AI Based Smart Signal Traffic Light Control System

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Abstract : Due to the growing number of vehicles on the road, traffic jams are becoming a typical occurrence both domestically and internationally. There are many man hours lost due to the regular traffic bottlenecks at important intersections. This makes an effective traffic control system necessary. As the number of city cars increases, one of the most enduring problems is traffic management. Traffic jams not only increase stress levels and cause more serious disruptions to our daily lives, but they also have a detrimental effect on the environment by raising carbon emissions. The growing population is causing megacities to face serious problems and major delays in their daily transportation-related activities. Regularly assessing traffic density and taking relevant action requires an effective traffic management system. Commuter wait times at the traffic signal point are not decreased, despite the fact that different vehicle types have their own lanes. To solve this problem in the current system, the suggested methodology uses artificial intelligence to gather real-time images from signals. For efficient traffic congestion management, this method computes traffic density using the YOLOv8 image processing methodology. The YOLOv8 algorithm detects several vehicles with greater accuracy. Intelligent monitoring technology reduces vehicle waiting times by coordinating time distribution and reducing traffic congestion at signal intersections through the use of a signal-switching algorithm. Thus, we are going to put into practice a smart traffic control system that is predicated on the use of real-time video processing techniques to evaluate traffic density.

Index Terms - Signal switching algorithm, YOLOV8, artificial intelligence, and traffic light system

I. INTRODUCTION

With the use of artificial intelligence, our novel approach provides an excellent substitute to successfully handle this difficulty. With the help of artificial intelligence, our system is able to recognize emergency cars approaching junctions and dynamically modify traffic light timings according to priority. Green signal intervals are carefully distributed to match the location and density of emergency vehicle congestion, reducing transit delays and guaranteeing prompt emergency response. With our system, emergency vehicle mobility through crowded regions might be optimized by drastically cutting response times for fire engines and ambulances, especially at crossings where numerous lanes meet. Furthermore, our solution requires little in the way of extra hardware or infrastructure improvements because it runs well within the current infrastructure. It is a flexible solution for urban settings with a range of traffic patterns and requirements because of its ability to adapt to different intersection layouts and traffic circumstances. In order to improve emergency response skills and save lives in our communities, we are dedicated to spreading our solution widely through strategic collaborations with municipalities and transportation authorities. Furthermore, our commitment to constant improvement fuels continuing research and development initiatives, guaranteeing that our solution stays at the forefront of technological innovation in emergency response and traffic management. We want to continuously improve and adapt our system to the changing demands of contemporary urban areas by remaining flexible and sensitive to new opportunities and challenges. Furthermore, our commitment to constant improvement fuels continuing research and development initiatives, guaranteeing that our solution stays at the forefront of technological innovation in emergency response and traffic management. We want to continuously improve and adapt our system to the changing demands of contemporary urban areas by remaining flexible and sensitive to new opportunities and challenges. Congestion is caused by a number of factors, including limited road capacity, heavy demand during rush hours, and protracted red-light waits. Conventional traffic lights, which follow set timetables, frequently find it difficult to adjust in real time to shifting traffic patterns, leading to inefficiencies that make the issue worse.AI-powered dynamic signal adjustments based on real-time traffic circumstances can improve traffic flow, reduce emissions and fuel usage, and ultimately make driving safer and more comfortable for all users.

II. EXISTING SYSTEM

The growing population and number of automobiles in metropolitan regions are making city traffic congestion a serious issue. Along with increasing fuel consumption, transportation costs, and carbon dioxide emissions, traffic bottlenecks also cause more delays and stress for drivers. Long red light waits, uncontrolled demand, insufficient capacity, and other reasons can all lead to traffic congestion.

III. PROBLEM STATEMENT

The technology's stated problem is to reduce emergency vehicle response times, which are frequently hampered by intersection traffic. About 95% of traffic crossings in India are still controlled by antiquated methods that are ineffective at directing traffic to make room for emergency vehicles. With the use of artificial intelligence (AI) algorithms, our suggested system can identify emergency vehicles stuck at crossings and assign the proper signal phases to speed up their movement. We hope to greatly increase emergency response efficiency and raise general road safety by removing this bottleneck.

