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Real-Time Vehicle Tracking for an Intelligent Urban Traffic System

Mr.Pitta Sankara Rao[1]., Hari Srinidhi[2]

1 Assistant Professor, Department of ECE, Malla Reddy College of Engineering for Women., Maisammaguda., Medchal., TS, India

2, B.Tech ECE (20RG1A04D1),

Malla Reddy College of Engineering for Women., Maisammaguda., Medchal., TS, India

ABSTRACT

A traffic management system is a sophisticated, integrated system that strives to promote safety, improve traffic flow, and boost overall transportation system effectiveness. To gather and analyse real-time data regarding traffic conditions, it depends on cutting-edge technology like sensors, cameras, and communication networks. Using traffic lights, road signs, and other traffic control equipment, this data is utilised to control traffic flow and to give drivers real-time information on accidents, traffic congestion, and other problems.

Reducing traffic jams, boosting safety, and improving the performance of the transportation system as a whole are the main objectives of a traffic management system. The technology can assist in cutting commute times, lowering fuel consumption and emissions, and improving general quality of life for city dwellers by streamlining traffic and easing congestion. The device can also aid in lowering the chance of accidents and other occurrences by giving drivers real-time traffic information, hence improving safety and security on the roadways.

Overall, a traffic management system is an essential part of contemporary transportation infrastructure, and as traffic volumes rise and urban populations rise, so will the significance of this component. To maintain the security, effectiveness, and sustainability of our transportation networks, traffic management system development and deployment must be given top priority by transportation plannersand politicians.

Introduction

A traffic management system (TMS) is a collection of technologies and practices that aid in the monitoring and control of traffic flow on roads, highways, and other transportation networks. The primary purpose of a TMS is to increase safety, reduce congestion, and optimize infrastructure utilisation.Sensors, cameras, traffic signals, communication systems, and data analysis tools are typical hardware and software components of a TMS[1]. These elements collaborate to gather real-time traffic data, assess it, and send feedback to traffic controllers, drivers, and other stakeholders.One of the most important advantages of a TMS is its capacity to allow traffic managers to make real-time choices based on the most recent traffic data. A TMS, for example, can automatically modify traffic lights to improve traffic flow or offer drivers with real-time information on alternate routes, delays, or accidents.Overall, a well-designed and implemented TMS may considerably enhance transportation network safety, efficiency, and dependability, resulting in a better life for individuals and improved economic growth for communities[2].Sure, here are some more specifics on traffic management systems:

A Traffic Management System includes the following components: - Traffic surveillance systems, such as cameras and sensors, to monitor traffic flow and identify incidents and congestion.

- Tools for traffic data analysis and management to handle and understand data acquired by surveillance systems.
- Intelligent transportation technologies, such as variable message signs (VMS), radio broadcasts, or smartphone apps, are utilized to offer real- time information to drivers. - Traffic control systems, such as traffic lights and lane control signals, are used to govern traffic flow.
- Incident management systems, which allow for the rapid identification and response to accidents, disabled cars, and other situations that may create delays or congestion.

The Advantages of Traffic Management Systems:

- Increased safety: TMS can help minimize the incidence of accidents by swiftly detecting and responding to problems, as well as by eliminating errors.

TMS may assist detect and alleviating congestion hotspots, adjust traffic signals and speed restrictions, and offer alternate routes to minimize traffic volumes by monitoring and assessing traffic patterns.

- Improved efficiency: Using real-time traffic data, traffic managers may make more educated traffic management choices, minimizing delays and improving travel times. TMS can help reduce air pollution and greenhouse gas emissions by decreasing congestion and smoothing traffic movements.

Overall, TMS can enhance transportation network performance by making it safer, more efficient, and more sustainable. The effectiveness of a TMS, on theother hand, is dependent on its design, implementation, and continuous maintenance, as well as collaboration between traffic managers, government agencies, and other parties involved in transportation planning and management.

Yes, here are some additional details on traffic management systems:

Traffic Management System Technologies:

- Vehicle detection sensors that detect the presence and speed of

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vehicles, such as inductive loops or radar.

