Real-Time Urban Traffic Density Estimation Using AI-Driven Vehicle Detection for Smart City Traffic Control

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***Abstract*—Traffic Congestion is Major problem in most of Modern Cities due to increasing number of vehicles, especially during the peak hour. The existing traffic signals use a fixed time signals where the time is fixed for each vehicle we cannot adjust the time signal automatically by detecting vehicle, our project mainly develops a smart traffic signal using YOLO (You Only Look Once), it mainly detects the vehicle and count the number of vehicle and it will store real time data and if the road has more traffic it will detect the vehicle till the last second of red signal and according to it will increase green time signal so that traffic congestion cannot occur and also the road where 2 vehicles on road where traffic signal is present it will detect it and according to it will provide green time signal and the areas where traffic signal are not there it will detects the vehicle and it will provide better routes for heavy vehicle which make the traffic less and traffic control system place a sign board that heavy vehicles are not a loud on particular road this system helps to provide a smart traffic management.**

***Index Terms*—Traffic Management, Artificial Intelligence- Based, YOLO Algorithm, Vehicle Counting, Smart Traffic System, Computer Vision.**

I. INTRODUCTION

Urban transportation plays an important role for development of modern cities. Proper movement of vehicles helps in saving unnecessary time on traffic signal and reduce air pollution. due to rapid increase in population numbers of vehicle have been increase on road, so the traffic congestion has become major problem in modern cities.

Each and every traffic signals work on fixed signal timing. These fixed signal systems do not change according to real time traffic conditions. As a result, number of roads in modern cities having heavy traffic and, the road with less traffic leads unnecessary waiting time, fuel wastage, and increase in pollution.

To understand this problem, and solve this issue intelligence traffic system is necessary, which is developed using modern technologies like Artificial Intelligence and Computer vision. This system can monitor traffic condition in real time and help in better traffic management.

In this project, a smart traffic Analysis is proposed using YOLO (You Only Look Once) algorithm. this system detects vehicles from video input from CCTV and counts them to understand traffic density. This information is used to improve traffic signal control and reduce congestion.

II. LITERATURE REVIEW

Traffic monitoring has been a major topic in intelligent transportation systems for many years. In earlier times, traffic system mainly used physical sensors such as loop detectors, infrared sensors and radar system to detect vehicles on roads. These were useful but required high installation cost and regular maintenance. With the improvement in the technology, computer vision methods started being used for traffic analysis. Image processing techniques like edge detection, background subtraction, and motion tracking were used to identify vehicles. However, these methods do not perform good and does not give proper results in high traffic conditions. In recent years, deep learning techniques have improved the accuracy of object detection systems. Models like Convolutional Neural Networks (CNN) and YOLO are widely used for detecting vehicles in images and

videos, among these, YOLO is widely known because it provides accurate and fast detection in real time.
Many researchers have developed traffic monitoring system using YOLO for detecting and counting vehicle. these systems help in understanding traffic.
Density and Monitoring and improving traffic management. Therefore AI-based traffic system is becoming more useful in smart city applications.

III. PROBLEM STATEMENT

Traffic congestion has become a serious issue in urban areas due to increasing in number of vehicles on road. The current traffic signal works on mostly fixed time and do not change time according to current traffic conditions.
The areas where traffic signal are not present there also traffic occurs the most, we have taken an example of college area where traffic occurs the most during peak hours. Because of this, many roads experience heavy traffic which leads to air pollution, unnecessary waiting time, and wastage of fuel.
There is need of a system that can observe and detect Real time Traffic monitoring on the basis of numbers of vehicles on the road according to it adjust traffic signal timing. such system can improve traffic congestion and reduce air pollution, and unnecessary wastage of fuels and improve traffic.

IV. OBJECTIVES

- To Develop a smart traffic control system using Artificial Intelligence.
- To detect vehicles in real time using the YOLO algorithm.
- To count the number of vehicles on different roads
- To understand Traffic density in different conditions
- To control traffic signal timing automatically.
- To reduce traffic congestion as well as waiting time.
- To improve overall traffic flow and management.

