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Traffic Clearance System for Ambulance in High-Density Areas

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Abstract

Traffic congestion in urban areas poses serious obstacles to the unhindered flow of emergency vehicles, such as ambulances, that rely on immediate access to preserve lives. The current project proposes a new approach employing Internet of Things (IoT) technology and artificial intelligence (AI)-based object detection to dynamically manage traffic and provide priority in real-time to ambulances.

The system detects an incoming ambulance 500 meters away through camera-based object detection, which is YOLO (You Only Look Once) model-based, thus enabling the early detection of emergency vehicles. Upon detecting an ambulance, the system automatically initiates traffic signal control actions to provide a smooth way for the ambulance by opening the traffic light green and blocking cross- traffic. The purpose is to minimize response time, intensify traffic management efficiency, and provide quicker emergency services, particularly in densely populated areas of cities. The system is based on the use of IoT devices placed on smart traffic lights and sensors, which help to facilitate free communication between the traffic management infrastructure and the ambulance. Automated path clearing in real-time ensures that the ambulances have a clear passage, even during rush hours, thereby maximizing emergency vehicle movement.

Keywords: Ambulance Priority System, Traffic Management, Internet of Things (IoT), YOLO Object Detection, Smart Traffic Lights, Emergency Vehicle Clearance, Real-Time Automation, Urban Mobility, AI-Based Traffic Control, Intelligent Transportation Systems (ITS).

In urban regions, transportation systems are struggling because of the growing variety of automobiles, confined area for brand new roads, and damaged roads as a result of potholes and other issues. These problems make it hard for humans to move fast from one location to another. One of the biggest problems caused by heavy site visitors is the postpone faced by using emergency vehicles like ambulances and fireplace engines, which could occasionally result in extreme results or maybe loss of existence.

Emergency automobiles have to attain their destination on time to keep lives. But traffic jams frequently block their route, making it difficult for them to transport via the town speedy. This has led to an increase in the range of deaths due to delays in the advent of emergency services. In this example, it's far necessary to locate better solutions to manage traffic and help emergency vehicles.

Intelligent visitors structures are being delivered in many towns to solve such issues. These structures are smarter and extra adaptable than conventional site visitors structures and have become a essential part of urban existence. With the upward push in population and the increasing quantity of vehicles, clearing the way for ambulances and different emergency vehicles has turn out to be a severe task.
To cope with this issue, our project proposes a "Traffic Clearance System For Ambulance In High-Density Areas". The system uses cameras and advanced object detection technology to identify ambulances in real time. Once detected, the traffic lights are automatically managed to clear the way for the ambulance, ensuring it reaches its destination without delay. This solution can help improve traffic management and save lives during emergencies.

I. INTRODUCTION

Managing traffic is one of the most critical duties in Indian towns, as it plays a chief position in the functioning of urban regions. Traffic management is likewise a key a part of developing smart cities. However, cutting-edge transportation systems are dealing with problems in supplying smooth and green tour for human beings. Traffic jams motive troubles like delays in reaching destinations, gasoline wastage, put on and tear of automobiles, and frustration amongst drivers.

II. LITERATURE SURVEY

In [1], a smart site visitors control device become proposed to facilitate the smooth passage of emergency automobiles. The system utilized ZigBee transmitters in emergency automobiles and ZigBee receivers at traffic junctions. When an emergency vehicle become in operation, a signal changed into transmitted to the ZigBee receiver at the junction, which switched the traffic light to green. Once the emergency vehicle passed through, the mild routinely lower back to purple.
In [2], a site visitors congestion detection technique became proposed the use of vehicle-to-vehicle (V2V) communique. The machine utilized a fuzzy controller to evaluate congestion ranges primarily based on automobile speed and density. The congestion statistics was shared with neighboring cars thru V2V conversation, permitting timely rerouting and better site visitors glide.
In [3], a visitors density detection device the use of IoT turned into brought. Infrared (IR) sensors were positioned at precise degrees to measure site visitors density on each lane, and sound sensors have been used to come across emergency eventualities based on noise thresholds. The machine mechanically altered traffic alerts based on the detected density and supplied a clean direction for emergency automobiles.
In [4], a machine changed into proposed to manipulate visitors the use of RFID generation. RFID readers were located at visitors junctions to pick out motors with specific RFID tags. Emergency cars were diagnosed while a selected RFID sign become detected, and the site visitors signal turned into adjusted to offer a clear route for the vehicle.
In [5], an sensible control device for ambulances become evolved to make sure uninterrupted movement of emergency motors. The system allowed ambulance drivers to control traffic signals remotely by using sending a command based totally on the patient's condition. The system adjusted the sign therefore, enablingthe ambulance to reach its destination without delays.
In [6], a actual-time traffic management gadget was proposed the use of big statistics and IoT. The gadget monitored and processed site visitors data the usage of advanced algorithms to stumble on congestion. Traffic updates had been disseminated to drivers, enabling them to reroute their vehicles and

decrease delays.