IV. MOTIVATION

This concept was inspired by the growing problem of intersection congestion, which is a modern issue that requires immediate action. Emergency vehicles, such fire engines and ambulances, are hampered, which emphasizes how serious the issue is. When intersection traffic jams get worse, they put patients' lives in jeopardy and make it more difficult for emergency personnel to get to vital locations like hospitals or fire scenes quickly. There is still opportunity for innovation because, despite attempts, current solutions have not been enough to address this urgent problem.

Need of Proposed System::

1. Improved Safety: Making sure that both civilians and emergency responders are safe is one of the main priorities in disaster circumstances. By using AI to identify emergency vehicles and adjust traffic, the system can reduce the likelihood of crashes and accidents, improving road safety overall.

2. Effective Emergency Response: In many emergency scenarios, time is of the importance. The system has the ability to save lives and minimize damage by ensuring that responders get at their destinations on time by rapidly identifying and prioritizing the passage of emergency vehicles.

3. Shorter Reaction Time: Conventional traffic management techniques might not always effectively make room for emergency vehicles, which could cause delays. Emergency vehicles may move through traffic more efficiently and with less reaction time thanks to AI-based technologies that can dynamically modify traffic signals and routes in real-time.

4. Better Traffic Flow: AI-based technologies can improve traffic flow generally in addition to helping emergency vehicles. The system can modify traffic signals and route assignments to reduce delays and boost the overall effectiveness of the road network by examining traffic patterns, congestion points, and other variables.

5. Adaptability and Scalability: AI algorithms have the capacity to continuously learn from real-world data, which enables the system to gradually enhance its performance and adjust to shifting traffic smart city projects or expanded to span other geographic areas. All things considered, an AI-based emergency vehicle detection and traffic control system meets vital requirements for resource optimization, safety, and efficiency in urban transportation contexts, making it a crucial part of contemporary smart city infrastructure.

V. PROPOSED SYSTEM

In this project, we propose the use of artificial intelligence to make the traffic system smarter. Computer vision software can be used to analyze digital camera images in order to parse lanes and identify vehicles. To create a record, the photos are categorized and subjected to machine learning algorithms. To regulate the timing of the signal in each lane, the traffic signal receives the count values from these records. In this case, an Intel convolutional neural network is used to identify the car. An important component of real-time operation, which is vital in today's systems, is Open CV, a large open source library for image analysis, machine learning, and computer vision. It can process images and movies to identify people, things, and even automobiles. Here, automobiles are identified and detected using a convolutional neural network. When developing a smart traffic system, vehicle detection and tracking are particularly beneficial. An image is taken and processed using the YOLO algorithm, a machine learning technique. The vehicle in the area of interest is detected using a convolutional neural network. Each car is counted separately, and the frames for each lane are used. As such, lanes with a higher volume of traffic will be immediately cleaned off without adding to the volume of traffic.
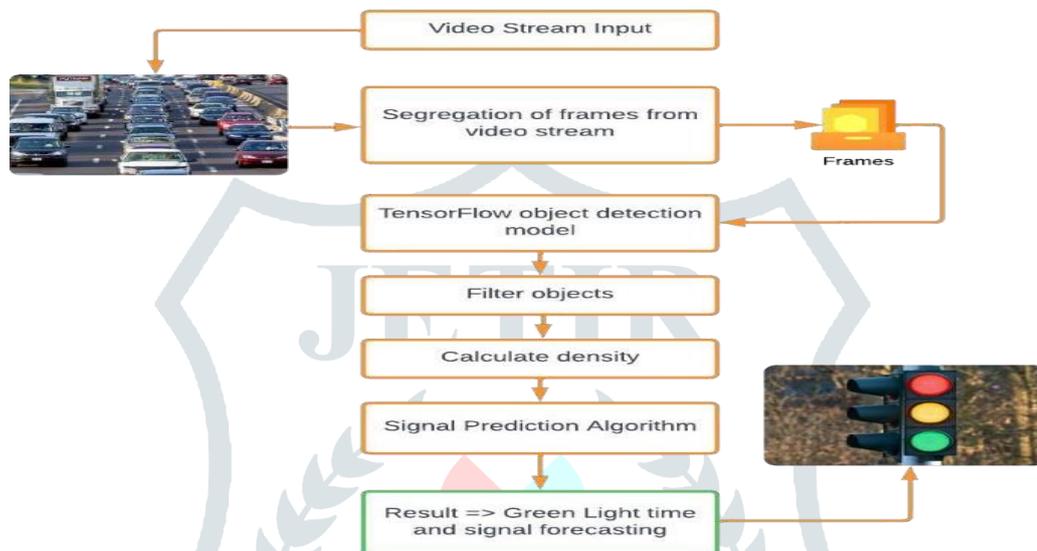