- Automatic Licence Plate Recognition cameras, which read licence plates and identify the vehicle

Closed Circuit Television (CCTV) cameras will be used to monitor traffic and detect incidents and bottlenecks.

- Data transmission technologies, such as Wi-Fi or cellular networks, to transport data between various components
- Data privacy: Collecting and analyzing traffic data might pose privacy concerns, particularly when ANPR cameras or GPS monitoring are used.
- Integration: Integrating multiple components of a TMS can be difficult, especially when the systems are owned by different government bodies or private enterprises. - Human factors: Even with modern technologies, traffic management still need human interaction and decision-making, especially when responding to events or crises.

Despite these challenges, the benefits of TMS can outweigh the costs, especially in densely populated areas where traffic congestion is a major issue.TMS can therefore boost economic growth and improve individuals' quality of life by decreasing congestion, enhancing safety,

events, as well as reducing congestion, which can help prevent accidents caused by disgruntled drivers.

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- Tools for traffic data analysis and management to handle and understand data acquired by surveillance systems.
- Intelligent transportation technologies, like as variable message signs (VMS), radio broadcasts, or smartphone apps, are useful in giving real- time information to drivers. - Traffic control systems, such as traffic lights and lane control signals, are used to govern traffic flow.
- Incident management systems, which allow for the rapid identification and response to accidents, disabled cars, and other situations that may create delays or congestion.- Improved safety: TMS may help reduce the frequency of accidents by immediately recognising and responding to

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- Improved efficiency: Using real-time traffic data, traffic managers may make more educated traffic management choices, minimizing delays and improving travel times. TMS can help reduce air pollution and greenhouse gas emissions by decreasing congestion and smoothing traffic movements.

Overall, TMS can enhance transportation network performance by making it safer, more efficient, and more sustainable. The effectiveness of a TMS, on the other hand, is dependent on its design, implementation, and continuous maintenance, as well as collaboration between traffic managers, government agencies, and other parties involved in transportation planning and management[4].

Vehicle detection sensors, such as inductive loops or radar, are used in Traffic

complicated urban regions with significant traffic volumes.

- Data privacy: Collecting and analyzing traffic data might pose privacy concerns, particularly when ANPR cameras or GPS monitoring are used. Integration: Integrating multiple components of a TMS can be difficult, especially when the systems are owned by different government bodies or private enterprises.

Despite these challenges, the benefits of TMS can outweigh the costs, especially in

Management Systems to detect the presence and speed of vehicles.

- Automatic Number Plate Recognition cameras aid in the reading of number plate numbers and the identification of cars.

Closed Circuit Television (CCTV) cameras will be used to monitor traffic and detect incidents and bottlenecks.

- Communication technologies, such as Wi-Fi or cellular networks, can send data between TMS components and give drivers real-time information. - Data analysis technologies, such as Geographic Information Systems (GIS) or machine learning techniques, to analyze and understand surveillance system data. Traffic Management System Difficulties:
- Cost: Developing and maintaining a TMS may be costly, especially in big,

densely populated areas where traffic congestion is a major issue[4].TMS can therefore boost economic growth and improve individuals' quality of life by decreasing congestion, enhancing safety, and increasing efficiency.

- Improved public transport: By lowering traffic congestion and improving traffic flow, TMS may also improve the operation of public transport systems, such as buses or trains, by reducing delays and enhancing dependability.

TMS can assist in making better use of

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existing transportation infrastructure, such as roads and highways, by optimizing traffic flow and decreasing congestion, which can help defer the need for costly expansions or new infrastructure.

- Improved accessibility: TMS can increase accessibility for all road users, including pedestrians, cyclists, and drivers with impairments, by giving real-time information regarding traffic conditions and alternative routes.

Related Work

Applications for video-based traffic surveillance analysis, which is a hot research field, are abundant in intelligent transport systems. Urban landscapes are more difficult to photograph than highways,

background clutter, and changes in vehicle attitude or orientation. The most contemporary video processing techniques for vehicle recognition, identification, and tracking are thoroughly examined in this paper[2]. In this study, we categorize vehicle recognition techniques into groups based on motion and appearance. These techniques vary from simple probabilistic to adaptive median filtering and frame differencing.