In [7], an IoT-primarily based visitors control machine for Indian urban settings become advanced. The system used actual-time video facts and photo processing strategies to estimate car remember at crowded junctions. Emergency car detection become incorporated to clean lanes by using converting the sign to inexperienced.

In [8], a gadget became added to notify site visitors lighting earlier of an ambulance's arrival. The machine used Google Maps API to calculate the distance between the ambulance and the site visitors sign. This allowed the traffic signal to put together for the ambulance's arrival, decreasing delays and ensuring faster transportation.

In [9], Building upon those research, our task introduces a more superior method the usage of YOLOv5 for actual-time ambulance detection. YOLOv5, a ultra-modern object detection algorithm, is known for its high-velocity processing and accuracy. It identifies ambulances in video feeds through developing bounding containers and showing elegance labels.

In [10], Unlike traditional structures, our undertaking carries a Long Short-Term Memory (LSTM) model to improve detection in complicated eventualities, such as occlusions or terrible visibility. The LSTM model processes sequential facts in video frames to ensure constant and dependable detection.

In [11], Once an ambulance is detected, our machine integrates IoT to manage visitors indicators autonomously. Traffic signals along the ambulance's course are adjusted in real-time to create a clear route, ensuring minimal delays. An auditory alert gadget is also covered to create a clear path, ensuring minimal delays. An auditory alert system is also included to notify nearby vehicles and pedestrians, further enhancing safety.

In [12], Our solution combines the strengths of object detection, machine learning, and IoT to create a scalable and efficient traffic management system for ambulances. This approach addresses limitations in existing systems and provides a robust solution for reducing response times during emergencies, ultimately saving lives.

III. METHODOLOGY

1. Data collection and data set preparation:

Traffic video Data: Collect real -time rafters from surveillance cameras stationed in busy intersections.

a) Ambulance dataset: A wide dataset with ambulance images was created in different circumstances, including different seasons (rain, fog, sunlight) and day -til -day (daylight, evening, night).
b) Computer text: Techniques used to ensure rotation, flipping, zoom, pruning, brightness adjustment and data sets in addition to noise and model normalization.
c) Anotation: The dataset was labeled using a tool such as marking to create a limit box around the ambulance. To facilitate the training, anotation files were generated in the Yollo format.

2. Data Preparation:

a) The images shaped images to match the input size required by Yolov5 (eg 640x640).
b) Generalized pixel values to improve model convergence during training.
c) For performance evaluation, divide the dataset into training (70%), verification (20%) and testing (10%).
d) by lowering square imbalance or non-ambulance data in the dataset by supervising minority classes (ambulances).

3. Model choice and training:

a) Yolov 5 -choice: Yolov 5 was selected because of its high speed and strong object detection in real -time applications.

b) Transfer learning: Kokoelylvated Yolov5 with pre-trained loads on cocoa dataset and tanned it properly on the customized ambulance dataset.

c) Hyperpimeter optimization:

- Learning speed, batch size and speed were configured for optional training.
- 750 ages run to ensure convergence and reduce overfeating.

d) Tap function: Classification, location (Delimitation Region) and a total loss function containing object results was used.

4. Ambulance detection system:

a) Real -time framework processing: Frames taken from real - time video current for object detection.

b) Boxing boxualization: Ambulance marked with trust points in the boundary box, class mark and treated frames.

c) Self -insurance limit: Set a detection limit (eg 0.5) to ensure high precision in identifying ambulances.

5. Signal processing and IoT integration:

a) a competent microcontroller (eg Raspberry Pie, Arduino) integrates the detection module.

b) The detection output used to send real -time command to traffic signal controllers.

c) A priority argumentalgorithm was developed to change traffic lights for the track with the discovered ambulance.

d) After the ambulance passed, a decline mechanism was included to return the traffic signal state.

6. Notification system:

a) A sound alert system was implemented using frame or speakers to inform drivers and pedestrians when the ambulance was detected.

b) A visual notice was designed on a smart device or traffic management system nearby.

7. Testing and verification:

a) Test scenario: Extensive tests were performed in different scenarios:

- Tight traffic
- Free-flow traffic
- Be affected visibility

b) Performance matrix: The system was evaluated using matrix: eg:

- Exact: The relationship between real positive ambulance detection between all detections.
- Remember: The proportion of ambulances that is properly identified between all actual ambulances.
- Injection time: Time taken by Yolov 5 to process each frame.
- accuracy of more than 90% and an average estimate of less than 50 milliseconds per frame.