Working:

In order to identify the vehicles in the first lane using a Raspberry Pi camera and the vehicles in the second lane using a USB web camera, we will read images of automobiles from video frames. The Open CV Software has built-in modules for image detection and recognition. As a result, the network is initialized and required packages can be imported straight. The YOLO Algorithm will identify and tally cars in each lane independently. We perform the detection after pre-processing the frames. Next, two categories are created from the vehicle output data for two distinct lanes.. When there are more cars in the first lane than the second, the green light will be given and the signal duration will be extended to clear the lane with more cars. The second lane will now receive a green light and the first lane a red signal if the number of cars in the second lane increases above a predetermined threshold. There may occasionally be a situation during this process where there are a lot of cars in one lane and very few in the other. In these cases, the lane with more cars will always receive a green signal, while the lane with fewer cars will never receive one. To prevent such circumstances, the suggested system incorporates a condition in the code that, if a lane does not receive a green signal, even after three minutes, the signal will automatically transfer from current to the lane that did not receive a green signal for a longer period of time. As a result, this can be utilized to clear traffic in all lanes without any issues.

VI. METHODOLOGY

Overview of Computer

Perception Computer vision, a subfield of artificial intelligence, allows computers to retrieve pertinent data from digital images, video frames, and other visual sources and use that data to perform specific tasks. In terms of principles, human vision and computer vision are almost the same. In contrast to human vision, which uses optic nerves, the retina, and the visual brain to comprehend and learn from changes in the environment, computers are educated to execute these tasks using data, cameras, and algorithms. A wide range of industries use computer vision, including manufacturing, the automotive industry, and the energy sector. A large amount of data is needed for photo recognition, and analytics are being used. The computer will analyze the data and keep learning if sufficient information is supplied.
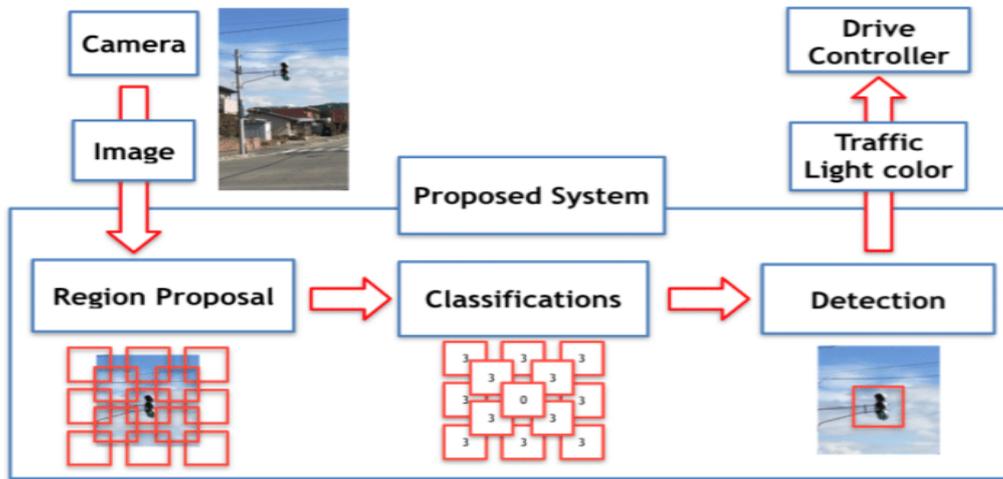
Tasks performed by Computer Vision

Classifying images is a method of observing and categorizing images. Whether the provided image corresponds to a specific class is accurately predicted by that.

