IOT-ENABLED REAL-TIME TRAFFIC MANAGEMENT SYSTEM USING ML

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***Abstract**:* The growing number of vehicles on the road and the increasing complexity of traffic patterns necessitate effective traffic management systems to ensure smooth and safe transportation. In this paper, we propose a real-time traffic management system that leverages real-time cameras to monitor traffic conditions and provides advanced functionalities such as identifying wrong-route vehicles and emergency vehicles using an integrated buzzer system. The system utilizes a network of strategically placed cameras to capture real-time video footage of road segments. The video feeds are processed using Machine learning models, enabling the system to detect and track vehicles accurately. By analyzing the captured data, the system can extract valuable information regarding traffic flow, congestion levels, and abnormal vehicle behaviors. One key aspect of the proposed system is its ability to identify wrong-route vehicles. Using image processing, the system compares the detected vehicle's position and direction of travel with predefined traffic rules and lane markings. If a vehicle is detected to be traveling in the wrong direction or deviating from the designated route, an alert is triggered. Additionally, the system incorporates an emergency vehicle detection mechanism. When an emergency vehicle is detected, the system activates a buzzer to alert other drivers and prioritize their movement to ensure a clear path for the emergency vehicle. The integration of the buzzer system for identifying wrong routes and emergency vehicles further enhances the effectiveness of the traffic management system. The effectiveness of the proposed system was evaluated with high accuracy with the YOLO V5 algorithm. The results indicate its potential for enhancing traffic management and reducing road accidents.

Keywords- ***Real-time traffic management, Machine learning, wrong route vehicle detection, emergency vehicle detection, buzzer system.***

I.INTRODUCTION

Urbanization is causing a very rapid rise in the number of vehicles in many cities worldwide, causing serious traffic congestion issues. This increases the need for roads to run as efficiently as possible. The control of traffic at road intersections is a significant factor that has an impact on the flow of traffic. A good traffic management system is required to ensure that traffic flow is as efficient as possible. Traffic signal management makes the simple control of heavy traffic using the three lights—red, yellow, and green—possible. The signaling is indicated by the lights. A flashing Red light means to stop, a yellow light means to get ready, and a green light means to proceed. Automatic light changes occur at regular intervals. People in the modern world have a lot of private vehicles on the road because most generations tend to use their private vehicles for their purposes rather than using public transportation.

Traffic congestion in urban areas and the development of smart cities are just two of the issues brought on by the growing number of vehicles on the road. In this scenario, we cannot limit their use of private vehicles, but we can control the traffic flow in congested areas. Nearly 1,55,662 people had experienced road accidents as a result of this traffic congestion or improper adherence to traffic rules. With the development of the Internet of Things and Deep learning models, we can address the problem of signal and road congestion lot of roadside locations with real-time traffic monitoring. Since the invention of this technology, it has been incorporated into ITS. The system for monitoring traffic is very helpful. To determine the cause of traffic jams, accidents on the road, and also traffic rule violations, such as counting the number of vehicles and speed, video footage from the on-road cameras can be analyzed. The Internet of Things and Machine learning technology make real-time traffic data possible.

II. RELATED WORK

The "Smart Traffic Management System employing IOT-enabled technology" plan focused mainly on traffic congestion, which delays the arrival of emergency vehicles like ambulances and fire trucks. Significant lives are lost as a result of this. We provide an answer to these issues in this research that can be applied broadly. IoT provides a remedy for these issues by providing advanced traffic control systems. The method makes it possible for emergency cars to travel more quickly and get where they need to be by using the green corridor. As soon as the RFID scanner reads the ambulance's RFID tag, the approaching traffic signal turns green [2].

The study by Nawaf Alsrehin, Magableh, and Ahmad F. Klaib. The primary focus of the research is traffic control techniques. We used data mining and machine learning technology to identify and calculate the traffic alone. The study's findings show that there is no industry-wide agreement on a traditional traffic control approach. This study should be noted by the traffic research group, traffic software developers, and traffic officials. It has an immediate impact on the establishment of a clear route for innovative traffic control concepts [3].