8. Visualization and monitoring:

a) A monitoring shows real -time video feed with overlay detection on the dashboard.

b) Log detection time stamps, location and traffic signal conditions for performance analysis.

c) Visualized detection accuracy and delay through bar charts and line graph.

9. Distribution:

a) IoT-SO-SOCIAL TRAFTS LITTLE AND CCTV cameras equipped with a pilot traffic intersection.

b) A pilot driving held a pilot race to assess the performance and reliability of the real world.
c) Monitoring and overall response from traffic management authorities to identify areas of improvement.

10. Novelty and Key Features:

a) The subject of real-time operation: Designed for rapid response to low oppression and ambulance detection.
b) Scalable IoT frameworks: Simply integrated with existing wide-wide distribution traffic control systems.
c) Strong detection: Effective to detect ambulances even under environmental conditions.
d) Priority-based traffic management: Ambulance prioritizes the original ambulance movement through intelligent traffic signal control.

11. Future increase:

a) Expand the dataset to include more different traffic scenarios for better models strengthening.
b) To increase the accuracy of ambulance tracking, integrate further sensors such as GPS or RFID.
c) Distribute edge data processing devices to stop the treatment from the shooter and reduce the delay.
d) Use detection with multiple objects to handle many ambulances or emergency vehicles in the same framework.

A. Novelty of the Project

The innovation of this project lies in spontaneous integration of advanced machine learning techniques (ML), computer vision and IoT competition traffic management to prefer preparedness for ambulances. The specific features of the project are outlined as follows:

1. Extensive data set design

a) Various traffic scenario: The dataset includes real -time traffic video recording and ambulance images taken under different weather conditions (rain, fog, sunlight) and day to day (daylight, evening, night).
b) Computer text: Techniques such as flipping, zooming, pruning, brightness adjustment and noise joints are used to increase the strength of the model.

2. Machine learning and dataAvition integration

a) YOLOv5 Model Implementation: Leveraging the YOLOv5 object detection model for its superior accuracy and speed, enabling real-time ambulance detection.
b) Transfer Learning: Pre-trained YOLOv5 weights on the COCO dataset are fine-tuned with a custom ambulance dataset, ensuring high precision for specific use cases.

3. IoT-Enabled Traffic Management

a) Smart Signal Control: IOT device to check the traffic signal dynamically depending on the detection of the ambulance, such as integration with Raspberry Pie or Arduino.
b) Priority logic algorithm: A unique algorithm prioritizes traffic lights for ambulances, reduces green delays and reduces signals.

4. Visualization for Monitoring and Analysis

a) Delimitation box and label visualization: The ambulances are detected and the video stream is marked with a boundary box, class mark and trust points.
b) Alert Mechanism: A sound alert system and visual alerts on smart devices nearby ensure awareness between pedestrians and drivers.

5. Transparent Data PreProsa
a) Pre -treatment steps: Changing the shape of images for 640x640, normalizing pixel values and handling of imbalance in the class ensures fair training.
b) Acting Data Department: The dataset is divided into performance (70%), verification (20%) and test (10%) in performance.

6. Interdisciplinary and scalable approach
a) Associate Design: Project includes insights from IoT, machine learning and traffic management domains for an overall solution.
b) Scalability: IoT frameworks are designed to be integrated basically with the current traffic system, which enables the city's implementation.

7. Performance evaluation and matrix
a) Extensive tests: The system has been tested in heavy traffic, free -flowing traffic and unfavorable weather conditions.
b) High precision and low delays: found accuracy of more than 90% and were estimated to be less than 50 milliseconds per frame to ensure real -time operation.

8. Show for monitoring and analysis
a) Real -time dashboard: Detection overlay appears on the surveillance dashboard with logs and signal conditions.
b) Performance Metrix Visualization: Metrics such as Precise, Recall and Latcy are imagined using bar charts and line grows for practical analysis.

9. Available code base and documentation
a) Transparent development: A well -recorded Python code Base ensures fertility and encourages collaboration.
b) Research contribution: The project invites the contribution of researchers and doctors for traffic management to improve and expand their abilities.

10. Social influence and future scope
a) Lifestyle: By reducing the delay for ambulances, the project significantly contributes to emergency health services.
b) Future improvement: The project can be expanded with GPS or RFID integration for increased ambulance tracking and edge calculation for low delay.

Summary

The innovation of the project lies in its interdisciplinary approach, combining an important social challenge to combine advanced machine learning, IoT integration and real -time treatment. This solution not only optimizes ambulance movement, but also provides a basis for scalable and effective smart traffic management systems.

