# AUTOMATIC SPEED CONTROL BY REAL TIME ROAD LANE AND VEHICLE DETECTION USING HAAR CASCADE ALGORITHM

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*Abstract*—The system uses computer vision to detect road lanes and vehicles in the real-time, adjusting the vehicle's speed for improved road safety. It also prevents accidents due to drowsy driving on highways. Haar cascade algorithm provides fast and accurate detection, implemented on Raspberry Pi. The system captures road images using a camera and processes them in real-time. It adjusts the vehicle's speed based on detected road lanes and vehicles, ensuring safe driving and maintaining a safe distance from other vehicles.

***Keywords— image processing; thresholding implementation; edge detection; background subtraction; haar cascade; tracking moving objects.***

## I.INTRODUCTION

The Haar cascade algorithm is a type of machine learning-based approach used for detecting the object in images and video. It is a popular algorithm because it is relatively Fast and accurate. It works by training a classifier on a large dataset of positive and Negative samples. The Raspberry Pi is a computer which is as small as credit card that is capable of running a variety of software and operating systems. When used with the Haar cascade algorithm, it can detect objects in real-time. Automatic speed control systems uses sensors and algorithms which is used to detect and monitor the speed of vehicles on the road. These systems can help reduce accidents and improve road safety by alerting drivers when they are exceeding the speed limit or when there is a risk of collision. They can also help reduce traffic congestion and improve fuel efficiency. Automatic speed control systems have been around for several decades. The first speed control system was introduced in the 1960s and used mechanical devices to regulate vehicle speed. Since then, there have been significant advancements in detection algorithms and sensor technology. Today, many automatic speed control systems use cameras, radar, and laser sensors to detect and monitor vehicle speed detection algorithms have also improved significantly over the years. The Haar Cascade algorithm was introduced in the early 2000s and quickly became popular for its speed and accuracy. Automatic speed control systems can help improve road safety by reducing the risk of accidents caused by speeding or reckless driving. They can also help reduce traffic congestion.In addition, they can help reduce the cost of healthcare and insurance by reducing the number of accidents and fatalities on the road.

## II. Literature survey

Vehicle and pedestrian discovery is crucial for Intelligent Transportation Systems, despite challenges like varying weather and lighting conditions. Detecting climbers among vehicles is a top priority for automakers, necessitating an automated system capable of identifying pedestrians amidst the surrounding vehicles. The performance of the system decreases as occlusion increases. This paper introduces the Haar Cascade Classifier and Background Separation system, which independently enable vehicle and pedestrian discovery. The Haar Cascade classifier, initially proposed by Viola-Jones, is an effective method for object detection, while the Background Separation system utilizes the K-NN algorithm to identify climbers.[1].

Recent advancements in artificial intelligence, particularly in deep learning, have revolutionized automation across various industries. Deep learning and computer vision have revolutionized intelligent systems. Intelligent Vehicle Systems and Intelligent Transport Systems greatly benefit from vehicle discovery, which includes tasks such as identifying road scenes, detecting disabled vehicles for finding alternative routes, and preventing accidents. This paper introduces the utilization of the state-of-the-art Mask R-CNN system, employing transfer learning, for vehicle discovery through case-wise segmentation. This approach simultaneously produces bounding boxes and object masks, ensuring accurate and flawless vehicle identification. The model showcased excellent performance in detecting both congested and small-objects. To conduct the study, TensorFlow and Keras frameworks were utilized with online GPU and also the cloud services from Google Colab. By combining various standard datasets, the model achieved remarkable accuracy, reaching 90.27% on the chart and scoring 92.38%. [2].

Automated vehicles have become an integral part of our technologically advanced world. When discussing vehicles, business and accidents are the foremost concerns. Accidents can occur due to various factors such as heavy traffic, adverse weather conditions like rainfall, unexpected slowdowns, and changes in speed. To address these challenges, ML, CV, and DL technologies are employed. The system is to increase visibility in low visible regions and calculate future conditions based on present assessments. This model improves visibility and driving experience particularly targeting sandstorms due to afforestation. It involves two steps: situation analysis, dehazing and vehicle discovery, and prediction. The estimation of traffic density and fire detection in worst-case scenarios using Python, DL techniques, TensorFlow and vehicle counting algorithms.[3].

