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AI Based Traffic Control System

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Abstract - The suggested AI BASED TRAFFIC CONTROL SYSTEM can replace the current traffic management system and is extremely scalable, compatible, easy to upgrade, and it can greatly increase traffic clearing. Accidents due to congestion have wasted a lot of time and polluted the environment are some of the transportation worries. The existing system may prove to be ineffective when vehicle usage rises quickly. The suggested solution uses computer vision software and Raspberry Pi 3B+ for density-based traffic control. Computer vision uses AI to detect vehicles with unique identity and records are created. Based on the vehicle detection, the count of vehicles is updated and given to the traffic system.

Keywords - Raspberry Pi 3B+, Computer Vision, Artificial Intelligence, Vehicle Detection

I. INTRODUCTION

In many parts of the world, traffic congestion has been getting worse, and all signs point to this trend extending. This poses an undeniable negative impact on the quality of urban life. Its primary manifestation is a progressive slowing down of traffic, which increases travel time, fuel consumption, other operating costs, and environmental pollution when compared to a continuous flow of traffic. In addition, road capacity is one of the main reasons to cause traffic congestion. Problems with road development and maintenance in the cities, driving practices that show little consideration for other road users, inaccurate information on traffic conditions, and inadequate management by responsible authorities who are frequently dispersed among a variety of different bodies, all serve to exacerbate the situation in the region.

The popularity of private vehicles in recent years has resulted in increasingly congested urban traffic. As a result, one of the major issues in major cities around the world is traffic. The harmful effects about congestion are suffered directly by vehicles that are trying to circulate. They affect not only drivers but also passengers of public transportation, who not only have to travel more slowly but also pay more for their tickets because of congestion. With the sharp increase in vehicle usage, the current traffic signal control only operates on a fixed time delay, which can be inefficient and result in significant losses. Therefore, it is imperative to maintain congestion under control. Metal, power, and coloured plastic were used to construct the first electronic traffic signal. It was not automatic, and a policeman in a booth operated it. The fact that there were just red and green lights is more intriguing. The majority of modern traffic light systems employ a wire loop that is hidden beneath the road. When a car drives over this wire, which carries electric current, the magnetic field it generates causes it to activate by sending a signal to a roadside computer.

Smart cities are being implemented in different parts of the world and to be more specific thanks to Artificial Intelligence. In doing so, these systems will reduce congestion, reduce pollutions, decrease time speed on the road and even prevent accidents. We also believe that this will help pedestrian and cycle traffic in doing so which means a city working in sync and the benefits will be unimaginable considering the worlds current use of the traffic systems. Considering these advantages, one can imagine the benefits to the city's economy, improvement in traffic safety and benefits to millions of people worldwide.

II. PROPOSED WORK

In this project, we provide an idea of making the traffic system intelligent using Artificial Intelligence. Images captured by the digital camera can be examined to identify vehicles and process lanes using computer vision software. The images are grouped and analyzed Machine Learning algorithms to obtain record. Using these records, the count values are sent to the traffic signal to control the timing of the signal in each lane. With this, the duration of traffic signal is managed by AI.

Here, the vehicle identification is performed using a convolutional neural network provided by Intel. Open CV is a sizable open source library for image analysis, machine learning, and computer vision, and it now plays an essential role in real-time operation, which is crucial in today's systems. It can be used to process photos and videos in order to recognize objects, people, or even cars. Here, Convolutional Neural Network is utilized to identify and detect vehicles. Detection and tracking of vehicles is very helpful in building a smart traffic system. YOLO algorithm is a machine learning algorithm in which the image is captured and processed. It uses Convolutional Neural Network to detect the vehicle in the region of interest. The individual frames for respective lanes are used and the vehicles are counted separately. As a results of this, in the lanes where there are more vehicles, will be cleared off at once without expanding the traffic further. Basically, smooth traffic clearance whether there are more or less vehicles.