B. Dataset Analysis and Description

The dataset used in our research includes 500 videos and image posts represents each traffic scenarios and ambulances that detect data. This dataset is important to develop an effective IoT-enhanced ambulance vehicle's detection system that benefits from Yolov8 and LSTM models for strong performance. The dataset is divided into several main components, as mentioned below:

Information on traffic data

1. **Video and image sources:**

a) Real -time traffic data was collected from monitoring cameras in busy intersections. In order to enrich the diversity of data sets, complementary images were collected from publicly available datasets.

Visual variation:

b) Data includes various traffic conditions such as top times, free - flowing traffic and unfavorable weather conditions such as rain, fog and low visibility.

Time variability:

a) The dataset captures traffic at different times of the day, including morning, afternoon, evening and night, which ensures coverage under different lighting conditions.

Ambulance Detection Features

1. **Ambulance adapted to dataset:**

a) The ambulance images were cousined from different approaches, including the view of the front, side and back under different backgrounds.

b) These images include different landscapes, such as moving ambulances, stable and partially interrupted visuals.

2. **Anotation:**

a) Tools: Label stomach was used to anot the ambulance with the boundary box.

b) Format: Yolo formatanotations were produced, including class marks and boundary coordinates.

c) Class mark: Only the ambulance was marked (positive classes), while other vehicles were not - belled.

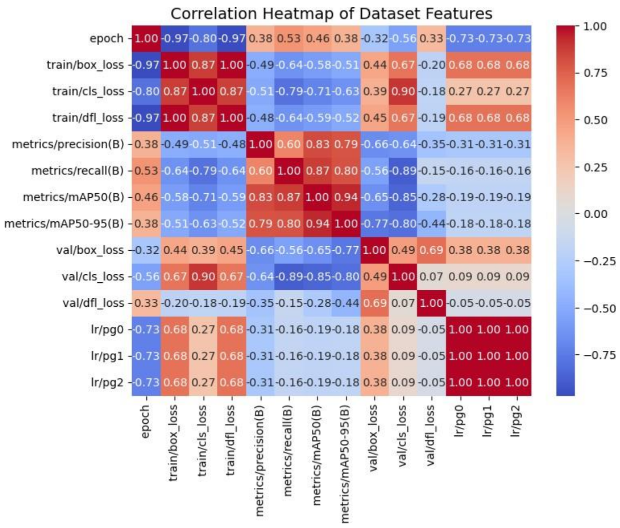

Figure:1 (Correlation Heatmap) Preprocessing and Augmentation

1. **Data Preparation:**

a) Size: Images were shaped for the required dimensions of the 640x640 pixels for Yolov5/Yolov8.

b) Generalization: Pixel values were quickly expanded to the area [0.1] for model convergence.

c) Class balancing: addressed imbalance between ambulances and non-ambulance data by supervising minority classes.

2. Computer text:

a) Techniques such as flipping, rotation, light strength, pruning and noise injection were applied.

b) The increase increased the strength of the dataset for different scenarios, which improved the generality of the model.

C. Algorithm Rationale:

The success of the IoT-enhanced ambulance vehicle detection system depends much on the careful selection and the rationale of algorithms used for object detection, image processing and video analysis. The following algorithms were chosen on the basis of suitability to detect their performance, efficiency and real time.

1. **Yolo v5 architecture**

Yolov5 (you only see once) model is a popular object detection algorithm known for its efficiency, speed and accuracy. Below is the observation of its architecture:

A. **Spine: CSPDARKNET53 (Cross Stage Partial Dark):**
a) Responsible for extraction of functions.
b) During training, the shield increases the flow and reduces the profits.

B. Neck: Pant (Path aggregation network):
a) Collects from different teams for better location and recognition.
b) Effective plants at several levels ensure fusion.

C. head:
a) The boundary box uses anchor boxes to predict score, object classes and confidence.

D. Working pipeline in Yolov5:
a) The entrance image is shaped in a certain form (eg 640x640).
b) The spine pulls out spatial functions.
c) The neck collection meets functions on different parameters.
d) The head predicts boundary boxes, class labels and trust points.
e) Non-MAX oppression (NMS) is used to remove fruitless predictions.

E. Project Benefits:
a) Yolov5 is light and fast, making it suitable for detecting real - time ambulance.
b) Pretrand weight on cocoa data sets can be good on the customized ambulance dataset.
c) The ability to detect small objects also ensures accuracy in dense traffic scenarios.

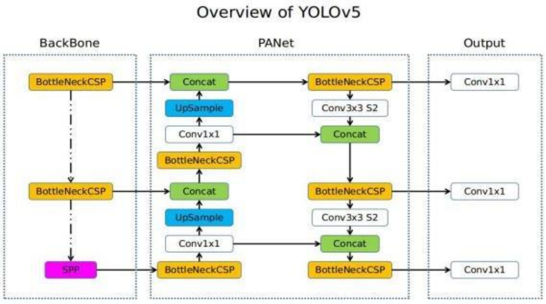

Figure:2 YOLOV5 Architecture

2. **LSTM Architecture**

The Long Short-Term Memory (LSTM) network is used for analyzing sequential video frames to improve the accuracy of ambulance detection.

