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The Development of Recognizing Type of Vehicle System for Carbon Emission Monitoring

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Abstract: A system that can recognize the type of vehicle by capturing and identifying the vehicles has been developed. The image of each type of vehicle has been counted, and the carbon emission has been calculated based on the numbers of the vehicles detected, which have then been displayed on the dashboard to monitor low carbon emissions. This project's motivation is to support Malaysia's plan to reduce its carbon dioxide emissions and reach the goal of having a low-carbon city by 2030. Most current systems have difficulty recognizing, mainly when using automatic number plate recognition. This is because the system needs to request data from the Road Transport Department of Malaysia (RTD), which can cause users to have privacy issues. Thus, the type of vehicle recognition was made to solve the problems, especially on the main road where the surveillance camera is set up. This system uses cameras and algorithms for machine learning to identify vehicles by looking at their shape and other visible features. YOLOv7 and OpenCV-Python have been applied to this system as these methods help to detect, track, count, and classify moving vehicles. Since Open-CV is Python's real-time computer vision library, the YOLO can be used directly with OpenCV. The result of the functionality test was based on how far away the camera was, which can detect vehicles from 1 km to 3 km away. Based on the analysis of the results, the total number of each type of vehicle correlates with the number of carbon emissions measured every minute. As a result, cars had the highest carbon emissions at 17097g, followed by motorcycles at 7571g, trucks at 3168g, and buses at 2466g in 5 minutes. Overall, this system can function well and raise awareness among road users to reduce the use of private vehicles as it can lead to higher carbon dioxide emissions to the environment.

Keywords: Vehicle Recognition System, Machine Learning, YOLO, Opencv

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1. Introduction

Mobility has always played an essential role in human society. However, it is becoming an increasingly crucial factor due to the ever-increasing distances that separate places like home, employment, educational institutions, shopping, and recreational facilities [1]. However, the increase in vehicles nowadays has led to carbon dioxide emissions issues[2]. It is well known that carbon dioxide emissions contribute to global warming and climate change[3]. Designing a vehicle recognition system helps provide better management for many applications. Therefore, vehicle recognition has been widely used in traffic and highway management.

Throughout history, to gather traffic data, the traditional method has been used to conduct manual data collection campaigns and hire human labor to count the vehicles, identify their type, or apply roadside surveys after stopping the vehicles [4]. In contrast to the human operator, the recognizing type of vehicle system to calculate the carbon emission by using a camera is more efficient because it can capture and identify a type of vehicle detected in the scene or image without tiredness for an extended time.

A new system was developed to improve the flaw of the existing system, such as when multiple objects are present, object recognition becomes difficult [5]. Other than that, when objects are fully or partially occluded, they are obtruded from human vision, which further increases the difficulty of recognition. In addition, most vehicle recognition systems nowadays use automatic license plate recognition software to recognize the type of vehicle. This kind of system needs to request data from The Road Transport Department of Malaysia (RTD), a government department under the Malaysian Ministry of Transport that has the drawback of exposing the privacy of the owner of the vehicles to the responsible authority . Therefore, in this paper, the type of vehicle recognition system was used to overcome those problems and ensure the security and privacy of the vehicle's owner.

2. Methodology

The methodologies used to detect and count based on vehicle type were YOLOv7, OpenCV, Coco Dataset, and DeepSORT. An artificial neural network known as a convolutional neural network (CNN) played a role in the functioning of this system [6]. Following the detection, recognition, and tracking of vehicles in a series of video frames by the system, which is then followed by the classification of vehicles that have been recognized according to their size into several classes, YOLO is equipped with a convolutional neural network (CNN), which enables it to recognize moving objects in real-time and perform object tracking using OpenCV. After the input video has been served to be processed, the frames from the video are extracted, the frames are then converted into the blobs, the pixels are then read, and the object detection model is called for each blob. The trained model identifies the object and creates the bounding boxes for each detected object. Following the completion of the vehicle tracking process, the detection line approach is implemented to accomplish the counting of vehicles and carbon emissions.

