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Vehicle Detection And Counting System Using Artificial Intelligence

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Abstract: There are multiple methods available for monitoring traffic conditions on roadways. With the advancement of artificial intelligence (AI) in image processing technology, there is an increasing interest in creating traffic monitoring systems that utilize camera vision data. This research paper presents a technique for extracting traffic information from a camera positioned at an intersection, aimed at enhancing road monitoring systems. The approach employs a deep learning model (YOLOv4) for processing images to detect vehicles and classify their types. Vehicle trajectories are estimated lane by lane by correlating the detected vehicle positions with a high definition map (HD map). From these estimated trajectories, the traffic volumes for each lane's direction of travel are calculated. The effectiveness of the proposed method was evaluated using samples across distinct criteria: vehicle detection rate, traffic volume estimation. The findings indicate a 99% success rate in vehicle detection, introduced in this research demonstrates the potential for gathering detailed traffic data installed at an intersection. The integration of AI technologies represents the primary contribution of this study, highlighting significant potential for enhancing existing traffic monitoring systems.

***Keywords*-:** Vehicle detection and counting, YOLO, artificial Intelligence.

I. INTRODUCTION

In urban areas, the growth in the number of vehicles usually surpasses the improvement of the existing traffic structures, and this causes severe pressure in traffic management. The results of the scenario involve economic, vehicle accidents, high levels of carbon and greenhouse gases, a long time to travel, adverse health problems, among others. Traffic management authorities are extremely effective in mitigating these problems. Traffic management systems collect information from various sources, analyze it to determine potential risks affecting the roadway network, and put in control methods most efficiently. Continuous video monitoring poses several challenges to the analysis of traffic by computers. Several sources of interference exist with automatically operating systems: shadows, and interference due to the vehicles, together with environmental conditions like rain, fog, and dust that can decrease the performance. Despite a huge number of dedicated attempts, a robust technique for vehicle counting in adverse weather conditions has yet to be obtained. There are several methods for highway traffic video analysis, but they are mostly limited to particular roadway scenarios without generalizability. The current techniques are mostly about permanent capture in fixed cameras operating under clear conditions, and they frequently separate the moving objects based upon background subtraction. Thus, it uses mass analysis and tracking of vehicles to analyze traffic flow.

However, these methods often suffer from blockages, shading, camera instability, misaligned cameras, and busy backgrounds. Car counting can present a massive solution for most traffic-related problems. The number of vehicles on a particular highway can provide useful insight into traffic trends. Based on this traffic data, governmental authorities may issue guidelines related to the construction or expansion of roads. Additionally, measures such as implementing one-way streets may be adopted during certain times of the day counter to pay. Barcode billing is a labour-intensive procedure that takes a lot of time. Because we have to scan each label manually, it requires lots of labour. Another drawback is that barcodes cannot be viewed at great distances. Therefore, our goal is to develop an automated billing system that uses RF identification.

II. LITERATURE SURVEY

In a study conducted by Jenisha R et al. [1] paper discussed the possibility of using a deep learning and OpenCV-based vehicle-counting system. The proposed system can recognize and count the vehicles passing through those particular areas, which will be helpful for traffic analysis and management. Real-time vehicle detection and counting accuracy has been tremendous in deep learning-based object detection techniques. It uses the YOLO v8 model, one of the best object detection frameworks based on the most attractive accuracy and real-time recall. The application areas for deep learning regarding vehicle counting are diverse: traffic monitoring and surveillance, ecological studies, retail research, and border patrol, among others.

Huansheng Song et al. [2] present vehicle detection and counting are two of the essential modules of highway management systems, and the efficiency describes the overall performance of the system. This paper deals with the challenge of providing accurate vehicle detection that varies significantly with vehicle sizes. A vision-based vehicle detection and counting system is proposed; the system is developed using a high-definition vehicle dataset derived from surveillance footage. The methodology used in the paper is object detection and tracking apt for highway surveillance video, thus constituting a strong framework of vehicle counting. Finds of the study provide significant information for research in European transport.

Haojia Lin et al. [3] representing traffic monitoring is one of the basic practices in ITS as it looks at and collects information on the status of the road network. This paper uses deep learning in the vehicle counting process in the traffic video analysis. Since there was no availability of annotated datasets, a transfer learning-based vehicle detection approach was proposed to provide better recognition in very small amounts of labeled data.

V. Sisaudia et al. [4] With the initiation of smart city developments, highway traffic management and monitoring of urban vehicles remain the biggest hurdles. Technological improvement over the past decades has significantly advanced solutions in connection with traffic management. The paper introduces vision-based technology in detecting and counting vehicles through cameras, tracking not just the vehicle count within a frame but also the speed of such vehicles, hence providing an integrated view for monitoring traffic.