The infrared sensor of the self-adaptive system was used to assess the car density, as stated in the heading of this paper by Dhruv Patel and Yogesh. There are sensors at the junction of the four roadways. The Arduino Mega microcontroller device receives the information and prioritizes the channel with the greatest number. This model has been simulated using Proteus modeling software. It is possible for anyone to construct this prototype because the hardware components have been dissected step by step. The traffic management results of the prototype are fascinating. Sensor-based devices are widely used in traffic signals [1].

Their paper named "In smart cities, a traffic management system that reduces automobile congestion described a system that manages traffic to reduce congestion. To lessen these impacts, time- and money-consuming adjustments must be made to the city's road system. During the Request period, vehicles can ask nearby road segments for traffic information. The Reaction assists vehicles in responding with the most current information on road circumstances. This system mainly investigates the Request and Response System for Traffic Information, and the performance evaluation shows our solution's ability to reduce traffic gridlock while needing little communication overhead [4].

Machine learning and the impacts of the weather on road conditions are used to predict travel times. Using a time series analysis of the data that was collected using machine learning, the author of this work forecasted the level of traffic gridlock using this technique. Additionally, we can determine a connection between traffic congestion levels and shifting weather factors using the proposed approach. Uber Movement transportation data for Mumbai, India was used to feed various machine learning models that had already been tested. On the basis of the data gathered from Uber, Our algorithm can therefore accurately predict how long it will take to move between different points (locations) in Mumbai city using data from Uber Movement. We can predict traffic based on conditions with the aid of this algorithm. Additionally, it offers superb precision [5].

III. EXISTING SYSTEM

One of the studies focused on a four-way road intersection Traffic signal Control System is designed to regulate traffic flow at a four-way road intersection using Infrared Sensor Module. Each road in the intersection is equipped with two Infrared Sensors that detect the traffic, the system controls the traffic signals to ensure the safe and efficient movement of vehicles. These modules are placed at strategic locations on each road of the intersection. They detect the presence of vehicles by emitting infrared signals and measuring the interruption of these signals.

The system is controlled by an Arduino microcontroller, which receives input from the IR sensor modules and processes the data to determine the traffic conditions at the intersection. The intersection is equipped with traffic signal lights for each road. These lights include red, yellow, and green signals to indicate when vehicles should stop, wait, or go through the intersection.

The microcontroller analyzes the input from the IR sensor modules to make decisions about the signal timings. The inputs take into account the number of vehicles detected on each road and allocate the appropriate signal timings accordingly. IR sensor modules continuously monitor the presence of vehicles on each road. When a vehicle is detected, the corresponding IR sensor sends a signal to the microcontroller.

The microcontroller receives the input from all the IR sensors and processes the data to determine the traffic conditions. Based on the detected traffic, the control running on the microcontroller adjusts the signal timings for each road's traffic signal lights. The traffic signal lights display the appropriate signals according to the microcontroller instructions.

For example, if one road has heavy traffic, the system will allocate a longer green signal to that road and shorter green signals to the other roads. If no IR sensor detects the signals, then each road will be given a green signal in the following order B, D, C, A, opposite roads individually for a set amount of time. The signals are coordinated to ensure a smooth flow of traffic through the intersection, minimizing congestion and delays. The system continuously monitors the traffic and adjusts the signal timings dynamically based on the changing traffic conditions.