V. SYSTEM DESCRIPTION

The proposed system is a smart traffic monitoring system based on Artificial Intelligence and Computer Vision techniques. It is developed to manage real-time traffic conditions more efficiently compared to current traffic systems

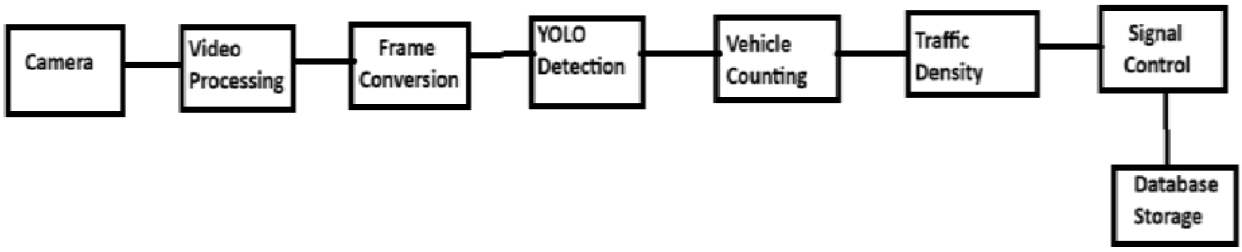

Fig 5.1: Block diagram of Smart Traffic Monitoring System

The block diagram shows the overall working of Proposed
System. First in this system a camera is used to capture live video of the road and the video is processed using image processing methods to get useful information. the captured video is divided into multiple frames (images) so that each frame can check properly. For vehicle detection, the YOLO (You Only Look Once) algorithm is used, which helps in detecting different types of vehicles like Bus, Cars, Rickshaw, Bikes, Trucks.
This algorithm is very fast and have ability to detect multiple vehicles in single frame with good accuracy.
After detecting the vehicles, the system counts the number of vehicle present on each side of road and according to this count, the traffic density is understood. According to this Traffic density the Traffic signal timing is changed (adjust. Roads with more Traffic are given high green time signal. And Roads with less vehicles are given low green time signal. The overall data of vehicles is stored in database for future use. This can help in improving Traffic management, Also the area where the traffic signals are not present there the system can still monitor traffic flow by Providing alerts or suggestions for proper road use. It will detect the vehicles on the

road and data of peak hours of that particular road to traffic control system to manage the traffic and provide proper route for those vehicles. This is helpful in places like rural areas or roads where traffic occurs the most where traffic signal is not present. this system can also detect rule violation for this system we have taken a real time example of areas such as our college area where traffic occurs the most due improper traffic management where traffic police are present but still their traffic occurs due it is main road where heavy vehicles and college going student office going students and visit the most therefore during peak hours traffic occurs the most