In this project, the type of vehicle recognition system was successfully developed and produced well in line with the objectives of the study that has been proposed. This system features detection and tracking modules with high accuracy and short delay. This system counted each type of vehicle using the YOLO method, which has been trained on the COCO dataset. An object label has been made used in order to take possession of items that have been labeled as vehicles. These objects include cars, motorcycles, buses, trucks, and other heavy vehicles. Overall, the system has practical work and knowledge about vehicle count and classification with time domain, and it can recognize various vehicles in the presence of any traffic zones. Furthermore, the system not only correctly rejects the background of some of the most congested traffic, but it also successfully counts the number of carbon emissions produced by each type of vehicle. This system was successfully work when tested in real traffic at Jalan Bentayan, Muar, Johor. The distance of the traffic that can be seen from the camera located there is approximately 1 kilometer.

The system performed statistical analysis on vehicles from live monitoring camera, as depicted in the following Figure 1. To be more specific, vehicle statistics is broken down into two sub-modules which is vehicle detection and vehicle tracking, and these two modules will be improved based on the evaluation of relevant performance metrics which end with carbon emission value output.

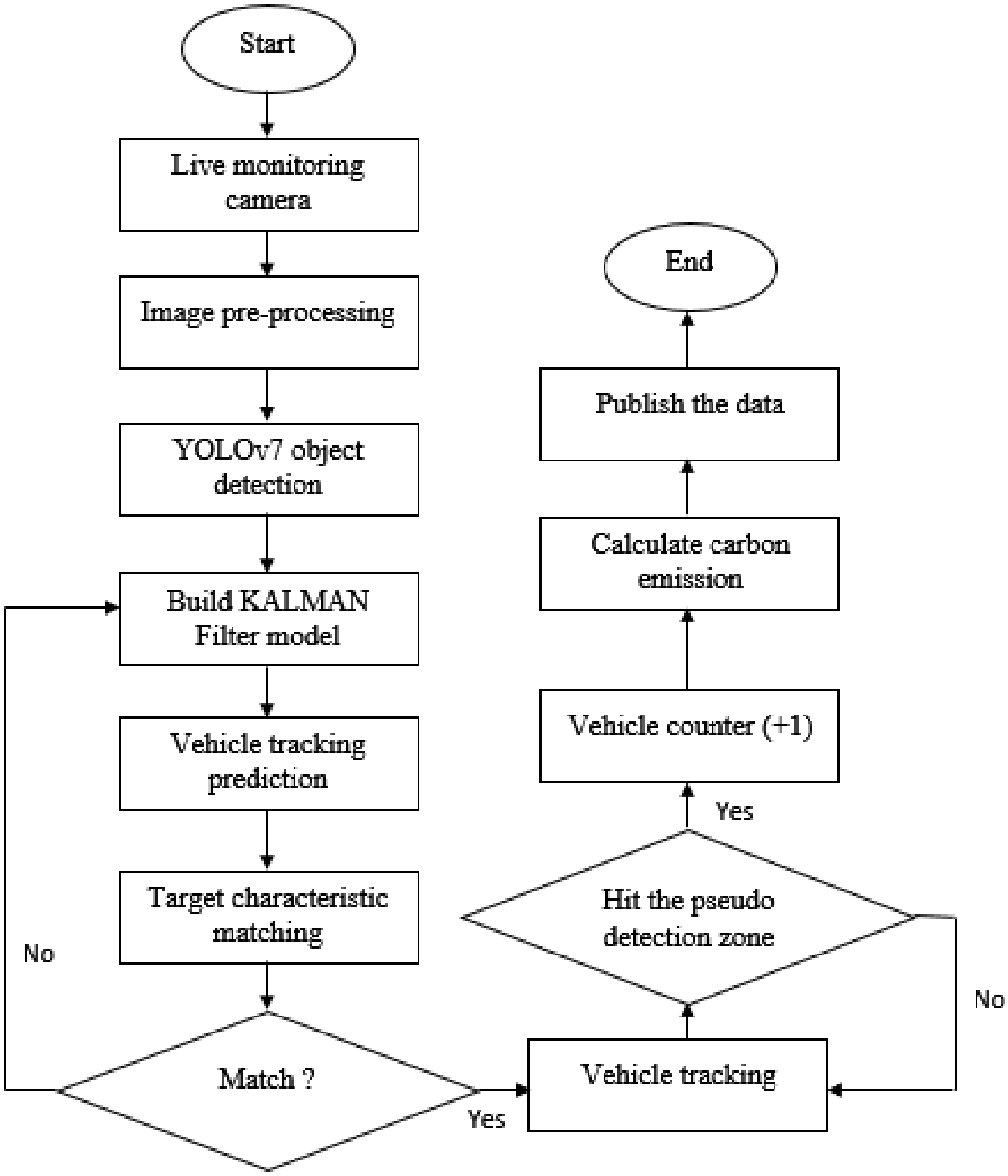

Figure 1: The flow chart for type of vehicle recognition system.