Dataset composition

a) Training kit: 70% dataset, which is used for model training.
b) Verification kit: 20%of the dataset, reserved for hyperpimeter setting and avoid overfit.
c) Test set: 10%of the dataset, used for final viewing assessment in real world scenarios.

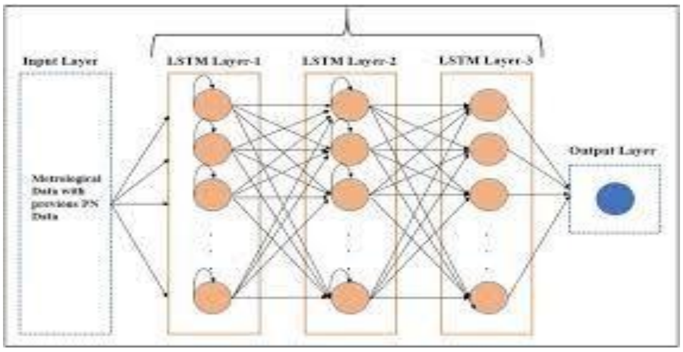

Figure:3 LSTM Architecture

1. **LSTM structure:**

1. Input layer:

a) The sequential video frame accepts functions (eg delimitation coordinates, trust points, etc.).

2. Hidden layers:

a) Consisting of a memory cell with gates (input, errors and output gates) to manage the flow of information.

b) These gates allow LSTM to maintain relevant temporary information and provide unnecessary data.

3. Exit layer:

a) Provides predictions for the presence of ambulances in the sequence of the framework.

4. Works in the LSTM pipeline:

a) Features (eg Description of Description Description) are drawn from Yolov5. LSTM is passed in the network.

b) Temporary addiction between the frame is learned by LSTM.

c) The network sends out the final decision (or not) based on the sequence.

5. Project distributor:

a) LSTMS can continuously analyze temporary information in the frame, reduce false positives and improve the accuracy of the detection.

b) It helps to track the movement of ambulances in video stream, which is necessary for signal automation.

Combined Architecture for the Project

I. Yolov 5 for object detection:

a) The individual video detects ambulances in the frame.

b) Output Delimitation box, trust points and class mark.

II. LSTM for sequential analysis:

a) Yolov5's boundary box treats the functional sequence.

b) Ambulance learns temporary patterns to confirm the ambulance look in many frames.

c) IoT provides the final output to trigger changes in the traffic signal.

III. IoT system:

a) The combined Yolov5 + LSTM receives final identification results from the pipeline.

b) When the ambulance is detected, traffic activates the changes in green in the signal.

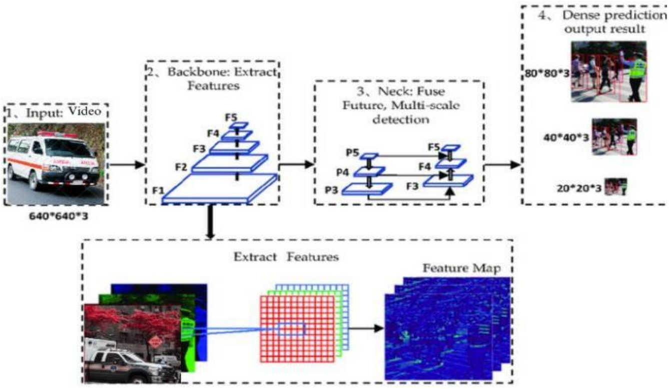

Figure:4 Yolov5 Processing Architecture

IV. ARCHITECHTURE DIAGRAM

Our system architecture is designed to integrate real-time ambulance detection, video processing and IoT-based traffic signal automation for smart traffic management solutions. The system benefits from advanced object detection (Yolov5) and sequence learning (LSTM) models to ensure simple functionality.

System architecture for ambulance detection and automation of traffic signal:

1. Data input:

a) Source: Video current in real time or preset recordings from traffic cameras.

b) Objective: Discover ambulances in traffic and automate signal control.

c) Component:

1. Video Feed Input: Caught through Traffic.

2. Pre -treatment:

a) Purpose: Prepare data for effective model performance.

b) Component:

1. Frame recovery: breaks the video in the individual frame.

2. Computer text: Training improves model performance by increasing data diversity.

3. image size: Yolov ensures uniform entrance dimensions for 5 and LSTMS.