Identifying a class of image and tabulating its appearance is the goal of object detection.

Object tracking is the process of following an object once it has been identified. It should continuously watch the object in this situation in addition to classifying and detecting it.

Content-based image retrieval is the process of getting an image from a big database based on its content rather than its size.

Working of YOLO Algorithm

It can identify and detect various objects in a picture instantaneously. The speed, high accuracy, and learning potential of the YOLO algorithm make it noteworthy. In keeping with its name, the method detects objects by requiring only one forward propagation through a neural network. The CNN is used to simultaneously predict bounding boxes and multiple class probabilities. Three techniques form the basis of the YOLO algorithm: intersection over union, bounding box regression, and residual blocks.
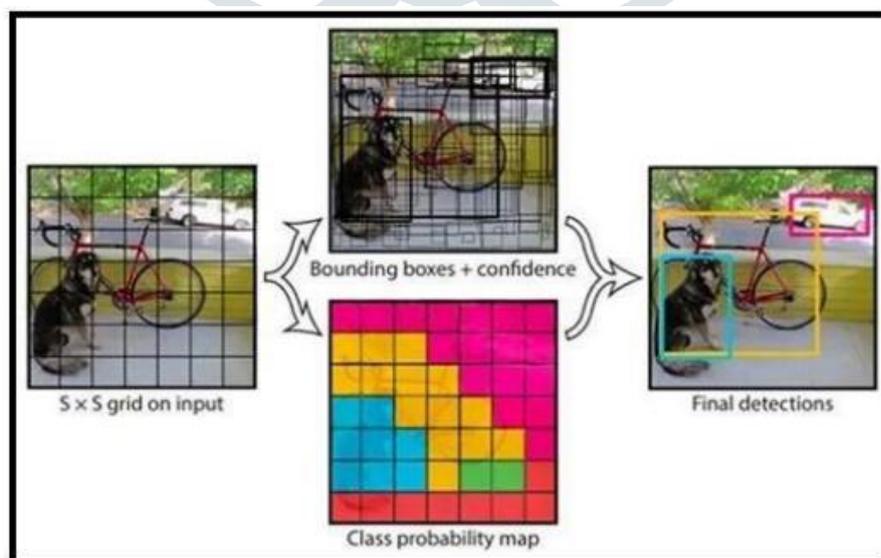
BENEFITS OF PROPOSED SYSTEM

Less emissions and less congestion

Increased safety and discipline in traffic

Along with the demand for greater safety and convenience, the world's increasingly urbanizing cities also make the adoption of this system and connected automobile technology necessary.

Better preparation and judgment

Saving time and improving operational effectiveness:

Better customer support and less annoyance

Reduced environmental pollution leads to better health.

Less traffic accidents and increased output

The system makes decisions on its own and executes the action based on the detection. Therefore, human labor is not needed.

The Yolo algorithm can learn on its own from past experiences. It results in a variety of mobility options, which is critical for smart cities.

VII. ACKNOWLEDGMENT

In order to manage urban traffic flow and improve road safety, effective traffic signal monitoring and management are essential. In order to enable prompt and precise traffic signal control, the system seeks to automatically identify and evaluate traffic lights in real-time video streams. The suggested AI-based traffic system has been successfully created and tested for implementation and operation. Computer vision technology and Raspberry Pi hardware are used to examine and assess the output. The YOLO algorithm and vehicle density are used in the suggested system to manage traffic signals. The system monitor the signal based on the count of vehicles it detects in video frames. The LED lights turn on and switch in accordance with the code's specified circumstances after receiving the message. For both Convolutional Neural Network and YOLO version three combinations with vehicle tracking, the vehicles counting framework's performance was adequate. In order to achieve high neural accuracy of detection, we have employed a convolutional neural network with seven layers.

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