Hardware used :
Raspberry Pi 3B+, Pi Camera, USB Web Camera, LED's and connecting wires
Software used :
Operating System: Raspbian OS, Compiler: Thonny python IDE, Software : Open CV, Algorithm: YOLO Algorithm.

HARDWARE SPECIFICATIONS :
1. Raspberry Pi 3B+ :

CPU type : 64-bit, quad-core Cortex-A53 processor
About Clock speed - **1.4** GHz
RAM size- **1**GB SRAM
Extended **40** Pin GPIO header
Pi camera connection via HDMI and CSI Camera
DC power input**: 5v/2.5A**
Micro SD slot for storing data and loading your OS

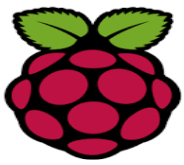
2. PI Camera :

Omni Vision 5647 camera module
Resolution - 2592*1944
Supports - 1080p, 720p and 480p

3. USB Web Camera :

Full HD resolution of up to 1080
MAC OS, Windows, Linux, iOS, and Android are all supported. Availability - USB 2.0

4. Software :



III. METHODOLOGY

3.1 Overview of Computer Vision

A branch of artificial intelligence known as computer vision enables computers to extract relevant information from digital photos, video frames, and other visual sources and carry out intended tasks using the information recovered. If AI gives computers the ability to think, computer vision gives them the ability to see, observe, and comprehend. Nearly identical principles govern computer vision and human eyesight. Human vision has lifetime capability of understanding and learning from changes in the environment, but instead of employing optic nerves, the retina, and the visual cortex to complete these tasks, computers are trained to do so using data, cameras, and algorithms. Industries ranging from the energy sector to manufacturing and the automotive sector employ computer vision extensively. For picture recognition, a lot of data is required, and analytics are being used. If enough information is provided, the computer will examine it and continue to learn.

Tasks performed by Computer Vision

* Image classification: It is a technique of seeing and classifying the image. That accurately predicts whether the given image belongs to particular class.
* Object detection: This technique identifies a class of image and tabulates its appearance.
* Object tracking: It refers to following an object after it is detected. In this case it should not only classify and detect the object but also should continuously monitor it.
* Content based image retrieval: Retrieving image from large database based on the content of the image and not tax associated with it.

3.2 Overview of YOLO Algorithm

You Only Look Once is known by the acronym YOLO. It instantly recognizes and detects different objects in a photo. The YOLO algorithm is significant due to its quickness, high accuracy, and capacity for learning. For real-time object detection, it makes use of convolutional neural networks. According to its name, the technique only needs one forward propagation through a neural network in order to detect objects.

This indicates that a single algorithm run is used to anticipate the full image. Multiple class probabilities and bounding boxes are simultaneously predicted using the CNN. Three methods—residual blocks, bounding box regression, and intersection over union make up the foundation of the YOLO algorithm.

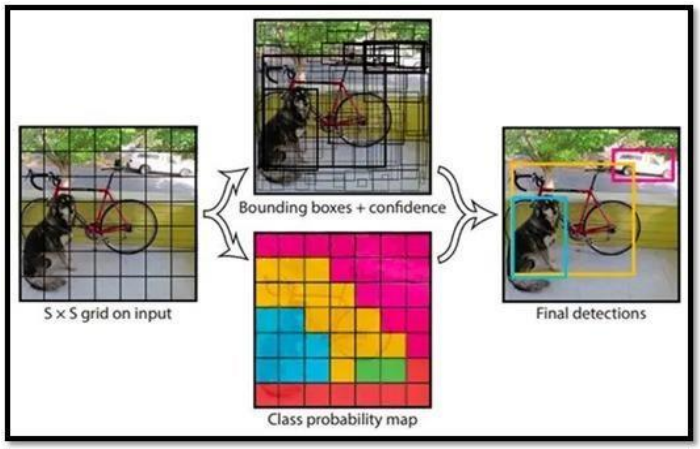


Fig.3.2.1 YOLO algorithm

3.3 Convolutional Neural Network

A particular kind of neural network that analyses data used in image recognition is known as a convolutional neural network. Convolutional, pooling, and fully linked layers are the three primary layers that make up its series of layers. Each of this layers contain some nodes that looks at data given as an input and produce output.