Unmanned aerial vehicles (UAVs) are increasingly used for cost-effective business monitoring and data collection on roadways. This study introduces a new methodology for accurately extracting vehicle trajectories from aerial videos. The system employs an ensemble sensor for vehicle detection, kernelized correlation filtering for tracking, and a mapping algorithm to convert positions to Frenet coordinates. A denoising process eliminates biased data. Evaluation with peak and non-peak hour videos shows precise extraction, with MSD of 2.301 m, RMSD of 0.175 m, and Pearson correlation of 0.999. [4].

This paper introduces a deep learning model for accurate and fast detection of vehicles. The model comprises three key modules: lane sensor, vehicle sensor, and taillight sensor. Where previous algorithms that rely on hand-coded schemes, we adopt a data-driven approach in both the vehicle and taillight modules. The lane discovery module, designed intricately, utilizes the intermittent Rolling Complication (RRC) mechanism and shadowing medium to detect vehicle boundaries. The same RRC mechanism is employed to identify taillight regions on detected buses. The lane and vehicle discovery modules improves speed and taillight discovery. We validate the model using datasets from (SKKU) University and (KITTI) University. The model performs good even in difficult conditions, achieving a remarkable 99% taillight detection rate on the SKKU dataset and an 86% detection rate on the KITTI 2D Object dataset. Furthermore, this system achieves a 100% taillight detection rate on a specific set of the KITTI Tracking dataset. [5].

The increasing use of vehicle-based technology and the upcoming emergence of autonomous vehicles have led to a growing interest in detecting road potholes. This study presents an automated system for pothole detection using the one-dimensional Haar Wavelet Transform (HWT) applied to accelerometer signals. The proposed methodology takes advantage of low-cost processing in both signal acquisition and analysis stages. The analysis involves a two-step threshold procedure to identify significant variations in the data associated with potholes. Adaptive threshold estimation eliminates the need for manual threshold setting and allows for the identification of normal signal patterns corresponding to acceptable road conditions. The proposed methodology proves effective not only in controlled terrain scenarios but also in real-world conditions. [6]. This paper presents a detailed approach for a small, low-cost autonomous car to follow lanes. A (DNN) and a (CNN) are trained to process camera images and generate steering and speed commands. The design of the automatic car and the implementation of the DNN and CNN are explained. Comparison is made with established models VGG16 and DenseNet. A FSM controls the car's behavior, transitioning between lane-detecting and stops states based on stop sign detection and obstacle presence. [7].

Bus operation and controlling traffic violations pose significant challenges for transportation authorities. Manual detection by placing traffic officers in specific locations is not efficient and cannot cover the entire metropolitan area. Some advanced countries have implemented stationary cameras to monitor traffic violations, but their coverage is limited to certain areas such as main roads, roundabouts, intersections etc. The paper introduces a real-time model for detecting traffic violations using vehicle-mounted cameras and edge devices. The edge device, equipped with a GPU, connects to the vehicle camera and monitors vehicles ahead, identifying potential driving violations. Specifically, we examine the detection of wrong U-turns as a case study, implementing an algorithm on the GPU-enabled edge device. To evaluate the system's feasibility, we assess its effectiveness in terms of video generation rate and data size. The results confirm the system's ability to efficiently identify violations well before video generation time. [8].

Vehicle discovery is a crucial aspect of advanced driver assistance systems. While deep learning techniques, especially deep neural networks, have shown remarkable performance on public datasets, their reliance on computationally intensive two-stage methods limits real-time deployment on embedded platforms. To address this, we propose a real-time single-stage vehicle sensor for the NVIDIA DrivePX2 platform. This paper presents three key contributions. Firstly, we introduce a discovery scheme that utilizes multi-scale features and multi-anchor boxes, enhancing the sensor's sensitivity. Secondly, we propose a novel data augmentation strategy that generates diverse training images with randomized appearances, improving the sensor's ability to detect partially visible vehicles. Thirdly, we introduce a specifically designed multi-stage image-based online hard example mining (MSI-OHEM) framework for single-stage sensors. MSI-OHEM performs fine-tuning on challenging examples and identifies slightly overlapping bounding boxes as valid positives. Compared to traditional object sensors, our proposed sensor achieves competitive average precision (AP) scores while maintaining efficient computational speed. Using base networks like MobileNetV2, GoogleNet, Inception-v2, and ResNet-50, our sensor achieves AP scores of 85.35, 85.62, 86.49, and 87.81, respectively, at frame rates of 64, 58, 48, and 28 FPS on the NVIDIA DrivePX2 platform, specifically for the vehicle class (automobile) on the VOC2007 test dataset.[9].