III. METHODOLOGY

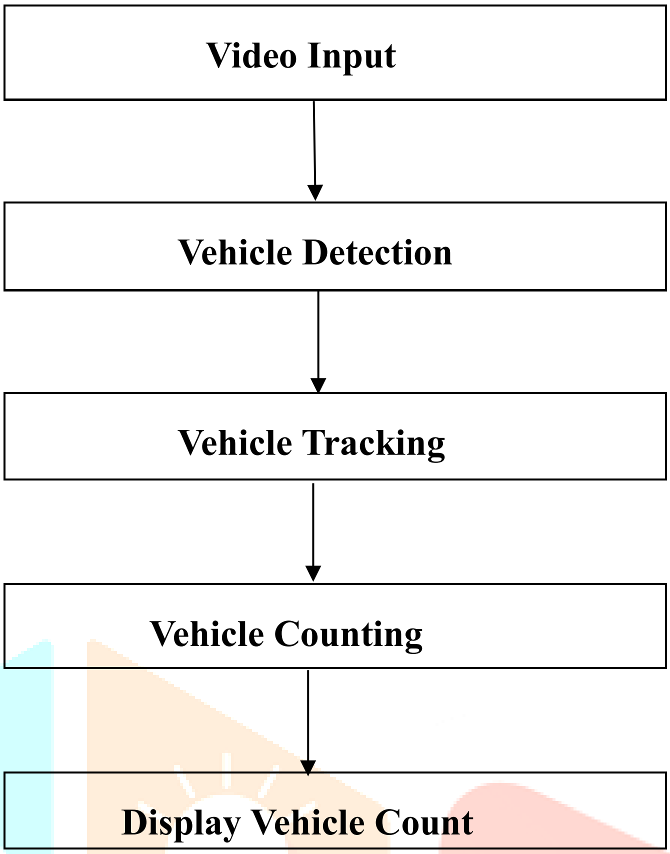

Fig.1 Block diagram of Proposed System

The figure no.1 shows the block diagram of vehicle detection and counting system.

Video Input: The system makes use of video as input to determine and locate vehicle detection. The input video is analysed using methodologies of computer vision and deep learning frameworks, namely, CNNs, to recognize the existence of vehicles in each frame. The system detects important features such as vehicle shape and motion as well as tracks their paths over successive frames. This allows for accurate vehicle counting and determination of different types, including cars, trucks, and motorcycles.

Vehicle Detection: It refers to the process of detecting and localizing vehicles in a video frame or an image through the use of various techniques and technologies. Vehicle detection in a system developed for vehicle detection and counting via deep learning is the process of vehicle detection and localization in video frames or images. This process applies advanced computer vision methods and deep learning architectures, including You Only Look Once (YOLO) frameworks to be able to identify vehicles effectively. The system processes the input data to identify characteristics such as shape, size, and edges, allowing it to distinguish cars from other objects or background components.

Vehicle Tracking: Vehicle tracking is the process of monitoring the movement of vehicles over time using various technologies and techniques. Techniques based on deep learning, such as Deep SORT (Simple Online and Realtime Tracking) and optical flow methods, are frequently utilized for this task.
These approaches help the system maintain precision, even in situations involving occlusions, overlapping vehicles, or variations in speed. By consistently updating the location and status of each vehicle, the tracking system supports accurate counting, flow analysis, and behavioural research. Vehicle tracking plays a crucial role in applications such as traffic congestion assessment, violation detection, and real-time optimization of traffic flow.

Vehicle Counting: Vehicle counting is the process of determining the number of vehicles passing a specific point or within a defined area. This method enhances vehicle detection and tracking by utilizing unique identifiers assigned during the tracking process, ensuring that each vehicle is counted only once as it crosses designated virtual lines or zones. Sophisticated algorithms and deep learning models guarantee high precision, even in difficult situations like heavy traffic, overlapping vehicles, or fluctuating lighting conditions. Vehicle counting delivers essential information for traffic management, urban development, and infrastructure improvement. By combining this functionality with detection and tracking, the system facilitates dynamic and scalable traffic analysis to aid smart transportation efforts.

Display Vehicle Count: A display count refers to the visual representation of the number of vehicles counted, typically shown on electronic signs. This data is usually presented on a dashboard, video feed overlay, or digital interface, with counts being updated in real time as vehicles move through specified zones. The system can classify counts by vehicle categories (such as cars, buses, and trucks) and offer comprehensive statistics, including hourly or daily totals. To improve data analysis and interpretation, visualization tools like graphs, charts, or heatmaps can be incorporated. Real-time vehicle count displays are essential for traffic control centers, facilitating informed decisions regarding congestion management, route optimization, and policy development.

IV. RESULT

The effectiveness of the vehicle counting and detection system can be assessed through a range of metrics. Below is an illustration of how these results may appear.

