ambulance's lane prior to its arrival at the traffic signal, therefore reducing the duration required for its journey to the hospital. One way to do this is by adjusting the traffic signal on the ambulance's path to green after it has covered a certain distance from the junction. Implementing RFID technology to distinguish between emergency and non-emergency scenarios helps prevent unnecessary traffic congestion. The transceivers and GPS provide communication between the traffic signal station and the ambulance during traffic signal operations. The technology at the junctions is fully automated, making human involvement unnecessary. An inherent limitation of this approach is its reliance on comprehensive data on the starting and finishing locations of the journey. If the ambulance is required to follow an alternate route for any reason or if the initial location is not known in advance, it will be unable to complete its operation. Congestion poses a significant challenge to the transportation infrastructure in most cities around the country. This seems especially true for countries such as China and India, whose populations are experiencing above-average growth, as seen in Figure 1. For example, there has been a significant surge in the numbers of automobiles in Bangalore City in recent years. Consequently, in the central areas, the average travel speeds on major highways are below 10 km/h during peak hours, and several arterial routes and junctions are operating at maximum capacity (i.e., the volume-to-capacity ratio exceeds 1). Key challenges identified in [10] include the management of over 36,000,000 vehicles, an annual traffic growth rate of 7% to 10%, roads with higher capacity ranging from 1 to 4, travel speeds below 10 km/h in certain central areas during peak hours, insufficient parking spaces for vehicles, and a shortage of police officers. The video traffic surveillance and monitoring system now in operation in

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Bangalore City was implemented in [11]. In order to determine the duration of each traffic light at each intersection, the traffic management staff must scrutinize data manually. The proposed system would provide this information to the neighboring police officers in order to enable them to respond accordingly.

II. LITERATURE REVIEW:

In the article "Vehicular Ad Hoc Networking Violation Detection Technique," Approximately forty persons under the age of twenty-five die in traffic accidents every hour worldwide. For those aged 5 to 29, this is the second most common cause of mortality, according to the World Health Organization. Drunk driving and ineffective law enforcement are two of the main causes in India. The traffic authorities' present optical detection of traffic violations system is not always reliable. It cannot be used everywhere. The need for easy-to-implement, reasonably priced solutions to traffic safety issues is high. In this study, we offer a traffic violation detection method for vehicle ad hoc networks to analyze driver behavior and identify speed limit crossings. For the 1000 m x 1000 m region, we used a GPS-based system, a digital map, and a sensor device in our study. We examined how every car in the network behaved. In this instance, the network has been separated into many clusters, each of which contains a base station or infrastructure node that serves as a point of contact for all the nearby cars. A control center (master control room) is the communication hub for all infrastructure nodes. The infrastructure node will notify the control center if the motorist disobeys any traffic laws. The basis for traffic safety is implied by the simulation result of our suggested model, which we ran using a graphics program. Drunk drivers are unable to elude the law.

"Multi-agent Q-learning-based traffic light control in non-stationary environments" Conventional traffic signal timing techniques do not provide an effective control over traffic congestion in many metropolitan locations where there is no peak pattern. Allowing traffic signal controllers to pick up on how to modify the lights according to traffic conditions is one option. However, since each controller is adjusting to the changes brought about by other controllers, this results in a classically non-stationary environment. This is likely to be computationally demanding and inefficient in multi-agent learning, where the efficiency declines as the number of agents (controllers) increases. In this study, we use methods from multi-agent reinforcement learning to represent a moderately large traffic network as a multi-agent system. Specifically, Q-learning is used, in which states are estimated by averaging the queue lengths of approaching connections. The approach may now be extended to multiple kinds of intersections thanks to a parametric description of the action space. The simulation

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results show that, for varying traffic needs, the suggested Q-learning performed better than the fixed time strategy.