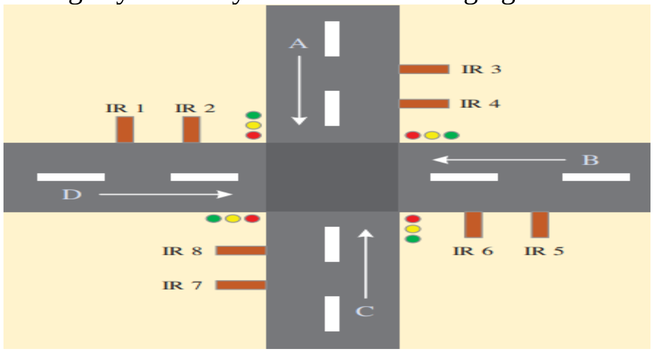

Fig 3. Architecture diagram for an existing system

IV. PROPOSED MODEL

The Real-Time Traffic Management System is a proposed solution that utilizes Raspberry Pi as the processing unit and a camera for traffic detection using machine learning (ML) algorithms. The system aims to efficiently manage traffic flow by dynamically adjusting signal timings based on real-time traffic conditions. Additionally, the system includes features to detect wrong-route vehicles and provide alerts for emergency vehicles using a buzzer. The Raspberry Pi is responsible for receiving input from the camera, running ML algorithms for traffic detection, and controlling traffic signals based on the detected traffic conditions. A camera is installed at the intersection to capture real-time footage of the traffic. The camera feed is used as input for the ML algorithms and helps identify the number of vehicles and their movement patterns. The Machine Learning algorithms process the camera feed to detect and analyze traffic conditions. They can identify the number of vehicles, estimate traffic density, and classify traffic as high, medium, or low based on predefined criteria. Traffic Signal Lights intersection is equipped with traffic signal lights for each road. These lights include red, yellow, and green signals to indicate when vehicles should stop, prepare to stop, or proceed through the intersection. The system includes a buzzer to provide audible alerts. It is used to indicate wrong-route vehicles and to notify the presence of emergency vehicles, such as ambulances or fire trucks. The Raspberry Pi is connected to the internet via Wi-Fi or Ethernet, enabling remote monitoring, data logging, and potential integration with other systems or services.

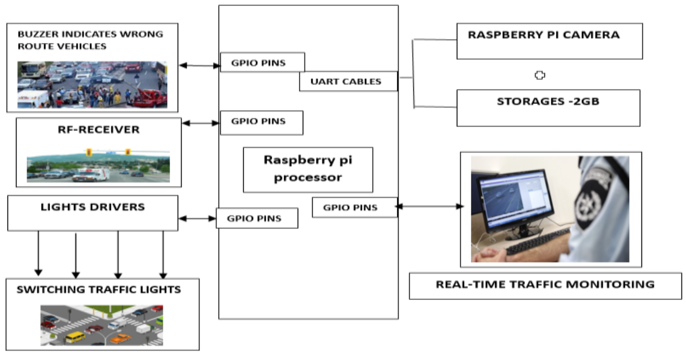

Fig 4.1 Architecture diagram for the proposed system

1. The camera captures real-time footage of the traffic at the intersection, which is then fed to the Raspberry Pi. The collected picture is then stopped at a filter where a region's height and breadth are determined only the presence of vehicles in that pre-defined zone is recognized. For each image being captured, this region's size is maintained. Tensor flow is a Python library that allows the performing of dataflow graphs that describe how data moves through a graph. Moreover, as soon as the item is recognized, a rectangular box is placed around it so that no one can visually validate that the target is detected as a vehicle. It also identifies vehicles traveling in the opposite direction.

2. This simulation has fixed some threshold values built into it if any of the four results fall within the threshold, simple static will be used, and each signal will have the same switching time because the traffic on all sides is either light or heavy with vehicles from all directions every side. Additionally, dynamic signal switching is activated if the threshold value from either of the computed results from signal processing is exceeded. Dynamic switching will determine the switching time based on how congested the route.
3. This system is constructed with the idea that if the amount of traffic and all signals change, how can threshold values stay the same? As a result, after a few computations, the model will figure out how to set the threshold value based on the data that the camera that captures the piled-up signals has recorded and chosen image, the detection and counting processes are carried out further with the ultimate goal of performing real-time monitoring. Based on the real-time data, traffic signals are switched on in the lane, and the Raspberry board controls the signals.
4. The Raspberry Pi, using ML algorithms, analyzes the camera feed to detect and classify the traffic conditions as high, medium, or low based on the number of vehicles and traffic density.
5. The Raspberry Pi determines the appropriate signal timings for each road's traffic signal lights based on the ML analysis. If the traffic is classified as high, the green signal is set for 90 seconds. For medium traffic, the green signal is set for 60 seconds; for low traffic, the green signal is set for 30 seconds.
6. The traffic signal lights display the signals according to the determined timings, allowing the smooth flow of traffic through the intersection. Simultaneously, the ML algorithms also monitor the camera feed to detect wrong-route vehicles. If a wrong-route vehicle is identified, the system activates the buzzer as an audible alert.
7. In addition, the ML algorithms detect emergency vehicles based on predefined patterns or sirens captured by the camera. Upon detection, the system activates the buzzer to alert nearby vehicles and give priority to the emergency vehicle.
8. The system can also log traffic data, send real-time updates to a web-based dashboard, or integrate with other systems or services via IoT connectivity.
9. The system dynamically adjusts signal timings based on real-time traffic conditions, optimizing traffic flow and minimizing congestion and delays.