The properties of moving objects, such as their high speed degradation and uncharted pathways, make it difficult to identify and track them. Detecting moving targets may be done in a variety of ways, however the noise of detection greatly affects the accuracy of detection[3]. The three-frame method is used in

in part because of camera placement, background clutter, and changes in vehicle attitude or orientation. The most contemporary video processing techniques for vehicle recognition, identification, and tracking are thoroughly examined in this paper[1]. In this study, we categorize vehicle recognition techniques into groups based on motion and appearance. These techniques vary from simple probabilistic to adaptive median filtering and frame differencing.

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this work to extract the target, and the extracted image is then processed using the mathematical morphology methodology. While successfully detecting moving targets, this method significantly reduces noise. According to the testing results, this method operates better in real-time, is appropriate for outdoor use, and is more accurate at recognising moving things.

Tracking vehicles is an integral part of intelligent transportation monitoring. However, there are currently problems with vehicle tracking, such as scale change, interference from too similar colors, low resolution video data, and others. The optical flow MCMC (OF-MCMC) tracking method for tracking moving objects is suggested in this paper as an improved Markov chain Monte Carlo (MCMC) tracking method[4]. We

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first estimate the vehicle's traveling direction in initial frames using the optical flow approach, and then address the scale change problem and replace the second-order autoregressive motion model with the ability to calculate the vehicle's speed

Parking on the street can cause major traffic problems, like accidents and congestion in urban areas. A trustworthy and practical method for locating

parking violations is given. The method is predicated on frame difference detection of abrupt changes in vehicle motion. In addition to the temporal information, vehicle traits from a static image are employed to reduce the false alarm and missing rate[5]. The proposed method generates a detection accuracy of94.7% and can precisely estimate parking duration, according to testing results on 24-hour streets. Comparing our method to previous solutions based on EPI image processing, it is evident that ours employs a video camera in a fixed place without operating the measurement vehicle

Recognition and counting of intelligent vehicles are becoming more and more important in the field of highway management. It might be challenging to see automobiles due to their wide range in size, which affects how precisely counts ofvehicles are performed[6]. An identifying and counting system for vehicles based on vision is suggested by this research to solve this issue. In total, there are 57,290 annotated occurrences in 11,129 images from a brand-new high definition highway vehicle dataset presented in this work. As contrast to the currently available datasets, the recommended dataset includes annotated

microscopic elements in the image and provides the whole data foundation for vehicle detection based on deep learning. For counting and detecting automobiles, the proposed system.

The description of a brand-new technique for categorizing autos from videos. Two novel concepts are presented: first, probes composed of local 3D curve groups which, when projected onto video frames, serve as characteristics for distinguishing distinct vehicle classes in video clips[7]. The second method uses class probability densities to identify groupings of 3D distances between pairs of 3D probes. The picture curves connected to the 3D ridges on the surface of the vehicle appear to be the most trustworthy image features for categorising cars. The bulk of these ridges are located at metal/glass interfaces, two-surface intersections, such as the back and sides, and self-occluding forms, such as wheel wells or apparent curves of the vehicle body, or silhouettes.

SYSTEM DEVELOPMENT

A data set

There are street surveillance cameras all over the world, but traffic photographs are rarely made public owing to copyright and security issues. Looking at the traffic photo dataset from the standpoint of image capture, we may divide it into three groups: automobile camera photographs, surveillance camera images, and non-surveillance camera images. The dataset utilized in our work comprises photographs of roads and typical streetscapes, which can be used to automatically recognise and count automobiles and will aid in the solution of issues such as 3D object identification and tracking. Here are some of the most widely used dataset lists around the world:

1) The dataset utilized in Tsinghua-Tencent Traffic-Sign contains around 100,000 photos obtained from automobile cameras and covers diverse lighting and weather situations, however no cars are indicated in that case.