One aspect of this system is its dual purpose of detecting auto thieves and implementing an environmental avoidance strategy. Additionally, traffic congestion during morning rush hour is a significant issue on our planet. Emergency vehicles, such as ambulance teams and police cars, but specifically fire department lorries, are intercepted by traffic during the morning rush hour. Consequently, many individuals will lose their existing residences when all these service trucks are unable to access it at their designated locations within a certain timeframe. Utilizing a technology attributed to humans, all ambulances may get clearance to have all the stoplights on their route change color, providing the designated vehicle with a single environmental signal. A synchronized traffic light at the sustainable stage of development is referred to as a "environmental continuous wave." Whenever a vehicle passes through a green traffic intersection with an established agreement to "green keep waving," it will get sustained neural signals while traveling. Sustainable ripples are a widely implemented principle worldwide. It is essential to maintain identification of vehicles used by both militants and unlawful entities. The sophisticated technology of the vehicle may effectively prevent a single automobile theft by navigating through signalized junctions and following a sustainable start waving route. The tracking system included within the range rover operates without the need for battery packs, unlike other group conformance tracking systems that rely on the global GPS subsystem. Data pertaining to this particular automobile should be updated inside the database. Hence, it is undeniably a two-domain system that would facilitate the identification of preferred vehicles, such as fire engines. This is a cut-back strategy that may be used to achieve sustainability.

The suggested barcode checkstops seem to disregard the difficulties of image analysis and light source fault techniques that are common for traffic volume systems, therefore affecting traffic signals such as ambulances. The aforementioned radio frequency identification is indeed effective at a cross-sectional area with a significant number of co-terminals. This paper presents a management approach for developing strategies to determine a diversity timeline during the live period of each traffic divisions attempting to pass. This same cutting-edge technology continues to operate flawlessly, generating the same assessment of an on-duty traffic officer. An integer arithmetic operation, along with the selection of options, is determined by the number of automobiles in each editorial and the packet processing. Keywords: online traffic signal (VTL), radio frequency identification (RFID), primary congestion control (PCC), and ambulances (EV).

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Completely The nation's rapidly increasing metropolitan regions have exacerbated urban expansion contrary to insurmountable thresholds, as seen by the use of QR codes and the global positioning system automated street discharge plan for paramedics. Consistently, fatalities have occurred due to both inefficient road traffic and inadequate control of ambulance services when vehicle traffic is impeded. Our proposed resolution to the dispute is a computerized traffic clearance system that incorporates GPS and radio frequency identification for ambulance staff. The purpose of this study is to reduce the time it takes for emergency services to arrive at the same clinic by ensuring that an emergency vehicle clears the road before it reaches its signalized junction. One possible approach is to establish a traffic light that would be positioned in the emergency services' route to the grass once it has covered a certain distance from the flyover. The use of QR codes to differentiate between disasters and non-disadventual situations will effectively reduce avoidable traffic congestion. Telecommunications devices and navigation systems have been employed to accelerate communication between the emergency vehicle and the stoplight maintenance facility. By using a completely computer-controlled approach, tecso projects road pedestrian crosswalks eliminate the need for human intervention. The economic growth of Bangalore in recent decades has been exponential. The quality of living has improved, but public transit is still inadequate, which has led to the exponential expansion of private vehicles. Bangalore is now one of the most accident-prone cities in India as a consequence of the tremendous proliferation of automobiles [1].Additionally, ambulances often get stalled at traffic lights because other cars are attempting to cram themselves into every available space in order to pass when the light turns green. In contrast to western nations, Indian towns lack the infrastructure and road design necessary to consider establishing dedicated lanes for emergencies. An other solution to the aforementioned issue is urgently needed, since patient lives rely on the ambulances arriving at the hospital quickly. Ensuring that the lane the ambulance is traveling in is cleared may help solve the issue of it being caught in a traffic bottleneck. In other words, the closest traffic signal has to be informed of the ambulance's approach in order for it to turn green and free up traffic. But not every ambulance will be used to transport emergency patients. Therefore, if the traffic clearance mechanism is used for every ambulance, it would undoubtedly cause traffic issues. We suggest creating a system that combines GPS with RFID (Radio Frequency Identification) in order to get around this problem.