10. The ML algorithms analyze the camera feed to accurately detect and classify traffic conditions, providing reliable data for signal control.
11. The system identifies wrong-route vehicles and alerts nearby vehicles using the buzzer, enhancing safety and preventing accidents.
12. By detecting emergency vehicles and activating the buzzer, the system alerts nearby vehicles and prioritizes the passage of emergency vehicles through the intersection.

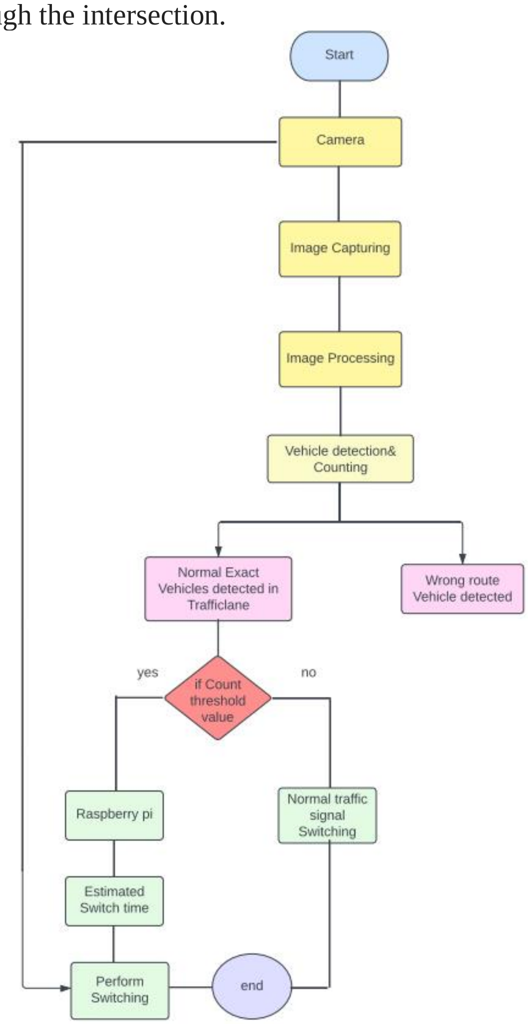

Fig 4.2 Flow diagram for a proposed system

The proposed model has three modules:

- Image acquisition process
- Performing Object detection
- Switching the traffic lights in the lane

A. IMAGE ACQUISITION PROCESS

Here, in this module, the operating system is Linux, an open-source program that is prone to rapid changes in live streaming. The raspberry pi camera is chosen because it can be used to take pictures when real-time data is being collected. In order to adapt to the evolving Linux environment, changes are made to the raspberry pi camera configuration.

B. PERFORMING OBJECT DETECTION

The object detection technique is being used in this instance for picture matching. Among other things, the object detection approach finds the picture pixels that match the shapes of the items visible in it. Also used to identify the car traveling the wrong way in the picture. The YOLO V5 algorithm performs this kind of object detection. and it offers quick speed, great precision, and simplicity of usage. The outcome is a binary image that contains the observed output.

C.SWITCHING THE TRAFFIC LIGHTS IN THE LANE

Compare the real-time traffic density with the reference image to determine the current traffic level. This comparison can be performed by analyzing the number of vehicles or the difference in vehicle positions between the real-time frames and the reference image. Based on the determined traffic level, set the duration for which the green light will remain on. For high traffic density, set the green light duration to 90 seconds. For medium traffic density, set the green light duration to 60 seconds. For low traffic density, set the green light duration to 30 seconds. Coordinate the switching of traffic lights based on the determined green light duration. When the green light duration expires, switch to the red light in the traffic signal system. Allow vehicles from other lanes or directions to proceed while the light in the current lane turns red. After the redlight duration, switch back to the green light for the lane, and the cycle continues.