2). Stanford Cars dataset is essentially a vehicle dataset obtained from non-monitoring cameras using a bright car appearance. This dataset will comprise a total of 19,000 estimated car categories encompassing the brands, models, and manufacturing years of the various vehicles.

2) Hardware and Software Requirements

The Following are the software requirements for this project:

1. 4.2 GB RAM
2. MS Window 7 and above Software Requirements
3. Visual Studio Code

Microsoft has successfully developed Visual Studio Code, also known as VS Code, which is essentially a free open-source text editor. VS Code works with Windows, Linux, and macOS. VS Code has effectively become one of the most popular programming tools in recent years, despite the fact that the editor is quite tiny and provides some complex capabilities. VS Code supports a wide range of programming languages, from Java, C++, and Python to CSS. Furthermore, VS Code allows users to add and create new extensions such as code linters, debuggers, and cloud and web development support. In comparison to other text editors, VS Code's user interface allows for a great deal of interaction.

VISUAL STUDIO COD

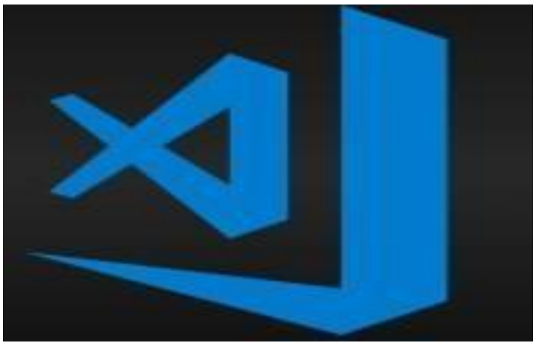

Figure : Visual Studio Code

TensorFlow

TensorFlow was launched in November 2015 and has since grown to become one of the most popular machine learning libraries. It has a big active developer community, including users who have contributed to its development, who may share their expertise and resources and give help to one another.TensorFlow is compatible with a wide range of platforms, including Windows, Linux, and Android, and it can be used with a variety of programming languages, including Python, C++, and Java.TensorFlow is useful for a number of machine learning applications, including supervised and unsupervised learning, reinforcement learning, and generative models, in addition to deep neural network training and inference.TensorFlow is supported by a large ecosystem of tools and frameworks, including Keras, TensorFlow Lite, and TensorFlow.js.TensorFlow is also very flexible, allowing you to create and train bespoke models by combining different types of layers, activation functions, loss functions, and optimizers.Overall, TensorFlow is a robust and adaptable machine learning and artificial intelligence technology, and its open-source nature makes it accessible to a diverse set of users and applications.

Figure : Tensorflow

PERFORMANCEANALYSIS

1) *Accuracy of Different Machine Learning Models:*

Random Forest

Random forests, also known as random decision forests, are a collaborative learning method that works by training a collection of different decision trees and outputting the class that is the mode of the classes classification or the mean prediction regression of the different trees. It explains why decision trees

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frequently outperform their training set.

1.1) *Artificial neural network*

Artificial neural networks are basically the computational systems that are inaccurately triggered by the biological neural networks that make up the brains of animals:

$$y_t = \alpha_0 + \sum_{j=1}^{q} \alpha_j g\left(\beta_{0j} + \sum_{i=1}^{p} \beta_{ij} y_{t-i}\right).$$

The integers p and q represent the number of input and hidden nodes.

The connection weights are j() j = 0, 1, ", q and I p j q) ij = 0, 1, ", ; = 0, 1, ", and the bias terms are 0 j. The logistic sigmoid function () x e g x + = 1 1 is commonly used as a nonlinear activation function. Other activation functions can also be used, e.g., linear, hyperbolic tangent, Gaussian, etc.

Comparisons and Results

In this particular section, we will be performing the performance tests of methods presented here above. We experimented with a video dataset containing 4 streets without cars. In this section, we will do the performance tests on the approaches described previously. We tested using a video dataset that had four streets devoid of automobiles. Our experiment used CNN and OpenCV for image detection for checking any emergency vehicle and thus making the lane free of use by removing the green light, as well as making the lane free when there is a large amount of traffic present in any particular site and adjusting the time of the other lanes' green lights accordingly.

