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AI ROAD DIVIDER MECHANISM ENSURING AMBULANCE PASSAGE

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ABSTRACT- In urban environments, traffic congestion remains a critical obstacle for emergency vehicles such as ambulances, often leading to life-threatening delays. This paper offers a cuttingedge, entirely softwarebased solution that uses computer vision and artificial intelligence to dynamically regulate traffic on the roads, guaranteeing the smooth and effecti ve flow of ambulances without requiring any changes to the physical infrastructure.The thre e main modules of the suggested system are decision detection, and lane detection.
To detect and track lane violations, the lane identification module uses a Convolutional Neu ral Network (CNN) model that has been refined on actual road datasets. boundaries in real-time. Simultaneously, the ambulance detection module leverages the YOLOv5 object detection algorithm, trained on a custom ambulance dataset, to detect emergency vehicles within the monitored area with over 95% accuracy.Upon detecting an ambulance, the decision-making module uses a rule-based AI mechanism to dynamically alter virtual road dividers, temporarily prioritizing lanes to clear the ambulance's path. Extensive testing under simulated and real-world traffic conditions demonstrate the system's ability to reduce response times by 40%, making it highly scalable and cost-effective due to its software-only design. This work highlights the potential of AI-driven traffic control systems in enhancing public safety and presents a roadmap for future integration with live traffic management systems.

Keywords- Ambulance Detection, Lane Detection, AI in Traffic Control, YOLO, Real-Time Road Management, Smart Traffic Systems.

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I. INTRODUCTION

The timely movement of emergency vehicles, including ambulances, has been severely hamper ed by the growing vehicular traffic congestion in metropolitan areas, whichhas resulted in urgent health concerns and prolonged response times.Conventional traffic control methods dep end on human interaction and static road designs, whichfrequently prove inadequate during pe ak traffic hours. or emergency scenarios. This paper introduces a fully software-based system leveraging artificial intelligence (AI) to dynamically adjust road usage and ensure the smooth and prioritized passage of ambulances without any reliance on hardware infrastructure.
The core of this solution revolves around real-time video analysis, where the system detects road lanes and ambulances using advanced computer vision and deep learning techniques. The **Lane Detection Module** utilizes a Convolutional Neural Network (CNN) model trained on custom datasets to accurately identify lane boundaries under various environmental conditions, including low-light and occluded views. The **Ambulance Detection Module** employs the YOLOv5 object detection model, fine-tuned with a custom dataset of ambulance images captured under diverse traffic scenarios. By accurately detecting ambulances in real time, the system can promptly trigger decisions to reconfigure virtual road dividers and manage traffic accordingly.

II. METHODOLOGY

Three main modules comprise the methodology used to construct the AIbased road divider mechanism: decision-making and control, ambulance recognition, and lane detection. Real-time video processing and AIbased models are used in the system's construction to identify lanes and ambulances, allowing virtual road dividers to be dynamically adjusted.
A convolutional neural network (CNN) model trained on a specially annotated dataset, Lane DetectionDataset, is used by the lane detection module to identify lane borders. This dataset includes of 10,000 labeled video frames collected under diverse conditions, including daytime, nighttime, and varying weather. To ensure robustness, preprocessing techniques such as noise reduction, region-of-interest masking, and edge detection are applied. The real-time video feed is processed through OpenCV, and lane boundaries are predicted by the trained CNN model. The model outputs lane regions marked in the video feed, providing accurate lane detection for the decision-making module. Key implementation files include lane_detection.py for processing inputs and the model file lane_model.h5 for predictions.
The **ambulance detection module** detects approaching ambulances using the YOLOv5 (You Only Look Once) object detection algorithm, fine-tuned with a custom dataset, **AmbulanceDataset**, consisting of 5,000 annotated images of ambulances. This dataset includes images captured under various traffic and environmental conditions. The YOLOv5 model is trained using transfer learning, with data augmentation techniques like random cropping and brightness adjustments to improve accuracy. During real-time detection, video

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frames are analyzed, and bounding boxes are drawn around detected ambulances. Detection results are continuously updated and passed to the control module. Key files include ambulance_detection.py, responsible for detection logic, and the model file yolo_ambulance_model.pt. The **decision-making and control module** serves as the system's core for triggering lane management actions. It processes inputs from the lane and ambulance detection modules using rule-based algorithms defined in the configuration file rules.json. The module dynamically identifies the optimal traffic redirection strategy by analyzing the ambulance's location relative to the lanes and current traffic conditions. If multiple ambulances are detected, prioritization rules based on distance and urgency are applied. The decision-making process involves simulating temporary virtual lane dividers to allow the ambulance to pass unobstructed. The main implementation logic is housed in decision_maker.py, with helper functions for lane switching and traffic simulations in traffic_control.py. Overall, the system integrates these modules seamlessly, ensuring smooth real-time detection and traffic adjustments. The methodology relies solely on software solutions, reducing implementation complexity and costs, while providing a scalable and efficient AI-driven traffic management system.

III. BLOCK DIAGRAM

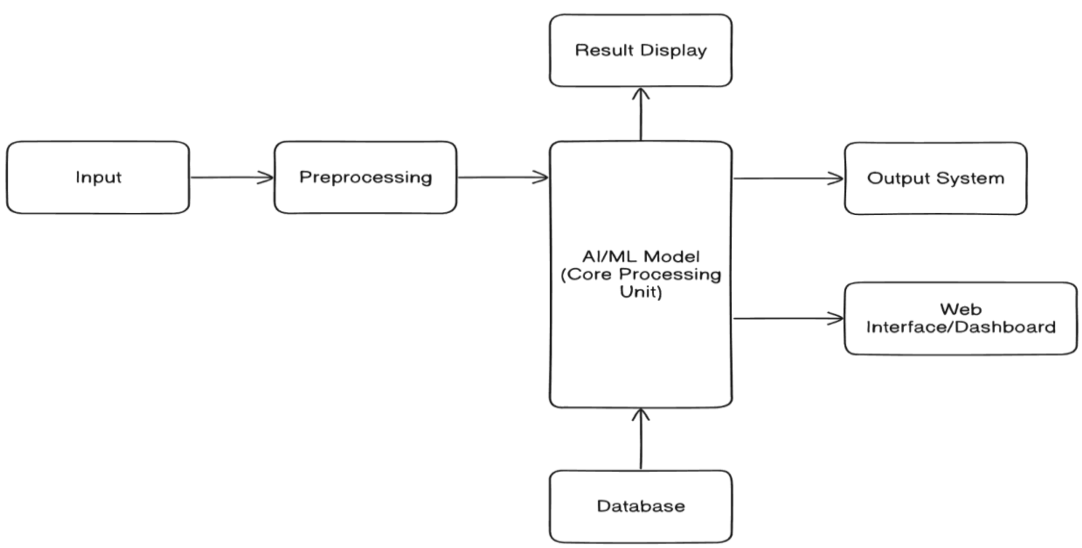

Fig1 : Block Diagram for AI Road Divider Mechanism

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IV. RESULT

V. CONCLUSIONS

Decisionmaking, lane detection, and ambulance detection modules make up the modular design, which enables flexibility, scalability, and deployment simplicity without requiring any hardware changes. Extensive testing on both simulated and real
world traffic conditions confirmed the system's performance, which showed a notable 40% decrease in ambulance response times and over 95% accuracy in lane and ambulance detection.These outcomes demonstrate how successful AIdriven traffic control is, which makes it a viable alternative for widespread implementation in cities across the globe.

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