The use of Deep Learning algorithms was applied to identify and mark the boundaries of four types of vehicles in monitoring video. The accuracy of the detection has been evaluated using performance measures such as mAP. Additionally, the DeepSORT method was implemented in the tracking module to track and gather statistics on the vehicles. The Kalman Filter has been utilized in this process, which functions similarly to a traditional predictor for vehicle statistics and only requires knowledge of the error-covariance matrix of previous predictions in order to make new ones.

3. Results and Discussion

3.1 Type of Vehicle Recognition System

Figure 2 shows the complete output for the type of vehicle recognition system that has been tested on real traffic located in Muar, Johor. This type of vehicle recognition system works to ensure the carbon emission level can be monitored and controlled by the responsible authority while facilitating all vehicle owners to be aware and give cooperation in supporting Malaysia's plan to achieve low carbon city.

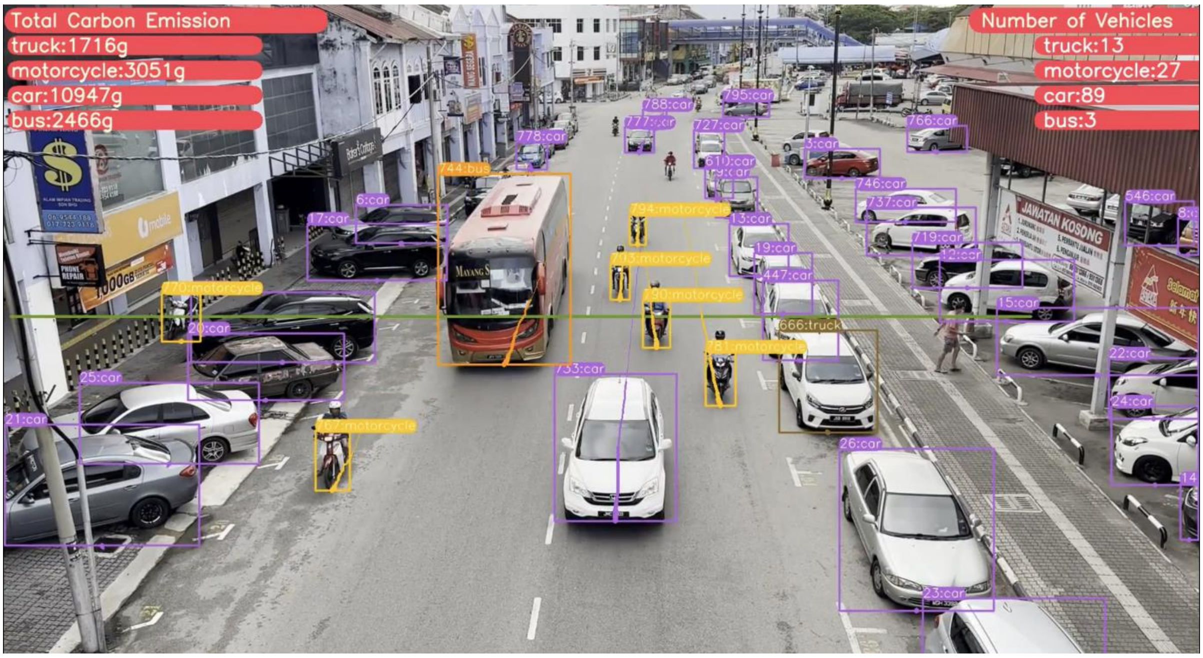

Figure 2: The complete output for the type of vehicle recognition system.

3.2 The Analysis of Type of Vehicle Recognition System

The carbon emission has been calculated using the average value of carbon emission for each type of vehicle. Table 1 shows the average value of carbon emissions by each type of vehicle, while Figure 3 shows the equation for calculating the vehicle's carbon emissions in this project.

