CHAPTER 5
ALGORITHM FOR OPTIMUM PATH PLANNING

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5.1 INTRODUCTION

The rapidly exploring random tree (RRT) architecture and technique are designed to explore non-convex high-dimensional domains efficiently and quickly. The main advantage of the RRT is its speedy identification of a practical solution to challenging obstacle configurations and its computing efficiency. The primary factors affecting RRT performance are the number of generated random points, segment length utilized for tree extension, the probability distribution for generating generated random points, and the number of trees used. The initial state of RRT consists of one node (the beginning point) and no edges.

In this study, the path planning for the autonomous vehicle (AV) is resolved primarily using a sampling-based approach. The advantage of sampling-based algorithms is that they can quickly find a viable motion plan, even in high-dimensional state space. For this research, the RRT algorithm is used to safely avoid any obstacles up ahead and return to the original path. Figure 5.1 shows an example of scenarios of vehicle changing lanes.

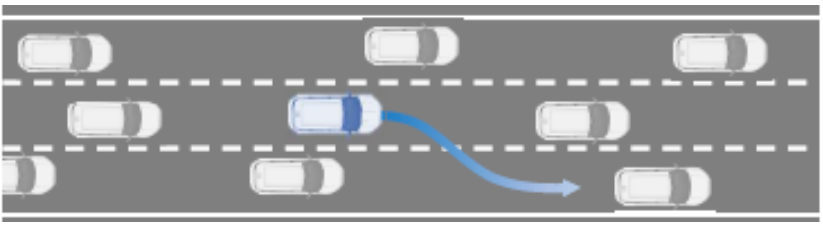

Figure 5.1 Lane change scenarios (Source: Petterson et al., 2017)

General research challenges for optimal path planning arise primarily due to the large number of car accidents happened throughout the year. Thus, as to avoid this keep happening and to ensure the autonomous vehicle can work well in real-world, research about this had to be done. One of the most important constraints is to ensure the AV has the best control system so that it will be ready to use and face many kinds of situations.

In Section 5.2, related works are first presented. The suggested method is described in Section 5.3, and the simulation research is explained in Section 5.4. Last but not least, the research's conclusion is drawn in Section 5.5.

5.2 PATH PLANNING

An AV is a group of cars that can travel to a certain area without the assistance of a driver (Zhao et al., 2018). As a result, one of the fundamental elements of the AV autonomy is autonomous reactive motion planning or simply path planning, where the control system of the vehicles discovers previously unknown barriers and plans a new course and trajectory to avoid the obstacle in real time and accomplish the target (Amin et al., 2015; Puente-Castro et al., 2022).

Despite the fact that motion planning has been thoroughly explored in the context of mobile ground robots, the bulk of the currently available methodologies have not yet been developed to the point of being used for actual AVs (Thomason & Knepper, 2022). This issue is especially significant when the car is travelling at a fast speed in a congested location and inclement weather (Batkovic et al., 2019).

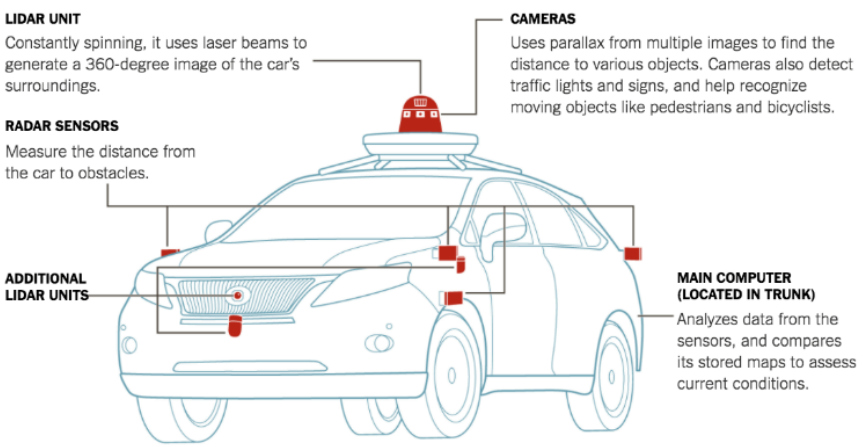

Figure 5.2 Example of autonomous vehicle configuration (Source: Metz et al., 2018)

The basic process of an autonomous vehicle system is shown in the following (Garcia et al., 2018). Global path planning is the process by which the system first establishes a path from the current location to the target location (Lai et al., 2021). On global routes, vehicles must pass through waypoints to move. The global path planning process frequently employs the Djikstra or A* algorithm (Gasparetto et al., 2015). The algorithm then uses the 3D cloud map of the surroundings. then quickly starts using its sensors to look for nearby objects.

Next, the system predicts the path that each object will take. The system then determines the AV's course and needed speed to go to the following waypoint (a process known as local route planning). It is sometimes referred to as search-based planning. Figure 5.4 shows on how the Djikstra and A* works finding the path.

Sampling-based planning is a different approach to path planning from search-based planning. The advantage of sampling-based planning was that it provided speedy fixes for significant problems (Elbanhawi & Simic, 2014; Ho et al., 2022). Perhaps the most widely used sampling-based planning algorithms are probabilistic roadmap method (PRM) and rapidly exploring random trees (RRT) (Karaki et al., 1996; Liu et al., 2022).