This paper presents an innovative approach called "RT_VDT" for accurately detecting and tracking vehicles on the road. RT_VDT is specifically designed to be compatible with ADAS and SDC. Its primary objective is to achieve precise and efficient vehicle recognition and tracking throughout the driving process. The approach offers fast computation capabilities suitable for CPUs with affordable GPUs commonly found in ADAS systems. RT_VDT utilizes a set of reliable computer vision algorithms that synergistically process raw RGB images to generate vehicle bounding boxes in the frontal driving space. These algorithms work collaboratively to enhance accuracy and strive for precise results. The algorithms are described, implemented using real road images and videos captured by camera. The performance of the RT_VDT system is thoroughly tested and assessed using real videos, demonstrating its consistent ability to detect and track vehicle boundaries.The paper discusses the strengths, weaknesses, and potential future advancements of the proposed approach. [10].

Intelligent transport systems (ITS) rely on real-time data collection, processing, and transmission for efficient business operations. Integrated detectors and CCTV cameras provide detailed information about traffic flow and anomalies. However, accurate computer vision algorithms face challenges in real terrain with occlusions and video interruptions. In this paper, we developed and evaluated an object shadowing system using real road footage, comparing its performance with other tracking algorithms.[11].

Autonomous driving vehicles, also known as driver-less buses, are among the most remarkable advancements of the twenty-first century. They are expected to become the future's efficient, crash-avoiding civic buses. These buses possess the ability to sense the environment, navigate, and perform transportation tasks without human intervention. Equipped with cameras, radar, lidar, GPS, and navigation systems, they can detect their surroundings and adapt to changing conditions using advanced control systems. The ultimate goal is to completely replace the world's transportation system, and many companies are already working towards this objective. Autonomous vehicles offer numerous benefits, including reduced congestion, decreased pollution, fewer accidents, time savings, energy conservation, and improved passenger safety. By embracing autonomous vehicles, we can overcome the challenges we face on the road and work towards a safer future. It is high time for Bangladesh to join this movement and invest in driver-less vehicles.[12].

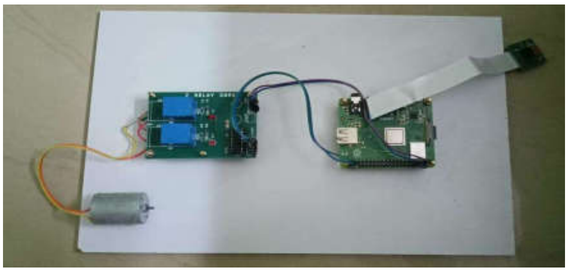
Drowsiness or fatigue is a major contributing factor to road accidents and poses significant challenges to ensuring road safety. Promptly advising drowsy motorists can prevent numerous fatal accidents. Various methods exist for detecting and alerting drivers about their drowsy state while driving. Facial expressions such as yawning, eye checks, and head movements can be utilized to infer drowsiness. Additionally, the driver's physical condition and vehicle behavior are analyzed to detect drowsiness. This paper presents a thorough analysis of different approaches to detecting driver drowsiness, categorizing them into three main groups: behavioral, vehicular, and physiological parameters. It reviews commonly used supervised learning methods for drowsiness detection, discusses their advantages and disadvantages, and provides a comparative analysis of different systems. Moreover, research frameworks are proposed to enhance comprehension in this field. In conclusion, the paper presents overall research findings based on extensive analysis, which will aid aspiring researchers in exploring further advancements in this relevant field.[13].

In many urban areas, increasing traffic has become a major problem, especially at traffic signals. Conventional systems fail to detect traffic or determine its density at signals, resulting in inefficient operations. Image and video processing, a rapidly growing technology and part of AI, can help address this issue. By analyzing real-time images and videos captured by cameras at intersections and traffic signals, traffic management can be improved. This system utilizes Raspberry Pi and OpenCV for image and video processing. It includes various technologies such as controlling traffic density, handling congestion, calculating overlapping images, implementing alert systems, and incorporating machine learning. The paper concludes by discussing future requirements for these important technologies..[14].