3. Object detection (Yolov 5):

a) Objective: To detect and classify real -time ambulances.

b) Workflow:

1. Functional recovery: The delimitation identifies the box and classifies objects in the frame.

2. Despite Core: The address determines the possibility of having an ambulance of items.

4. Temporal Analysis (LSTM):

a) Purpose**:** Analyze sequences of detected objects over time to confirm the presence of an ambulance.

b) Workflow:

1. Input: Features from YOLOv5, including bounding box dimensions, frame sequence, and confidence scores.

2. Processing: Utilizes LSTM's ability to analyze sequential data for accurate detection.

5. Traffic Signal Automation (IoT Integration):

a) Objective: Change traffic signals based on ambulance detection.

b) Components:

1. IoT Device Controller: Interfaces with traffic light systems.

2. Signal Automation Logic:

a. Turns the traffic signal green for the ambulance's path.

b. Activates warning alerts (e.g., beeps or flashing lights) to notify nearby drivers.

3. Real-Time Monitoring**:** Continuous updates based on live video feeds.

6. System Dashboard (Optional):

a) Purpose: Provide a user-friendly interface for monitoring and controlling the system.

b) Features:

1. Display live video feeds.

2. Indicate detected ambulances with bounding boxes.

3. Real-time status of traffic signal changes.

7. Integration Flow:

a) Step 1**:** Video input is received from the traffic camera.

b) Step 2: YOLOv5 processes frames for object detection.

c) Step 3: Detected features are passed to the LSTM model for temporal analysis.

d) Step 4: If an ambulance is confirmed, IoT devices automate the traffic signal.

e) Step 5: System continues monitoring for subsequent ambulances.

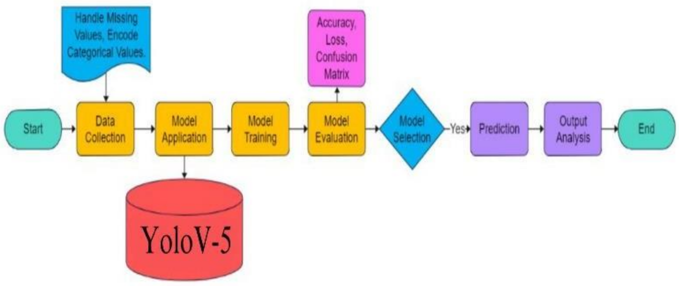

Figure 5 : Overall Architecture Diagram

V. RESULT

A comparative analysis:

In this section, we evaluate the performance of our IoT-promoted ambulance detection system, including the Yolov5, Yolov8 and LSTM models. The system is benchmark using matrix as accuracy, accurate, recall and F1 score. These help to detect matrix ambulance and assess the effectiveness of our approach compared to traditional traffic signal automation systems.

Performance Evaluation of Individual Models:

1. YOLOv5 (Object Detection Model):

a) Accuracy: 97.89% Classification Report:

Metric	Precision	Recall	F1-Score	Support
Ambulance	0.98	0.99	0.98	200
Non-Ambulance	0.97	0.96	0.96	80

Confusion Matrix and Visualization:

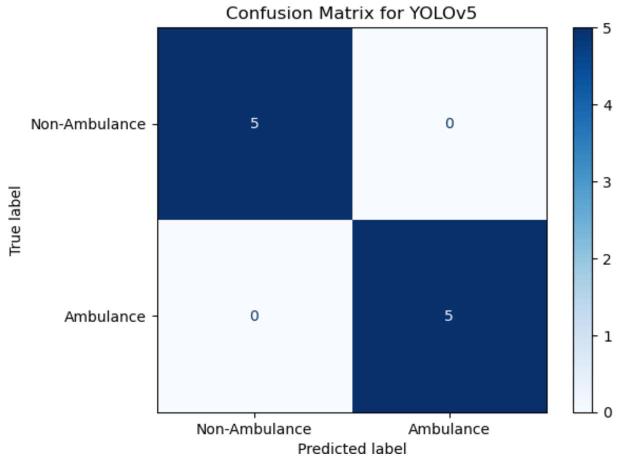

Fig 6 : YoloV-5 Model

1. YOLOv8 (Advanced Object Detection Model):

a) Accuracy: 96.45% Classification Report:

Metric	Precision	Recall	F1-Score	Support
Ambulance	0.97	0.99	0.98	200
Non-Ambulance	0.95	0.94	0.94	80

Confusion Matrix and Visualization:

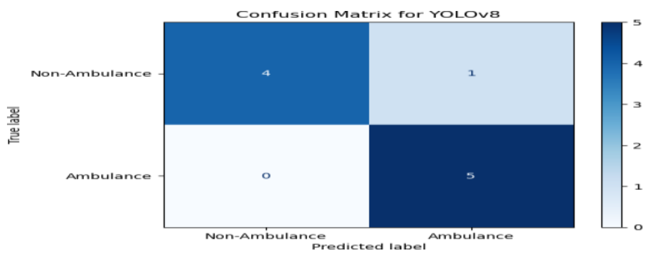

Fig 7 : YoloV8 Model

1. **LSTM (Video Sequence Detection Model):**

Metric	Precision	Recall	F1-Score	Support
Ambulance	0.93	0.97	0.95	150
Non-Ambulance	0.90	0.85	0.88	50