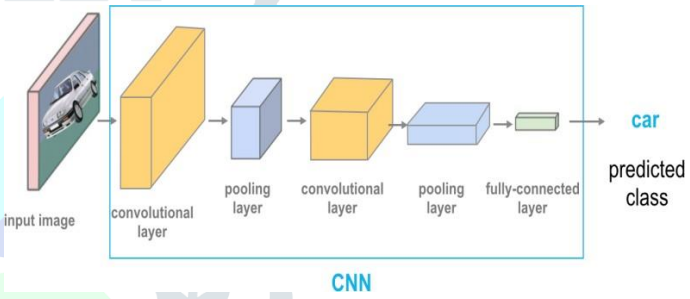
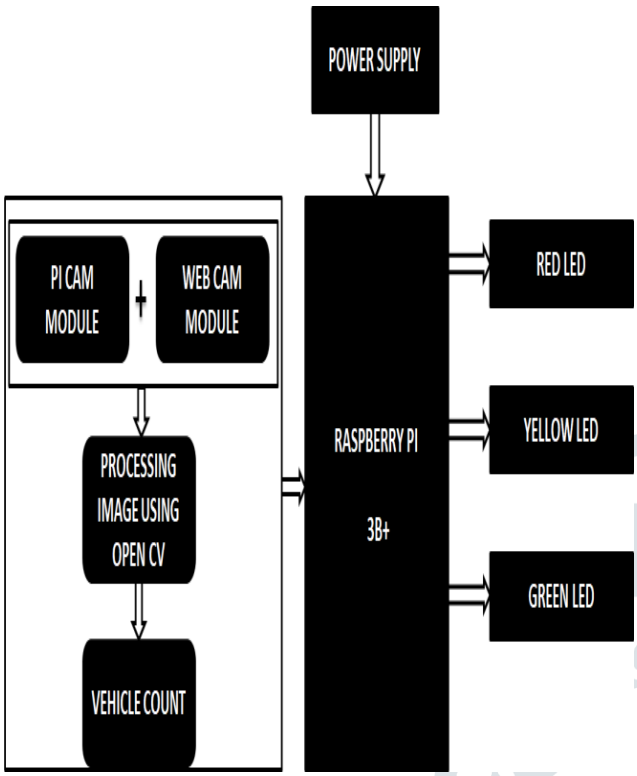


Fig.3.3.1 Convolutional neural network layers

Convolutional layer act as feature extractor, it identifies particular features of an image. It consists of different filters, these filters are small grids of values to produce filtered output. Max pooling is one of the most popular types of pooling layer, which follows after convolutional layer. In this layer the extracted features will be assigned with some weights. Different weights will be allocated for different features in a image.

IV. DESIGN AND IMPLEMENTATION

4.1 Block Diagram



4.2 Working of proposed system

We are going to read images of vehicles through video frames such that the vehicles in the first lane is detected using Raspberry pi camera and vehicles in the second lane is detected using USB web camera. The Open CV Software consists of in built modules which support image recognition and detection. Hence necessary packages can be imported directly and the network is initialized. YOLO Algorithm will detect and count vehicles separately for both the lanes. First the frames are pre-processed and we run the detection. Then the output data of vehicles is grouped into two categories for two different lanes.

When there are more number of vehicles in the first lane than the second lane, the lane with higher number of vehicles will be cleared soon by giving green signal and increasing the time of the signal.

Now if vehicles in the second lane start increasing beyond a certain count, then green signal will be now given to second lane and red signal to first lane. During this process there might be a case sometimes where there will be large number of vehicles only in one particular lane and very few vehicles in the other lane then green signal will be given continuously for lane with more vehicles and the lane with less vehicles will never be given the green signal. In order to avoid such situations, in the proposed system we have a condition in the code that if any lane is not given green signal even after say three minutes then automatically the signal will be switched from current to the lane which was not given green signal for a longer duration. Hence this can be used for smooth traffic clearance in all the lanes without any problem.