The figure 2 shows the following result as:

Total count =3, Current count = 0 , Gate is open

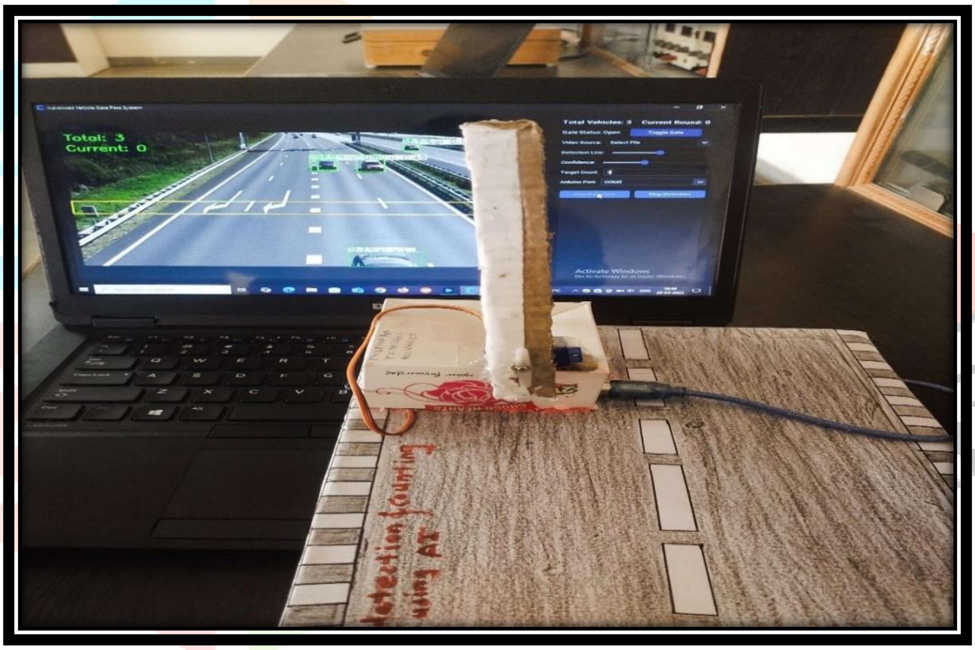

Fig.2 Vehicle current count is 0 and Gate is open

The figure 3 shows the following result as:

Total count =3, Current count = 2, Gate is open

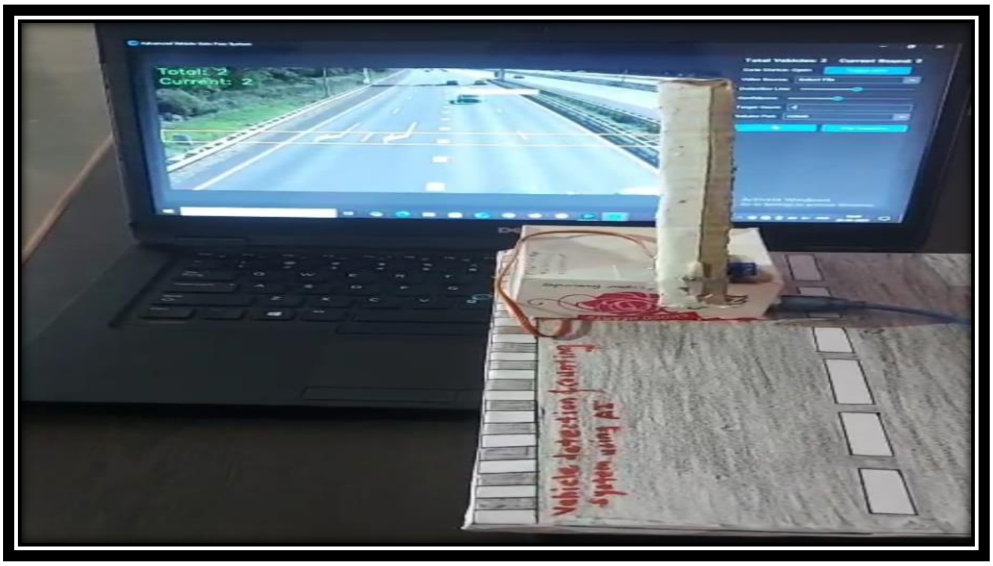

Fig.3. Vehicle current count is 2 and Gate is open

The figure 4 shows the following result as:
Total count =3 , Current count = 3, Gate is open