VI. METHODLOGY

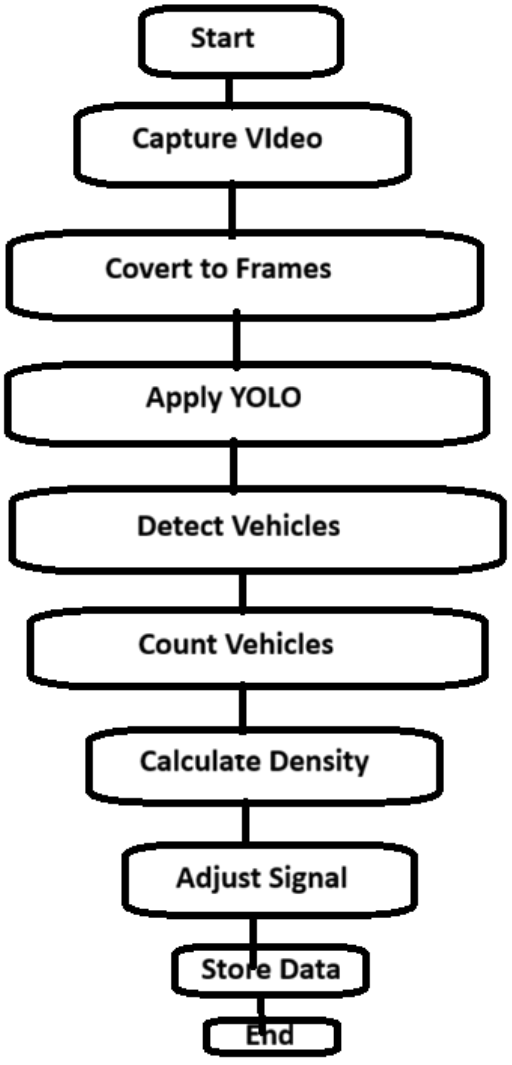

Fig 6.1: Flowchart of Proposed Methodology

The Methodology of the Proposed System Describes how the traffic Monitoring system works in a simple and systematic way.

This system starts by capturing live video of the road using a CCTV camera. The captures video is then converted into frames (images) so that each frame can checked properly. After that the YOLO (You Only Look Once) algorithm is applied to detect vehicles present in each frame. it helps in detecting different types of vehicles such as cars, bikes, buses, trucks and Auto-rickshaw with accurate correctness using bounding boxes. once the vehicles are detected the system will count the number of vehicles.

According to that count, the traffic density is calculated. based on traffic density, the system adjusts the traffic signal timing automatically. Roads with more traffic are given more green signal time, while roads with less traffic less green time signal. At last, all traffic data is stored in Database for future use or analysis or any further improvement.

VII. EXPERIMENTAL RESULTS

The experimental results of the proposed System show that it performs effectively in real time traffic monitoring. The system was tested using different traffic video inputs, including recorded and live traffic detection.

It was able to detect multiple vehicles such as cars, bikes, buses, auto-rickshaw, scooters, trucks, etc in single frame.

The YOLO algorithm provided Fast detection with good accuracy.

In the output, the bounding boxes were generated around each detected vehicle. which helps to identify vehicle position. the system successfully counted number of vehicles in each frame and determined traffic density accurately.

These results show that the system can work under different traffic conditions such as low, medium and high traffic. however slightly changes were observed in detection accuracy, during heavy rain and poor lighting.

Overall, the system performs reliable and proved to be useful traffic monitoring and management.

Fig 7.1: Overall Experimental Output of Detecting Vehicles

VIII. ADVANTAGES

Real-time Traffic Monitoring: The system monitors traffic in real time using cameras, which helps in understanding road condition easily and quickly.

Reduction in Traffic Congestion: it reduces traffic congestion by adjusting signal timing based on the number of vehicles on the road.

Improved signal Efficiency: The system improves Signal efficiency by avoiding fixed timing.

Detection of Multiple vehicles: It can detect multiple vehicles in the same time using YOLO (You Only Look Once) algorithm.

Useful in NON-Signal areas: It can be used in areas without traffic signals to monitor and manage vehicle movement.

Support for Smart City Development: It helps in smart city development by improving traffic management using modern technology.

IX. LIMITATIONS

The system performance may reduce in poor lighting conditions such as night or heavy rain.
It requires good quality camera for accurate detection of vehicles.
The system needs proper internet support for real- time processing.
Detection accuracy may slightly decrease in every crowded traffic conditions.

X. FUTURE SCOPE

The system can be improved by using advanced cameras for better accuracy.
It can be connected with smart city systems for better traffic management.
More features like traffic rule violation detection can be added.
The system can be expanded for use in large city areas and highways.

XI.CONCLUSION

Traffic congestion is one of the common problems in many cities in India due to increase in number of vehicles. Managing traffic using old fixed signal systems is not always useful, as it does not handle real-time traffic conditions. because of this, there is a need for a smarter and more adjustable traffic management system
In this project a smart traffic monitoring system is developed using Artificial Intelligence and computer vision. the system uses a camera to capture road video and applies the YOLO algorithm to detect vehicles. According to number of vehicles, the system calculates traffic density and adjusts signal timing accordingly. this helps in improving traffic flow and reducing unnecessary waiting time. These results show that the system works properly in detecting vehicles and Analysing traffic conditions. It can be useful in real-time traffic monitoring and can reduce human effort.
Overall, the project helps in understanding how Artificial Intelligence can be used in Traffic management and can be useful for smart city development.

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