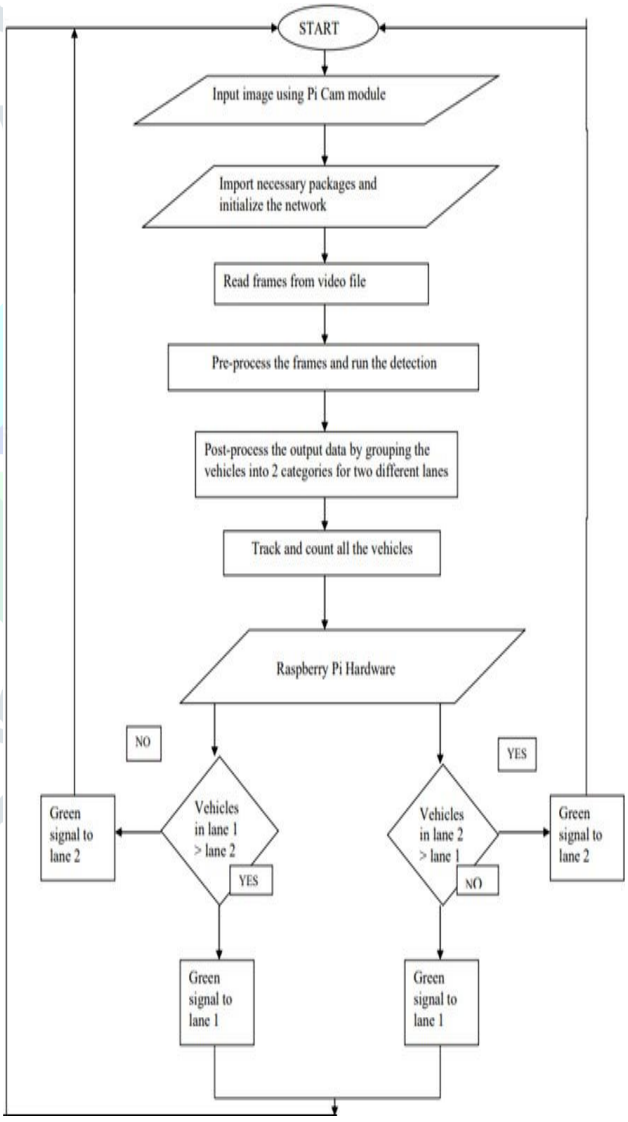


Fig.4.2.1 Flowchart

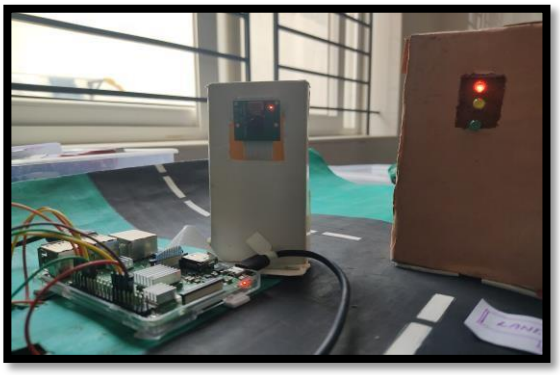


Fig.4.2.1 Prototype

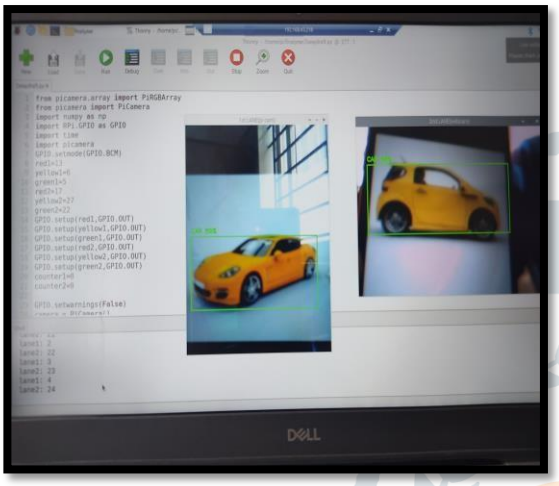


Fig.4.2.2 Detected output

V. ADVANTAGES AND DISADVANTAGES

5.1 Advantages

- Reduced congestion and less emission
- Improved road traffic discipline and safety
- In addition to the need for increased convenience and safety, the deployment of this system and connected car technology is necessitated by the world's rapidly urbanizing cities.
- Better planning and decision making
- Time saving and operation efficiency
- Improved customer service and reduced frustration
- Improved health due to less environmental pollution
- Reduce road accidents and enhanced productivity
- Based on the detection, the system takes self-decisions and performs the operation. Hence human work is not required.
- YOLO algorithm has self-learning capabilities from previous experience.
- It leads to diverse transportation which is important for smart cities.

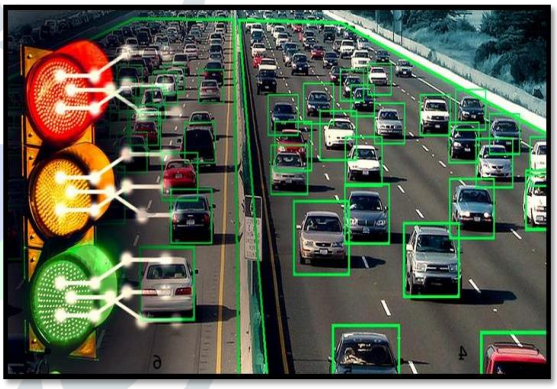


Fig.5.1.1 Real time implementation

5.2 Disadvantages

- Requiring significant funds to adopt
- It’s hard to detect an error
- AI needs human assistance

5.3 Applications

Artificial intelligence-based systems can be a smart investment for governments looking to get the most out of their restricted funds for streets and roads. The ability to manage more traffic and a growing population while lowering the capital expenses of creating new or rebuilt roadways is made feasible by them. Only 15% of the world's population was residing in metropolitan regions a century ago. More than fifty-five percent of people live in cities today, and sixty-eight percent are projected to do so in 2050. Hence urbanization needs smart traffic system implementation. With all the development comes an equal rise in traffic, necessitating the use of technology to help control the movement of