D.SYSTEM SETUP PROTOTYPE

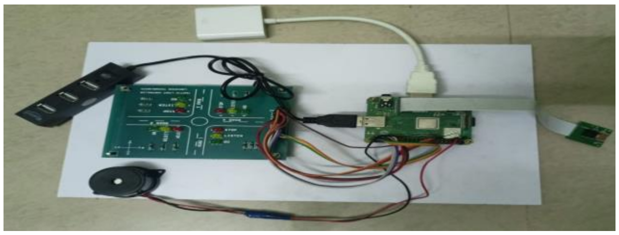

Fig 4.3 Prototype for proposed work

V. WORKING ON YOLO V5

An object detection network called YOLO (you only look once, version 5) is used. It is one of the most potent pre-trained models to provide the highest level of accuracy. The combination of RCNN with SSD results in YOLO, which is a lot quicker, more effective, and more potent algorithm. One will be able to identify an image by using object recognition in YOLO, as well as the position of a specific object, or its placement in the image.

Furthermore, because the model was trained on a sizable amount of data, it can recognize photos that have been randomly positioned, meaning that it can recognize objects that have been rotated 360 degrees. Yolo is so proficient that it can even discriminate between two items that are quite near to one another. Unlike the conventional method of classifying every image and creating predictions. Yolo takes a single, intelligent glance at the image. It creates an MxM grid and splits the picture into N different segments. Yolo is now using its algorithm step-by-step for each division to estimate the confidence score, indicating whether the item is there. Yolo employs IOU, and intersection over union is an object detector on a specific dataset. Yolo discovers an object performance factor based on the confidence score.IOU explains how two nearby items may be quickly identified without compromising the precision of models made up of two fundamental parts.

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Fig 5. Algorithm for controlling vehicles

Fig 5.1 shows the traffic analysis displayed here and the possible conditions the system will base. This system will only stop or proceed back to the starting point of the process. if it is accomplished and meets the conditions correctly.

VI. RESULT & DISCUSSION

The device was put to the test utilizing the raspberry pi camera in traffic lanes with low to heavy traffic and automobiles traveling in the incorrect direction to reduce traffic congestion.

STEP:1

Set up the Linux environment with a Raspberry Pi processor

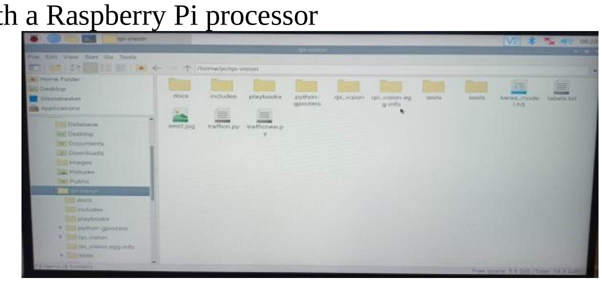

Fig 6.1 Linux environment

STEP:2

Live camera detection for identifying traffic.

Fig 6.2 Real-time object detection

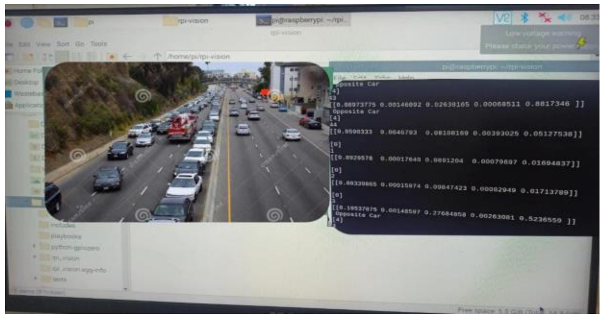

Fig 6.3 Wrong-route vehicle detected

STEP:3

Switching the traffic signal lights based on the density of traffic congestion like high, low, and medium traffic with 100% accuracy. And is also used to detect the wrong route vehicles.