Table 1: The average value of carbon emission by each type of vehicle.

Vehicle Type	Average Value of Carbon Emission	References
Car	123 g/km	[7]
Truck	132 g/km	[8]
Bus	822 g/km	[9]
Motorcycle	113 g/km	[10]

$$\text{Carbon Emission} = [\text{Average value of carbon emission (g/km)} \times \text{Total distance in the frame (km)}]$$

Figure 3: The equation for calculating vehicle's carbon emission.

The effectiveness of this system was evaluated through the use of a live monitoring camera on a traffic road in Muar, Johor. Figure 4 shows the display on CCTV dashboard while Figure 5 shows the total carbon emissions data for each type of vehicle taken from the camera at peak hour which is 5:30 pm for a period of 5 minutes. This time was chosen as it allows for a brief analysis of the system's ability to accurately recognize and count when there are many objects in the frame. The total number of each type of vehicle detected in 5 minutes is 24 for truck, 67 for motorcycle, 139 for car and 3 for bus. The results revealed that cars had the highest carbon emissions at 17097g, followed by motorcycles at 7571g, trucks at 3168g, and buses at 2466g. Therefore, the higher number of vehicles detected depicts the higher carbon emission.

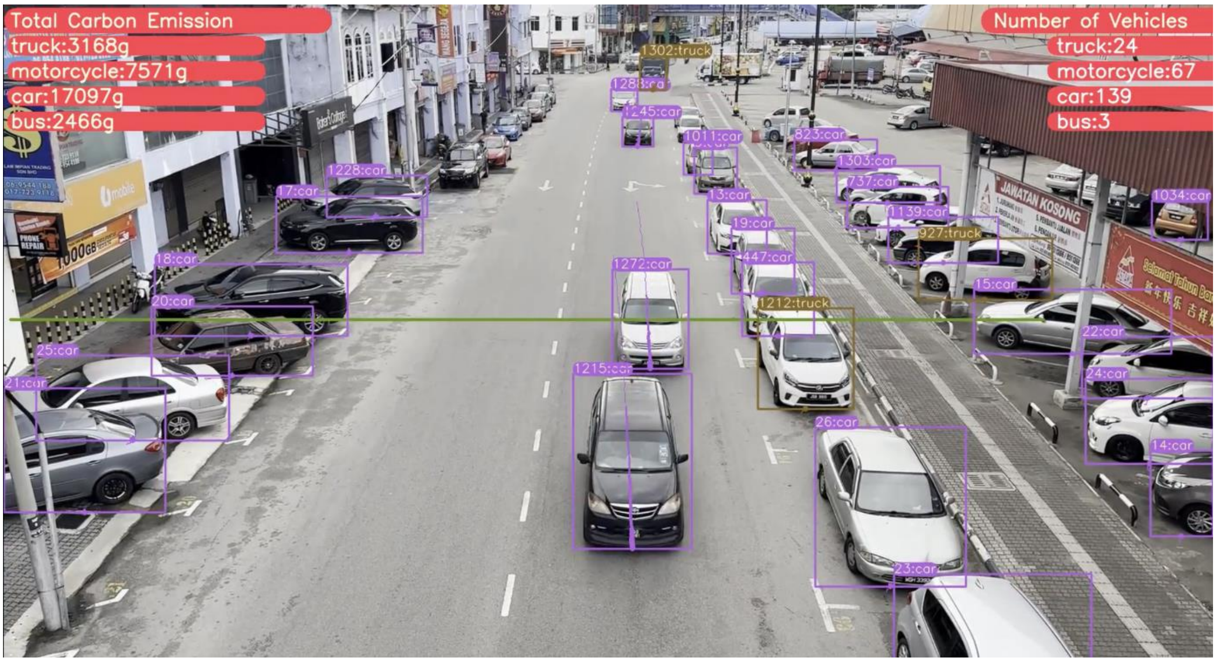

Figure 4: The display on CCTV dashboard.

