I. INTRODUCTION

Autonomous Vehicle (AV) is an emerging application of automotive technology. They can recognize sights, plan paths, and control their own movements when interacting with drivers [1]. Advances in AV technology have created opportunities for building smart cities. AV has become a popular topic in recent years [2]. Researching various computer vision methods, path planning algorithms and control theory has been a very interesting field for the automotive industry.

The use of AV is expected to reduce transportation costs and the use of human labor. However, to apply it to the environment is actually still a challenge for researchers because it involves issues of cost and safety. An example is an AV developed by Google called Waymo Driver [3], where Waymo uses an original car which of course requires a sizable fee. As an alternative approach in developing AV, the researchers used a simulation approach [4]. This simulation approach offers advantages, for example, it is relatively safer and cost-effective because the simulation is carried out based on computers and software [5]. Therefore the authors create a simulation-based AV system.

In the context of simulation-based autonomous vehicles, there have been many studies that have created simulation-based autonomous vehicles using various types of simulators. In [5] [6] [7] they made a similar simulation using the Udacity self-driving simulator, researchers [5] will drive the car manually and the image data will be captured by 3 cameras installed in the car. The image data will be used to train the model with Convolutional Neural Network (CNN) using Keras and the model output is in the form of steering commands for an Autonomous Vehicle so that the simulated car can walk avoiding obstacles in the form of boxes on the road. In this research, a reliable model has been created so that there are no collisions when the simulation is run autonomously.

CARLA Simulator introduced by [8] is an open-source simulator for autonomous vehicle simulation. CARLA provides several digital assets that can be used free of charge. In their research they succeeded in creating a simulation system to navigate an urban environment that contains various vehicles and pedestrians.

In [9][10], they used The Open Racing Car Simulator (TORCS) to create an autonomous vehicle simulation to avoid physical accidents. In their research, they created an autonomous vehicle simulation system that can mimic the intelligence of human drivers who can adapt self-driving vehicles to real-world road conditions..

Researcher [11] introduced the Simulation for Urban Mobility (SUMO) Simulator. Researcher [12] simulated the flow of road traffic using the Simulation for Urban Mobility (SUMO) Simulator. They stated that with SUMO simulator, a communication network between vehicles on the highway can be created. Researcher [13] created an AV simulation but in the form of a Platooning system using the same simulator. In this study they succeeded in simulating an autonomous vehicle platoon system with the first car being the leader and the car behind it will follow the movement of the car that is the leader of the platoon. Vehicles in this system can communicate with each other and send feedback for actions that will be carried out during the trip.

Researchers [14] also tried to create a self-driving car simulation system using the RoadView simulator. They modeled traffic simulation using image data and Geographic Information System (GIS) on the road. From the results obtained, RoadView can provide a more photorealistic scene.

In the context of deep learning, there have been several studies that apply deep learning methods in their research, including the following:

In [15], researchers created a light enhancement network (LE-net) based on convolutional neural networks for connected autonomous vehicles on dark roads such as in rural areas. They then built a

model to compare high-light images in daylight with low-light images. After testing, the LE-net they built had better results than the compared model.

In [16], they discuss advanced deep learning architecture and optimization when used for medical image segmentation and classification. Deep learning can be used to assist in the development of the medical world in detecting various diseases by processing medical imaging data.

From several previous studies, deep learning is widely used in processing image data, therefore, in this study we use deep learning methods in modeling using the CNN algorithm to training our image data. In this study we use previous research [5] as a reference and follow their method.

But, unlike previous research [5], our research does not use objects in the form of boxes on the track, but only uses a simple simulation model in the form of a path for cars to traverse with the same simulator. And also different from previous research [5], in this study we took datasets from several participants so that various kinds of Human-Behavioral-Driving could be obtained to serve as input for the model that was built.

Therefore, this research focuses on creating a deep learning model for AV simulation with udacity self-driving car simulator using the Convolutional Neural Network algorithm to predict steering angle and after that will see the results of the performance of the model built using the Multi Human-Behavioral-Driving dataset.