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Before the detection from our dataset the following input is taken:
Before the detection from our dataset the following input is taken:

After the detection of the cars from our video dataset the following output is produced

Following are the findings from the traffic signal management and control system based on vehicle density:

In theWithin one minute, the yellow light at signal 1 will illuminate to indicatethat the red light at signal 1 is approaching, as well as to indicate to vehicles at
signal 2 that the green light is about to blink.

After a specific period of time, ultrasonic sensor (US) pins were attached to theArduino board for the installation of dynamic light control as shown below: According to the table above, ultrasonic sensors (US) are in charge of providing information about the crowd to controllers so that they may decide whether or notto run the traffic lights on the various sides.

Traffic Modes	US1	US2	Timing Green light
No Car	Low	Low	10 Sec
Normal Mode	High	Low	60 Sec
Traffic Jam Mode	High	High	90 Sec

The number and location of sensors totally depends on the length of the street mentioned in the project and increasing the sensors in the project also gives more accuracy in determining the amount of crowd, but the cost will be also increasing due to this.

CONCLUSION

Expanding on the importance of careful planning, investment, and collaboration for the successful implementation of a traffic management system, Before designing and deploying such a system, it is critical to have a thorough understanding of the local traffic conditions, needs, and challenges. Population density, road infrastructure, traffic volume and patterns, as well as the availability of data sources and communication networks, must all be considered.Furthermore, a traffic management system should be designed to be adaptable and flexible in response to changing traffic conditions and evolving technologies. This necessitates continual performance monitoring and assessment of the system, as well as continuing research and development to increase its capabilities and efficacy.Involving the public in the development sector and, in the case of the deployment of a traffic management system, may also assist boost awareness and support for the programme. By offering real-time.Finally, while a traffic management system can provide significant benefits, it is not a panacea for all traffic problems. It should be viewed as part of a wider strategy to sustainable urban mobility that includes encouraging public transit, active forms of transportation, and land use design that prioritizes walkability and accessibility.Finally, a well-designed and executed traffic management system hasthe potential to improve urban mobility, safety, and sustainability. However, in order to realize its full potential and contribute to the creation of more livable and sustainable cities, it requires careful planning, investment, collaboration, and

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continuous monitoring and improvement.A well-designed traffic management system may also be beneficial to the economy. It can boost production and efficiency by economy.One of the most difficult aspects of designing a traffic management system is making it accessible and helpful to all parts of society. Pedestrians, bikers, public transportation users, and drivers of various sorts of vehicles are all included. It is critical to ensure that the system is constructed with equality and inclusion in mind, so that all people of the community benefit.In addition, the introduction of a traffic management system can also provide opportunities for innovation and job creation. As technology continues to evolve, there is a need for skilled professionals to develop, implement, and maintain these systems.This has the potential to offer new job possibilities as well as encourage an environment of creativity and technical growth in the transportation industry.

decreasing congestion and improving travel times. It can also bring more visitors and tourists to a city, which can help the local

FUTURE WORK

Some potential areas of future work for traffic management systems include:

1. Integration with self-driving cars: As self-driving cars become more common, traffic management systems will need to be able to communicate with them in order to optimize traffic flow and maintain road safety.

2. Application of machine learning and artificial intelligence (AI): Machine learning algorithms may assist traffic management systems in predicting traffic patterns, identifying possible concerns, and adjusting traffic flow accordingly. Individual drivers can also benefit from more customized and effective route planning thanks to AI.

3. Expansion to non-road modes of transportation: Traffic management systems may be expanded to control forms of transportation other than roads, such as public transportation, bike lanes, and pedestrian walkways. This can aid in the development of a more connected and efficient transportation network.

4. Incorporation of environmental factors: To improve traffic flow and minimize emissions, traffic management systems may be developed to include real-time data

on air quality and meteorological conditions.

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