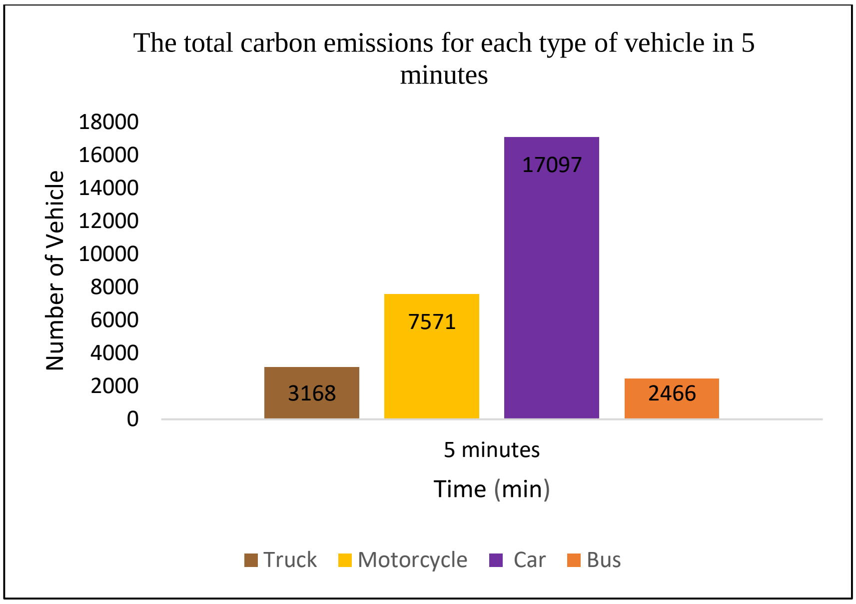

Figure 5: The total carbon emission for each type of vehicle in 5 minutes.

4. Conclusion

This simple yet intricate system designed to help the community be more alert on the carbon emissions level conditioned in Malaysia. This is due to the rarely-seen issues that can have a tremendous negative impact and damage, such as rising global temperatures, which would affect environmental conditions, food and water supplies, weather patterns, and sea levels.

A type of vehicle recognition system was designed to facilitate the responsible authority in monitoring traffic and carbon emission level in specific areas, especially those with the most congested traffic. The result of designing a type of vehicle recognition system with a carbon emission calculation that has been set up in programming code, resulting in the success of the tracking system, which shows that the system can be worked based on procedures by producing input and output in an organized way. The analysis in this paper demonstrated that private vehicles such as cars and motorcycles have the highest usage on traffic roads and only a few public transportations are detected. Based on this situation, the responsible authority will be more alert to taking action to reduce private vehicle usage in traffic and encourage the use of public transportation in the community as the system displays the amount of carbon emission.

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References

1. R. A. Hadi, G. Sulong, and L. E. George, "Vehicle Detection and Tracking Techniques," *Signal Image Process. An Int. J.*, vol. 5, no. 1, pp. 1–12, 2014.

2. Media Communications Department. "Net Zero Carbon Emissions Petronas Global." https://www.petronas.com/sustainability/getting-to-net-zero. [Accessed Jul. 06, 2022]

3. Ministry of Environment and Water KASA, "National Low Carbon Cities Masterplan," NLCCM (nrecc.gov.my). 2021.

4. S. K. Selvaperumal, "Review of car make & model recognition systems Review of Car Make & Model Recognition Systems," no. August, 2018.

5. M. Mohammed, M. B. Khan, and E. B. M. Bashie, *Machine learning: Algorithms and applications*, no. July. 2016.

6. MATLAB Central "What Is a Convolutional Neural Network?," What Is a Convolutional Neural Network? 3 things you need to know - MATLAB & Simulink 2023. (Accessed Feb. 10, 2023).

7. European Environment Agency, "Average CO2 emissions from newly registered motor vehicles," Average new car CO2 emissions by country - ACEA - European Automobile Manufacturers' Association [Accessed: Jan. 15, 2023]

8. Georgette Kilgore. "Truck CO2 Emissions Per Km Calculator: Find Semi Truck Carbon Footprint." Truck CO2 Emissions Per Km Calculator: Find Semi Truck Carbon Footprint (8billiontrees.com) (Accessed Jan. 15, 2023).

9. Carbon independent, "Emissions from bus travel," Emissions from bus travel (carbonindependent.org) pp. 5–7, 2021.[Accessed: Jan. 15, 2023.]

10. CO2 everything. CO2 Everything | Carbon Footprints of Products & Activities [Accessed Jan. 15, 2023].