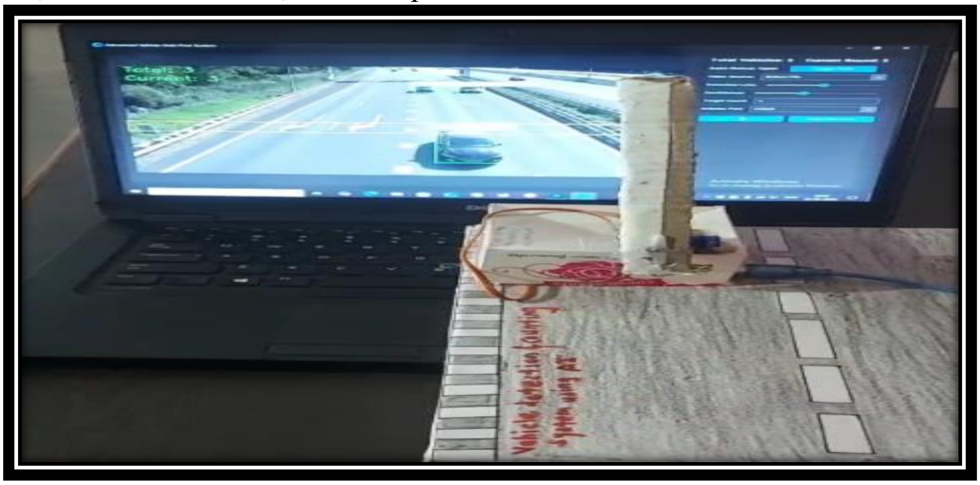

Fig.4. Vehicle current count is 3 and Gate is open

The figure 5 shows the following result as:
Total count =3 , Current count = 0, Gate is closed

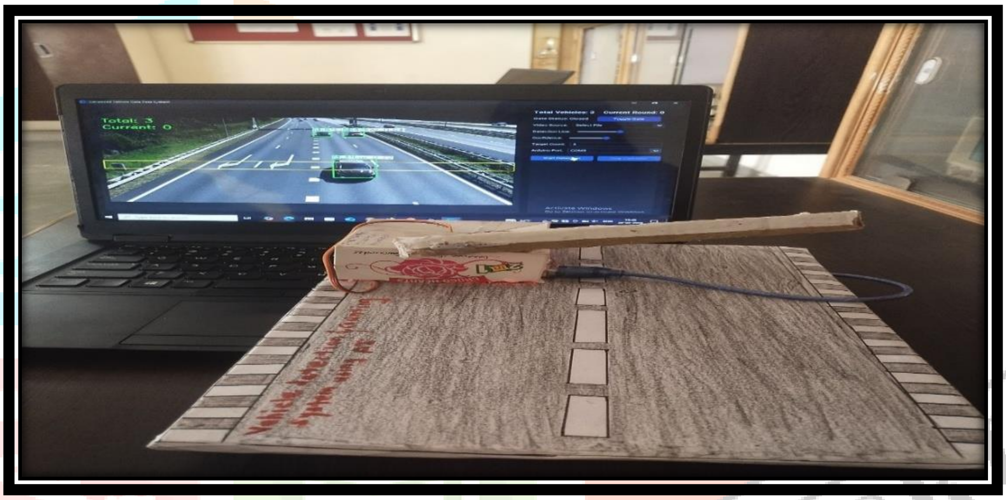

Fig.5 Vehicle current count is 0 and Gate is closed

This is a deep learning-based system that detects automobiles and counts them, as compared to traditional techniques, which would have a much higher amount of accuracy and efficiency improvement. This network uses a kind of neural network like YOLO, looking through varying environment conditions, tracking the number of cars in real time. When reset the total count of the vehicle, the total count along with the current count is represented of the existing vehicle count. If the same count of the total number and current number is repeated then the display result stops and the current value becomes zero.

V. DISCUSSIONS

Some of these models can process real time, which makes them suitable for application in traffic management and smart city initiatives but suffers occlusion and changing illumination. Their scalability and efficiency mainly position them for immense utilization in autonomous vehicles and urban infrastructure development undertakings.
It has less than 10% errors when the object size is small in the far part of the road. As said above, in case the sizes of objects are smaller than the section considered, the full-image detection method cannot recognize most of those objects placed in the far area. Our approach enormously increases the small objects to be detected in such areas. Furthermore, our approach would be better than the full-image detection strategy in detecting objects near the road.
The application includes relieving traffic congestion, enabling intelligent transportation systems, and advancing autonomous driving technologies. Moreover, despite some of the chronic challenges, these models are transforming urban planning and transportation into scalable, efficient, and dependable solutions.

VI. CONCLUSION

Vehicle detection and counting systems that utilize deep learning depend on a combination of integrated techniques to achieve precise and effective results. The approach employs a deep learning model (YOLOv4) for processing images to detect vehicles and classify their types. The system monitors the movement of detected objects, and vehicles are counted as a Current count and Target count. This system compares the current vehicle count with the target count and displays the vehicle count as output. This system is used in traffic management to monitor vehicle flow, optimize traffic signals as well as it is used in Toll Collection, Parking Management, Smart City Development, Accident Detection and Analysis, Environmental Monitoring, Market Research etc.

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