The problem of traffic congestion is steadily increasing due to the easy availability of motorcars and a rapidly growing population. This results in commuters being stuck in long traffic jams for hours, causing significant time wastage. Another factor contributing to the issue is the emergence of private ride-hailing services as an alternative to insufficient public transportation. Unexpected diversions caused by road maintenance, construction work, and accidents further contribute to traffic congestion. In some cases, bad road also a significant factor. It is crucial to address this significant problem as it wastes time and also poses risks to road safety and the environment. Our objective is to develop a system that utilizes advanced technologies like real-time video processing and ML to identify the root causes of congestion. By doing so, we can eliminate traffic issues and increase road safety effectively. [15].

## III. THE PROPOSED SYSTEM

Image-based vehicle and lane detection uses computer vision to track vehicles and lanes in images or video streams captured by cameras mounted on vehicles or roadside infrastructure. The primary goal is to improve driver assistance systems, autonomous vehicle navigation, and traffic management by providing real-time information about the surrounding environment. The technology involves various steps, including image processing, detection of objects and Tracking which can be implemented using a types of deep learning algorithms. It is used to enhance road safety, reduce the traffic congestion, and increases the transportation system efficiency.



Fig(a)

Fig(a) - Figure shows the connection of the hardware section.

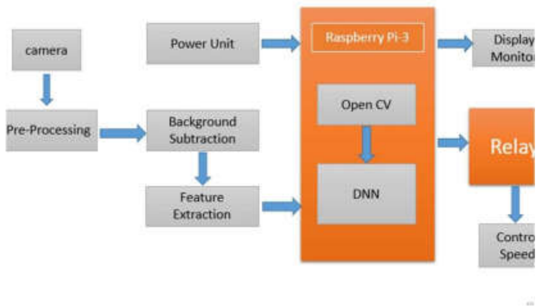
### *A. Algorithm*

Haar Cascade Classifiers

The Haar cascade algorithm is a method of object detection which uses a trained classifier that can detect objects in images or videos. The algorithm works by analyzing different features of the image, such as edges, lines, and textures, to identify objects. In the context of the road lane and vehicle detection, the Haar cascade algorithm is used to recognize the specific features of lanes and vehicles. For example, the Haar cascade lane detection algorithm is used to recognize the distinctive texture and color patterns of road lanes, while the Haar cascade vehicle detection algorithm is trained to recognize the shapes and proportions of different types of vehicles.

### *B.* Block Diagram

In the hardware section consists of various components, such as relay module, motor, raspberry Pi, Pi Camera.




Fig(b)

Fig(b) - Figure shows functional the block diagram.

1. Camera

Here, Pi camera is used to because it can capture high-resolution images and videos, and interfaced with the Raspberry Pi to create a compact and affordable image-based detection system. This makes it an ideal choice for applications such as vehicle and lane detection, where real-time image processing and analysis is required.

2. Pre-Processing

It is used in applications, such as computer vision, medical imaging, and remote sensing. Proper pre-processing can improve the accuracy and efficiency of subsequent processing steps and help extract meaningful information from images.

3. Background Subtraction

Background subtraction is an important technique which is used to track the objects and to analyze the motion. By identifying the moving objects in a scene, it can help extract meaningful information and improve the accuracy of subsequent processing steps.

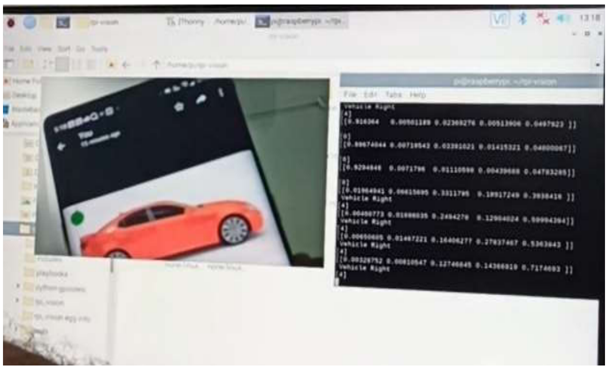
4. Feature Extraction

Feature extraction in image processing is the process of extracting meaningful information or features from digital images. These features can be used in subsequent processing steps, such as classification, recognition, or segmentation. In image processing,Features can be defined as characteristics of the image that represent specific visual patterns or structures. These can include edges, corners, textures, colors, or shapes. Feature extraction algorithms identify these patterns and extract them from the image, often using mathematical operations such as convolution or filtering.