people and commodities. The AI based system can also help the traffic agencies in penalizing the offenders and act as deterrent. The cameras installed can detect and identify the vehicles which disobey traffic rules and fine them electronically. The AI based traffic system can cut-down the waiting time at traffic signals by almost half. Hence there is a scope and need for smart traffic implementation in real world to ease clogged roads and cope up with growing number of cars.

VI. CONCLUSION

6.1 Results and Discussion

Implementation and working of proposed AI based traffic system is successfully designed and tested. The output is analyzed and evaluated with Raspberry Pi hardware and Computer Vision technology. In the proposed system the traffic signals are controlled based on the vehicle density and YOLO algorithm.

The system detects the vehicles in video frames and based on the count of vehicles the signal is monitored. Upon receiving the message the LED lights are turned on and switch according our conditions given in the code.

The performance of vehicles counting framework was satisfactory for both Convolutional Neural Network and YOLO version three combinations with vehicles tracking. We have used seven layers of convolutional Neural Network which gives high neural accuracy of 93.3% in detection.

6.2 Future Scope

In this paper the project AI based traffic control system is developed by integrating all the hardware components. Existence of every module has been examined and placed carefully, thus contributing to the best working of the unit. Hence in the future implementation of this project, we look forward to overcome all the disadvantages with the benefits of expanding technology using highly advanced components. The prototype can be developed further to make a wearable device and the design can be made more easier to access and user friendly.

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