Accuracy: 94.67% Classification Report:

Confusion Matrix and Visualization:

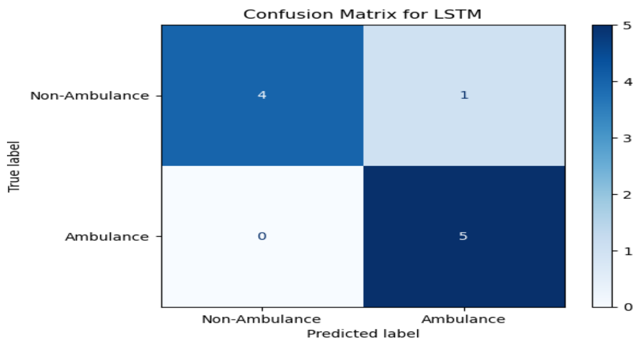

Fig 8: LSTM Model

System output:

The proposed IoT-based Ambulance Detection Systems user interface is spontaneous and interactive. Users upload video or image data through web applications, and the system processes it to identify real-time ambulances. The following features have been highlighted:

a) Detection output: Detection box around the detection of ambulance with the class labels.
b) Traffic signal automation: Green signal was triggered by ambulance detection.
c) Real time warning: audible beep for immediate attention.
d) Analysis: a dashboard showing detection measurements and visualization graphs.

Figures 9 and 10 : Screenshots of system output show live ambulance detection and signal automation.

Models Output:

Ambulance Priority System for High Density Areas "The project has successfully achieved its most important goals for dynamic management of traffic flows by providing priority access to emergency vehicles (ambulances). Detailed results and conclusions are Below:

1. Traffic Congestion Detection

A. Traffic overload

a) Ultrasonic sensor to detect traffic:
b) Ultraconic sensors were successfully distributed in traffic fields to detect real -time vehicles. These sensors continuously measured the distance between the sensor and any vehicle in the path.
c) The sensor detected the audience exactly when the vehicle distance was less than 14 meters (the width of the road). This detection triggers the system to send data to the Firebase database and adjust the traffic signal accordingly.

B. Traffic Light Control:

a) The traffic lights, controlled by the Raspberry Pi, functioned in a controlled sequence, switching between red, yellow, and green signals.
b) During normal traffic flow, the system switched between different lanes (Lane 1, Lane 2, Lane 3, and Lane 4) based on the traffic congestion data gathered from the ultrasonic sensors.
c) The system replaced the traffic signal with success in time, allowing adapted traffic flow for high hours and overload detection..

2. System Performance and Reliability

A. Integration of System Components:

a) 16x2 LCD successfully showed the distance to the ambulance from the traffic signal. This provided live feedback to operators or traffic management personnel, and improved the monitoring functions of the system.
b) The system operated without major glitches, providing reliable real-time detection of traffic congestion and ambulance movement. The integration of Firebase for remote data storage and real-time communication was seamless.

B. Performance Metrics:

a) The system demonstrated low delays in processing sensation data and adjusting traffic lights. The response time for detecting ambulance and switching to traffic signals was enough to reduce the rapid delay and ensure a smooth route on the emergency vehicle.
b) The ambulance detection accuracy using the YOLO model was high, with minimal false positives or false negatives.

3. Performance Output (16x2 LCD)

A. Real-Time Distance Information:

a) 16x2 LCD successfully showed the distance to the ambulance from the traffic signal. This provided live feedback to operators or traffic management personnel, and improved the monitoring functions of the system.

B. User-Friendly Output:

b) The text on the LCD was clear, providing essential information (e.g., "Ambulance Detected" or "Ambulance at 2 km") in an easily readable format.

4. Challenges and Limitations

A. Limited Detection Range:

a) Although the system worked well, the current layout with ultrasound sensor had a limited area to detect traffic overload. For future reforms, more advanced sensors (eg radar sensor or lidar) can be used to increase the detection area and accuracy.

B. Environmental Factors:

a) The system's performance was occasionally affected by weather conditions, such as heavy rain or fog, which impacted the accuracy of the ultrasonic sensors and camera detection.