5. Open CV

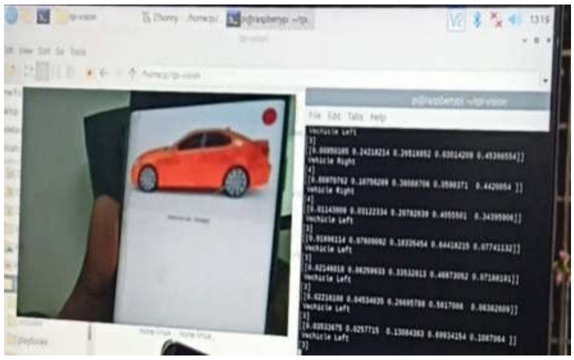
OpenCV is an opensource library of programming functions and algorithms for computer vision, image processing, and machine learning. It is used for image and video processing functions such as filtering, segmentation, and feature extraction. For Object detection and recognition functions such as Haar cascades and deep learning-based methods.

*C. Result and Discussion*



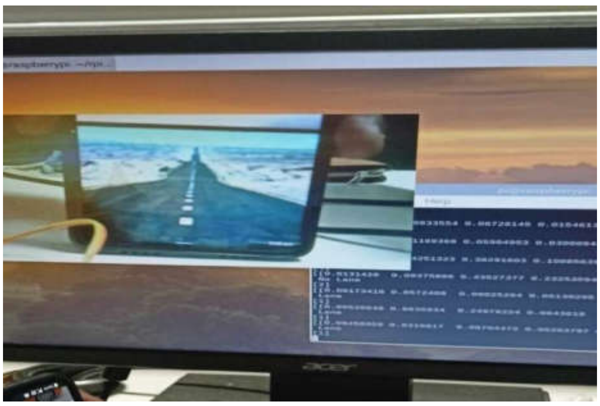
Fig(c)

In this scenario, the system has detected a vehicle positioned on the right side of the road. This information is valuable for various purposes, including speed control. By knowing the position of the vehicle, the system can adjust the vehicle ‘speed accordingly, maintaining a safe distance from the detected vehicle and ensuring smooth traffic flow. The detection of the vehicle's right position contributes to the overall functionality that provides the essential input for decision-making and adaptive speed adjustment. It enhances the system’s ability to respond to changing road conditions and contributes to improved safety and efficiency on the road.



Fig(d)

In this scenario, the system has detected a vehicle positioned on the left side of the road. This information is valuable for various purposes, including speed control. By knowing the position of the vehicle, the system can adjust the vehicle’s speed accordingly, maintaining a safe distance from the detected vehicle and ensuring smooth traffic flow.



In this above scenario, the system has detected a lane, which provides valuable information for various purposes, including speed control. By knowing the location and boundaries of the lane, the system can adjust the vehicle's speed accordingly, ensuring that it stays within the designated lane and maintains safe driving The detection of the lane contributes to the overall functionality that provides the essential input for decision-making and adaptive speed adjustment. It helps the system to accurately determine the vehicle's position on the road and optimize its speed based on lane boundaries. By detecting and tracking lanes in real-time, the system can enhance the accuracy and effectiveness of speed control, ensuring that the vehicle remains within the appropriate lane and adheres to the specified speed limits.

Fig(e)

The system's failure to detect any lane boundaries or markings on the road signifies the absence of lane detection under automatic speed control through real time road lane and vehicle detection using the Haar cascade algorithm. Alternative methods or driver intervention may be required to maintain safe driving conditions in the absence of lane information.

### *D.* MERITS OF THE PROPOSED WORK

The proposed work that address the demerits of existing work are:-

1. Image Preprocessing: This system will use image preprocessing techniques that improves the reliability of object detection and increases the features of input images.
2. Object Detection: This system will utilize advanced object detection algorithms, such as Haar Cascade or DNN-based models, to accurately detect and track vehicles and road lanes in real-time.
3. Feature Extraction: This system will perform feature extraction on detected objects, enabling you to identify and classify specific types of vehicles and/or road lanes.
4. Speed Control: This system will use the extracted features to automatically adjust the speed of the vehicle, promoting safe and efficient driving behaviors.
5. Hardware Implementation: This system will be designed to run on low-cost hardware platforms, such as the Raspberry Pi, making it accessible and easy to deploy at scale.

### *E.* Conclusion

The Haar Cascade Algorithm is a tool which is used to detect objects, to detect vehicles and road lanes in real-time. By using the detected vehicle and road lane information, an automatic speed control system can be implemented, which can adjust the vehicle speed to ensure safety and efficiency on the road. The proposed system can help reduce the number of accidents on the road, especially in Highways where the driver may be distracted or not paying attention.

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