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III. SYSTEM IMPLEMENTATION:

MODULES:

- **Image Preprocessing Using Canny Edge Detection**
- **Mask R-CNN**
- **OPEN CV**

MODULES DESCRIPTION:

Image Preprocessing Using Canny Edge Detection & CNN

A picture may be defined as a two-dimensional function f(x, y), where x and y are spatial location coordinates. An image's intensity or gray level at a certain set of coordinates (x, y) is governed by the magnitude of function f. An image is considered digital when the values of x, y, and the amplitude of f are all finite discrete integers. Digital image processing (DIP) is the use of digital computer technology to process digital images. Each every component of a digital image has a distinct position and function. Pixels are the assigned designation for the constituent elements. To enhance understanding of image segmentation, let us use a simple example. Please refer to the image shown below:

Here, there's just one item: a dog. We can predict that there is a dog in the provided picture by developing a simple cat-dog classifier model. However, what if a picture contains both a dog and a cat? In that case, we can train a multi-label classifier. There's one more warning, though: neither the animal nor the item in the picture will be known to us. This is where the concept of image localization enters the picture (sorry!). It assists us in locating a certain item inside the provided picture. We then depend on the idea of object detection (OD) in the event that there are several objects present. With the help of OD, we can forecast each object's class and position.

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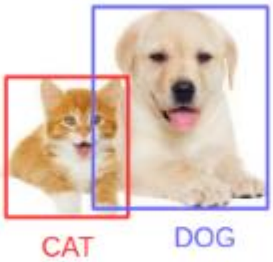
Image Localization



Object Detection

We must comprehend the contents of the picture before we can identify the items or even categorize them. Insert: Segmentation of Images.

Five phases make up the Canny edge detection algorithm:

1. Suppression of noise;
2. Gradient computation;
3. Non-maximum suppression;
4. Double threshold;
5. Hysteresis-based edge tracking.

You will be able to get the following outcome after following these instructions:

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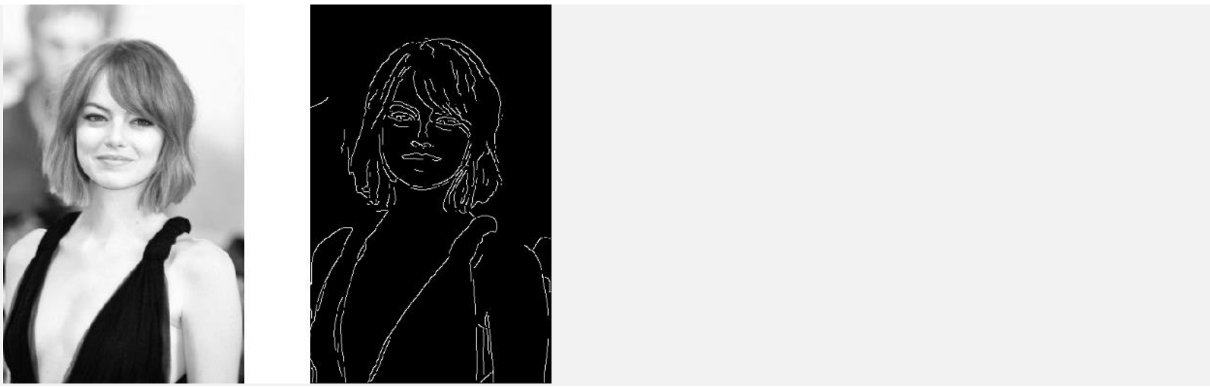

Original image on the left — Processed image on the right

Mask R-CNN

Mask R-CNN, a deep learning architecture, was created by data scientists and researchers at Facebook AI Research (FAIR) to generate a mask for each individual element in a picture, meticulously pixel by pixel. It is essential to give particular consideration to this notion—it is exceptional!

Mask R-CNN was developed as an extension of the popular Faster R-CNN object recognition framework. The Mask R-CNN model incorporates an additional branch into the previous Faster R-CNN outputs. The Faster R-CNN approach generates two outputs for each object shown in the image:

• The class

• The coordinates of the enclosing box

To this, Mask R-CNN adds a third branch that also outputs the object mask. View the graphic below to get an understanding of the inside workings of Mask R-CNN:

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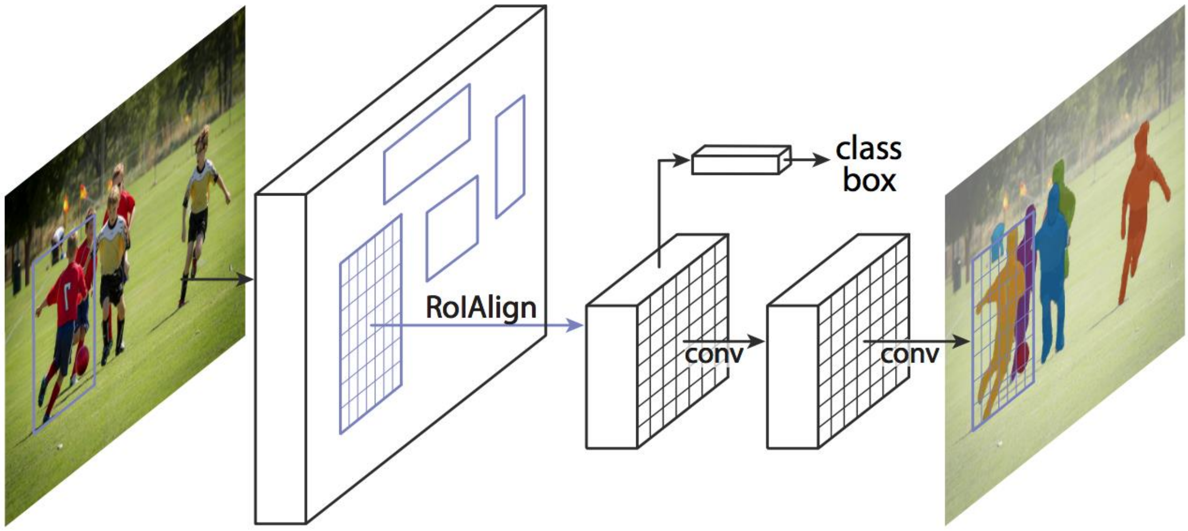

Source: arxiv.org

1. We feed the ConvNet a picture as input, and it returns the image's feature map.
2. Using these feature maps, the region proposal network (RPN) is implemented. This gives back the object suggestions and their objectness rating.
3. To make all of the proposals the same size, a ROI pooling layer is applied to these proposals.
4. Lastly, a fully connected layer receives the suggestions and uses them to categorize the objects and output their bounding boxes. It also gives each proposal's mask back.

Mask R-CNN is the current state-of-the-art for image segmentation and runs at 5 fps.

OPENCV:

Among the fundamental elements that are crucial in modern processes is computer vision, which encompasses a vast academic collection of vision-based, computational, and picture editing tools. This technology has the potential to analyze photos and videos in order to comprehend individuals or groups, objects, and maybe even handwritten text created by humans offline. This scripting language can really handle the construction of its cuda elements, including evaluation, when it is integrated with other repositories of similar kind. Many bits of information that are contained in the original picture may be acquired by using vector space to identify the pattern and its many characteristics and performing mathematical operations on these features. With the use of OpenCV, we are able to extract several sorts of information from the original picture, such as the two faces and the fact that the person in the image (me) is wearing a watch, bracelet, and other items.

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This is only a basic introduction to OpenCV; in our next articles, we'll cover applications and other topics.

Uses for OpenCV: OpenCV is used to solve many applications; a few of them are mentioned here.

facial recognition

automated monitoring and inspection

number of individuals – count (such as foot traffic at a mall)

Vehicle counts and their speeds on highways

Interactive artwork displays

Finding anomalies (defects) throughout the production process (the occasional faulty items)