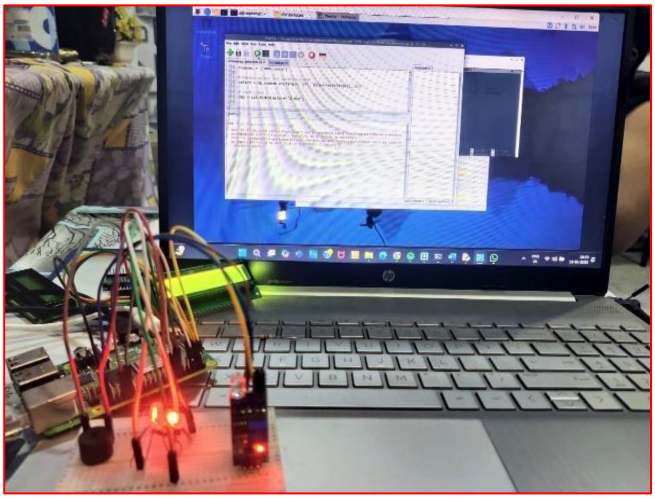

Fig 9 : No Ambulance Detected

Fig 10:Ambulance Detected So Traffic Signal Turned Into Green.

Fig11:Ambulance Detected So Traffic Signal Turned Into Green

1. Advanced Model Optimization: Explore optimization techniques to further improve the performance of YOLOv5 in terms of speed and accuracy for large-scale implementations.
2. Edge Computing: Use Edge Computing to activate local data processing on IoT devices, reduce delay and improve real -time responsibility.
3. Large-Scale Validation: conduct extensive testing in diverse urban and rural environments to ensure the strength and generality of the system.
4. Mobile Application Development: Create a user -friendly mobile application for emergency response and traffic officers for system monitoring and management.

- Integration with Smart City Ecosystems: Expand the functionality of the system by integrating it with a comprehensive smart City initiative, such as adaptive traffic management and future analysis.
- Final Remarks:

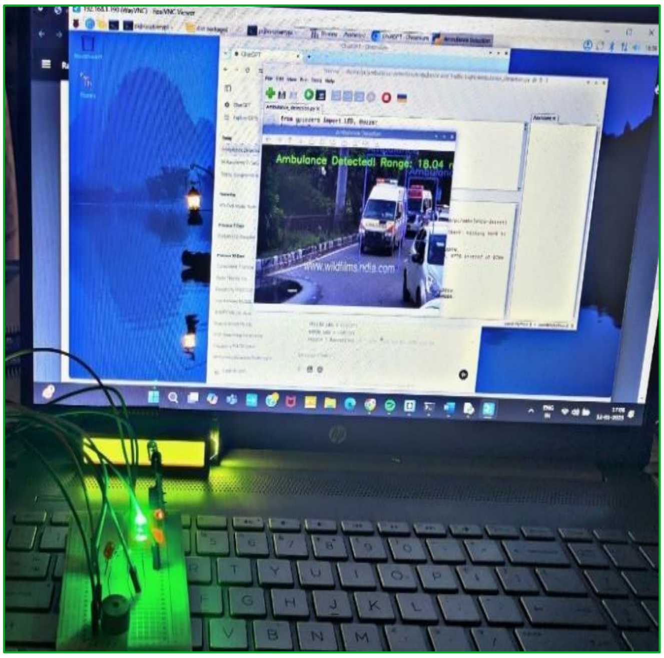

Fig12:Ambulance Detected With In 18.04 Meters Range.

VI. CONCLUSION

Conclusion:

Finally, our proposed IoT-promoted ambulance detection system performed, using the Yolov5 object detection model, extraordinary performance to address the important problem of managing emergency traffic scenarios. The system effectively detects real -time ambulances and automatically provides traffic signal control to provide a spontaneous and effective passage for emergency vehicles. Through extensive evaluation, Yolov proved to be very accurate and reliable for 5 tasks, making it an ideal alternative for distributing real world.

Integration of IoT technology with Yolov5 ensures that traffic signals can be automatically adjusted without the need for manual intervention. This innovative solution not only improves the emergency time, but also helps to save life by reducing the delay caused by traffic overload.

Main observation:

1. Better accuracy: Yolov5 demonstrated high accuracy and reliability when it comes to detecting ambulances in video streams, and securing effective operations in diverse traffic environment.
2. IoT-based automation: Integration of IoT units, such as sensors and signal controllers, allow real-time traffic signal for automation, reduce human addiction.
3. Real -time system: Ambulance and control signals that detect system ability ensure a quick and accurate response immediately during the emergency.
4. Scalability: The design of the system is suitable for different traffic conditions, which is suitable for distribution in different geographical regions.

Future Scope:

While the system has shown promising results, there are opportunities for further improvement and innovation:

The proposed IoT-based ambulance detection system, powered by YOLOv5, represents a significant innovation in smart traffic management. By combining advanced machine learning techniques with IoT automation, the system provides a reliable and efficient solution to a critical problem. This project serves as a stepping stone for future advancements in traffic management and emergency response, ultimately contributing to saving lives and improving urban infrastructure.

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