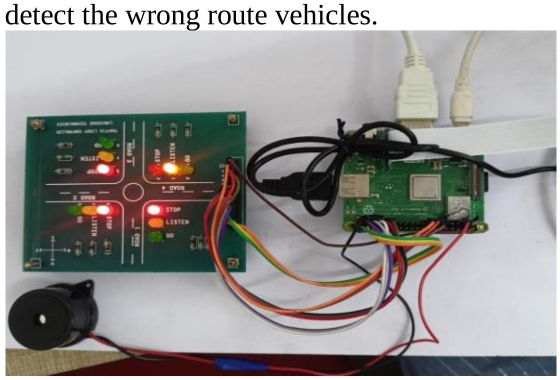

Fig 6.3 Signal switching

```
  with tf.name_scope('accuracy'):
    with tf.name_scope('correct_prediction'):
      prediction = tf.argmax(result_tensor, 1)
      correct_prediction = tf.equal(
          prediction, tf.argmax(ground_truth_tensor, 1))
    with tf.name_scope('accuracy'):
      evaluation_step = tf.reduce_mean(tf.cast(correct_prediction, tf.float32))
  tf.summary.scalar('accuracy', evaluation_step)
  return evaluation_step, prediction


def save_graph_to_file(sess, graph, graph_file_name):
  output_graph_def = graph_util.convert_variables_to_constants(
      sess, graph.as_graph_def(), [FLAGS.final_tensor_name])
  with gfile.FastGFile(graph_file_name, 'wb') as f:
    f.write(output_graph_def.SerializeToString())
  return
```

Fig 6.4 Algorithm for the working of Accuracy

Fig 6.4 shows that the accuracy of traffic flow in the real-time Environment.

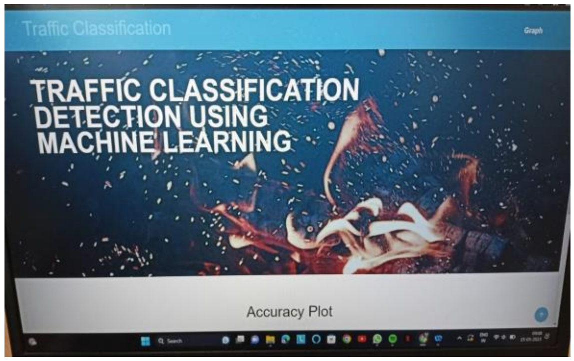

Fig 6.5 Home page for graph plotting

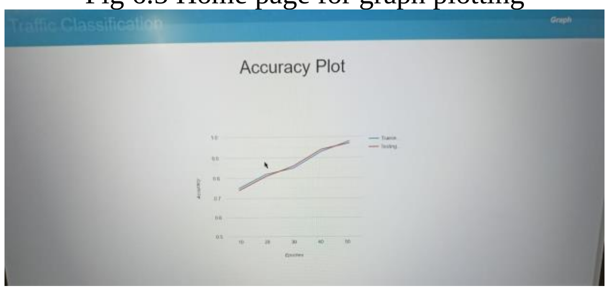

Fig 6.6 Low to High Traffic

As shown in Figures 6.5 and 6.6 one can infer that Yolo v5 can process many frames with less execution time as compared to other pre-trained models.

Yolo computes its pretrained in terms of precision and recall, precision measures how accurate your predictions and recall measures how correctly the objects are classified.

VII. CONCLUSION

The goal of Real Time Traffic Signal Monitoring & Handling systems is to address the traffic issue that most cities in both urban and rural regions are experiencing. Aid with this project, where the main goal is to reduce traffic congestion almost entirely without the installation of any technology. As part of the gear needed for the setup, a camera, and a Raspberry Pi board must be interfaced, creating portable media. The trained model may be applied to ensure smooth traffic flow while minimizing road disruption. The reaction time will be slower even if the model requires more training time. The model is set up so that it determines the signal's smart switching timing on all sides of the road so that no one has to wait on the road for an extended period of time and traffic moves smoothly.

VIII. FUTURE SCOPE

The prototype model may be easily modified in the code to be utilized at intersections with more than four roads. To prevent emergency vehicles from becoming stopped in traffic and to lessen traffic accidents in congested regions, a system with sound detection for wrong-route cars in the traffic lane and emergency vehicles can also be used.

The IOT-based Raspberry Pi board is a gadget. It can run numerous programs simultaneously without stuttering and has wired and wireless connectivity functions. This paper may be utilized to add extra traffic lanes. Additionally, a GSM module for human emergency contact can be added. The emergency contact number will be called or messaged if a traffic accident occurs in the lane. Although it will cost more, the outcomes will be more beneficial and superior.

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