stitching of a street view picture

Image and video retrieval and search

Navigation and control of driverless cars and robots using object recognition

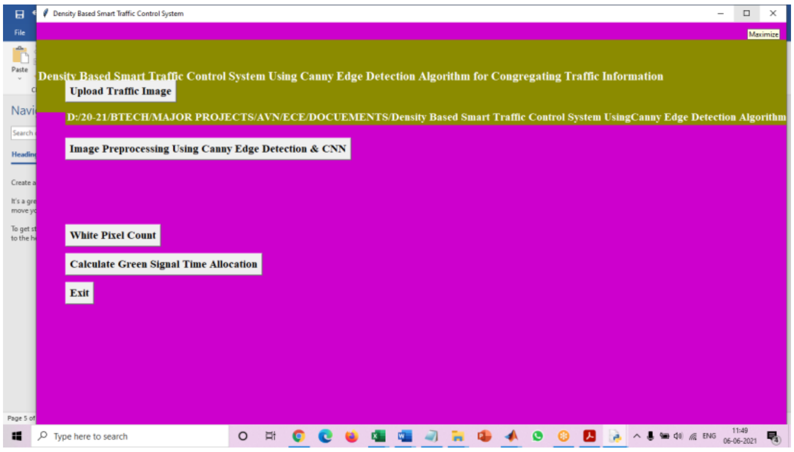
analysis of medical images

3D structure from motion in movies

TV Channels' awareness of advertisements

Functionality of OpenCV

IV. SCREENSHOTS



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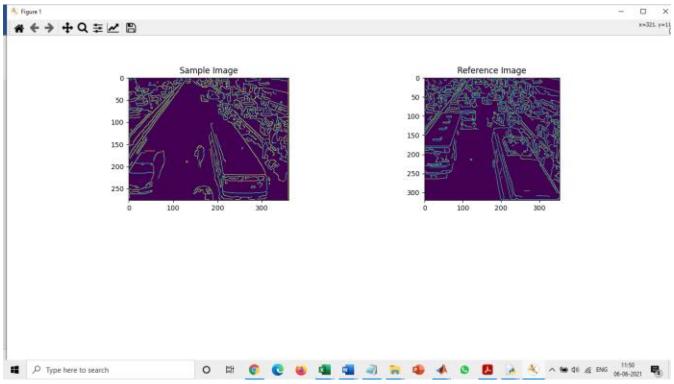

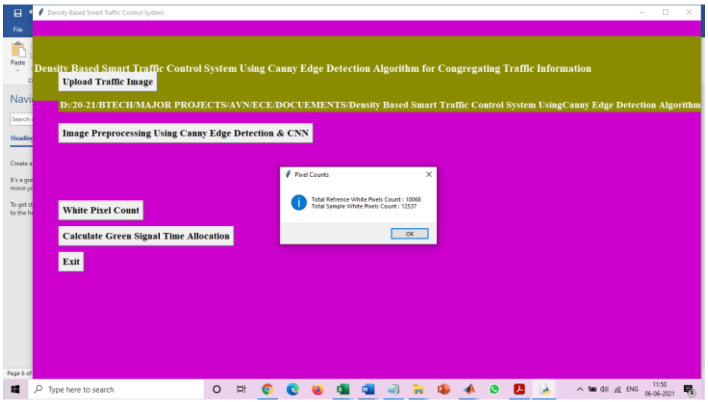

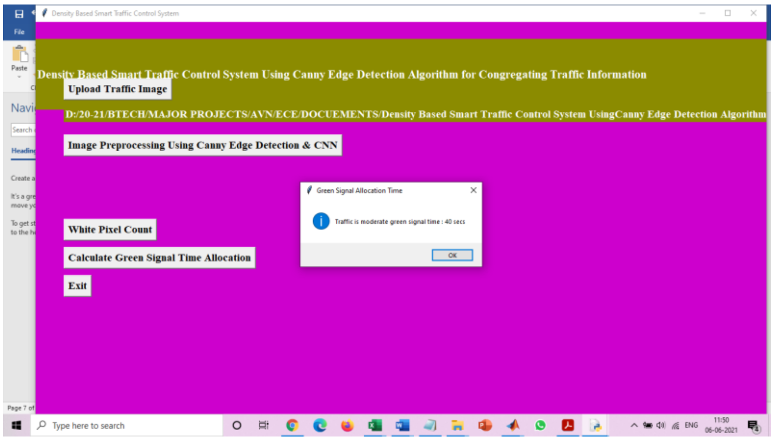

V. CONCLUSION

This paper introduces a concept for an intelligent traffic management system that utilises image processing techniques to quantify density. In addition to highlighting the limitations of the current outdated traffic control system, the advantages of the proposed traffic management system have been shown. For this reason, four illustrative photographs depicting different traffic situations have been acquired. Upon completion of edge detection, the degree of similarity between the sample and

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reference images has been calculated. Temporal allocation has been performed for each individual image based on this similarity, utilizing the time allocation method. Furthermore, the Python programming language has been used to demonstrate the congruities in percentage and time allocation among the four given images. Furthermore, in addition to presenting the schematics of the proposed intelligent traffic management system, the hardware implementation has verified the necessary results.

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