I. INTRODUCTION

In recent years, autonomous vehicle technology has emerged as a dominant area of interest within the automotive industry. Along with the considerable market demand for autonomous vehicles, a significant number of automotive manufacturers have initiated the integration of autonomous driving features into their vehicles, either partially or fully. The capacity of autonomous vehicles to function without direct human input can mitigate the possibility of accidents resulting from human oversight or inattention [1]. In order to enable autonomous vehicles to operate without human input, the approach that is currently being taken is to utilise machine learning.

Object detection represents a fundamental aspect of autonomous vehicles [2], [3]. It enables autonomous vehicles to identify objects in the surrounding environment, including both vehicles and other objects [4]. This information is then used to determine the necessary steering responses to avoid collisions. This study explores of the balance between accuracy and speed of object detection algorithms under real-time conditions, one of the important factors that ensure safety in the application of autonomous systems.

In recent years, several object detection methods have been developed that are particularly pertinent to real-time detection. The selection of these algorithms was made based on their significance in the domain of object detection. Faster R-CNN is distinguished by its high accuracy, YOLO is renowned for its real-time performance, and SSD achieves an optimal balance between speed and precision. The analysis of these algorithms within the context of a simulation facilitates comprehensive evaluation of their applicability in autonomous driving scenarios [5], [6].

The development of object detection in autonomous vehicles still remains under-researched, particularly in studies utilising simulations with the latest algorithms, as previously mentioned. Despite the considerable progress achieved in the field of object detection through the utilisation of algorithms such as Faster R-CNN, YOLO, and SSD, previous research has yet to demonstrate comparative studies conducted in simulation-based environments. Some studies, such as those referenced in [5] and [7], have focused exclusively on object detection in specific scenarios, lacking a comprehensive simulation approach. This gap emphasises the necessity for further exploration to determine the most efficient algorithm for real-world autonomous vehicle applications.

With regard to the advancement of autonomous vehicles, it is imperative to employ scenarios that do not endanger the surrounding environment. Scenarios for autonomous vehicle development should be capable of facilitating rapid, traffic-based experiments that are cost-optimised for scenarios that are challenging to replicate in the real world.

The utilisation of simulators has been adopted in a variety of domains, particularly with regard to the development of autonomous vehicles. In their study, Wu et al [8] conducted a characteristics analysis of several simulators, including Udacity, CARLA, and DonkeyCar Simulator. This research employs a computer-based simulation approach, namely DonkeyCar Simulator [8]. DonkeyCar Simulator was selected as the simulation platform due to its open-source, TensorFlow-based design [9] and its specific focus on driving behaviour research [10].

This study aims to assess the effectiveness of object detection algorithms in simulations conducted on the DonkeyCar platform. The analysis in this study includes the calculation of mean average precision (mAP) and processed frames per minute (FPS), with the objective of measuring the trade-off between speed and accuracy of the models. The findings are expected to provide insights for real-time implementations. Furthermore, the model training time is also taken into account in order to support continuous development. By comparing three state-of-the-art algorithms, namely Faster R-CNN, YOLO, and SSD within the simulator scenario, along with performance measurements and inference time, the most efficient algorithm for object detection in autonomous vehicles is expected to be identified. Furthermore, it is expected that the finding of this research will also contribute to the advancement of knowledge in the autonomous vehicle development field.