CHAPTER I

INTRODUCTION

1.1 Research Background

Transportation or vehicles are a means of transportation on the road consisting of motorized vehicles and non-motorized vehicles, for example, motorcycles and cars for motorized vehicles, and bicycles which are non-motorized vehicles (Kementerian Perhubungan Republik Indonesia, 2015). Their existence is crucial because it makes it easier for person to move from one place to another. When this tool is finished being used, the related transportation tool must be parked in a special place so that it is easy to access and does not take up public space on the road. Places or buildings provided for parking or what are called parking lots (Badan Pengembangan dan Pembinaan Bahasa, Kementerian Pendidikan dan Kebudayaan Republik Indonesia, 2016) are one of the places that must be provided today, including in campus areas, especially at Ganesha University of Education.

The existence of parking spaces is becoming increasingly crucial amidst the increasing use of motorized vehicles, particularly in Bali. According to the Bali Provincial Statistics Agency, there were 5,016,351 motorized vehicles recorded in Bali in 2023, a significant increase compared to the number of motorized vehicles in Bali in 2022, which was only 4,756,364 units (Badan Pusat Statistik Provinsi Bali, 2023; Badan Pusat Statistik Provinsi Bali, 2024). Naturally, with this increase in numbers, the need for parking spaces will also increase. This condition must also be accommodated by many places in Bali, such as shopping centers, campuses, hospitals, and so on. One way to address this is to provide dedicated parking spaces

on vacant land, generally designated specifically for specific types of vehicles. For example, parking spaces specifically for cars or specifically for motorcycles. Some ways to organize the parking spaces provided, so that they are neat and easily accessible, include implementing parking-related signs, such as no parking signs or parking signs specifically for large vehicles. This kind of thing can be seen on the central campus of Ganesha University of Education.

The central campus of Ganesha University of Education consists of several faculties, each with its own building and grounds. The area surrounding the central campus is often used as student parking. There are numerous parking areas, and they generally have their own parking regulations. Many of these areas are designated for large vehicles. These areas are usually marked with warning signs warning motorcycles not to park in these areas, as shown in Figure 1.1..

Figure 1.1 No parking sign for motorcycles

However, based on observations made by the author over the past four months, specifically in the Faculty of Engineering and Vocational Studies parking area from October 2024 to January 2025, several individuals still park their motorcycles in the area. This makes the sign installation ineffective, as it is still

violated. Some concrete evidence of these parking violations can be seen in Figure 1.2. Therefore, to prevent this, technology such as computer vision can be implemented for monitoring.

Figure 1.2 Photos of parking area violations at the Faculty of Engineering and Vocational Studies. (a) taken on January 2, 2025, (b) taken on December 2, 2024, (c) taken on November 21, 2024, and (d) taken on October 23, 2024.

Computer vision encompasses a range of methods for creating numerical representations of visual images, called feature vectors. Most of these methods are optimized for specific tasks, such as face recognition, object detection, texture analysis, and others (Holm et al., 2020). The parking area monitoring process at Undiksha's central campus can utilize computer vision to detect and classify objects based on surveillance camera input. The output can be classification results and detection of parking violations by certain individuals.

One computer vision model that can be used for this task is YOLOv10. This latest model from the YOLO series was just released in May 2024 and is claimed to be one of the state-of-the-art models for object detection tasks. YOLOv10 uses a different system compared to the previous YOLO series. The difference lies in the use of NMS or Non Maximum Suppression. YOLOv10 does not use NMS, aka NMS-free. Instead, a one-to-one matching mechanism is used in the prediction process, eliminating the need for NMS in the post-processing session (Wang & Liao, 2024). The results of testing this model prove that its speed and accuracy are better than previous models. In just approximately 10.0 ms, the YOLOv10 model has achieved a fairly high accuracy, approaching 55.0 percent using the COCO AP dataset. This figure outperforms other popular models such as YOLOv8, YOLOv9, RTMDet, and RT-DETR, as well as other YOLO series. The number of parameters is also smaller compared to those models (Wang et al., 2024). Based on this, it is very possible for YOLOv10 to be used as a real-time vehicle object detection and classification model in parking lots, to detect violations in those areas, given its high speed and accuracy..

Another computer vision model that can be used to detect and classify parking violations is Faster R-CNN. This model has been around since 2016 and is still widely used today. This model has a relatively high accuracy compared to other YOLO models, below the YOLOv10 and YOLOv9 generations. By using the RPN mechanism and Fast R-CNN detector, this model is able to extract features and classify images accurately and with a low computational cost (Ren, He, Girshick, & Sun, 2016).

Therefore, to perform the task of a parking violation detection system, computer vision algorithms in the field of object detection can be used, namely using YOLOv10 and Faster R-CNN, a deep learning architecture commonly used for real-time object detection tasks. Based on this study, a study entitled "Vehicle Parking Violation Detection System in Large Vehicle Parking Areas Using YOLOv10 & Faster R-CNN" is proposed.

1.2 Research Problem

Based on the above background, the following problems can be formulated:

1. How can parking violations be detected using YOLOv10 and Faster R-CNN in a simulation video of the large vehicle parking area at Undiksha's central campus, in accordance with predefined parking criteria?
2. How can the performance of YOLOv10 and Faster R-CNN models be evaluated in detecting parking violations in the simulation video, and which model demonstrates superior effectiveness?

1.3 Research Objectives

The main objectives of this research are as follows:

1. Identify and explain the detection process of parking violations using YOLOv10 and Faster R-CNN models that comply with parking regulations in simulation videos of the large vehicle parking area at Undiksha’s central campus.
2. Evaluate and compare the performance of YOLOv10 and Faster R-CNN in detecting parking violations, and determine which model performs more accurately and reliably in the given simulation context.

1.4 Research Boundaries

The research boundaries established for the above model design are as follows:

1. Python version 3.10 (or higher) will be the primary language used in the model design.
2. The datasets used will consist of motor vehicle photos obtained from the COCO platform (a freely accessible dataset collection site) for training and testing, as well as live simulation videos recorded at the case study site for model testing.
3. The simulation process will use input videos taken directly from the case study site, in this case, the large vehicle parking area on Undiksha's central campus.
4. The parking areas on Undiksha's central campus that will be used for the simulation videos are the parking area in front of the Faculty of Engineering and Vocational (FTK) garden, the postgraduate parking area, and the Faculty of Mathematics and Natural Sciences (FMIPA) parking area.
5. The large vehicles referred to in point 3 are minibuses or cars. Parking motorcycles in these areas will be considered a violation.
6. The definition of parking is based on UU No. 22 tahun 2009 is the condition of a vehicle stopping or not moving for a period of time and being abandoned by the driver (Kementerian Perhubungan Republik Indonesia, 2015). This definition will serve as a parking restriction (a vehicle is considered parked) with the following criteria:
    a. The vehicle must stop, or not move, in the parking area.

b. Person objects must leave the parking area.

c. The parking area mentioned above is a static area with predetermined coordinates in the code.

7. A vehicle will only be considered to have violated parking regulations if it meets the following requirements:

   a. The type of vehicle parked is a motorcycle, as explained in point 5.

   b. The parking of the vehicle meets the criteria in point 6.

1.5 Research Benefits

The benefits of this research can be divided into two, namely:

1. Theoretical Benefits
   - Increased the author's knowledge of how to create a system and model for detecting parking violations.
   - Can be used as a basis for future research.
2. Practical Benefits
   - The author can complete his undergraduate thesis.
   - This research can be applied to CCTV at Undiksha to control and monitor parking areas on campus. Furthermore, this research can also be applied to parking areas in other locations, such as highways, hospitals, and other public places.