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Development of Path Planning Algorithm for Self-Parking Decrease Dependence of Maneuver Position

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Automated Guided Vehicles have begun to be used to save labor in distribution warehouses. It is essential for automatic guided vehicles to stop at loading docks and parking lots. In this case, the similarity of the configuraions makes it possible to apply technologies that have been developed for autonomous driving system and driver assitance system in the past. In this study, the technology developed for automatic car parking systems is applied to construct an automatic parking system for Automated Guided Vehicles. The automatic parking system for Automated Guided Vehicles can park autonomously at the target parking position by generating a trajectory based on the position and attitude of the vehicle that has traveled autonomously or manually near the parking area, the target parking position and attitude, and the surrounding environment, and by following the generated trajectory.

In this paper, we describe the development of a path planning algorithm based on the relationship between the park out path from the parking position and maneuver position, focusing that the vehicle behavior in drive and reverse are equivalent in the extremely low speed range. We propose an algorithm that reduces the dependence on the initial parking position and enables multiple switchback by calculating the park out trajectory from the target parking position and the trajectory connecting to that park out trajectory independently, each using a different method. For the generated trajectory, we consider the application of a clothoid curve as a transition curve, considering the followability of the path when used in vehicle control.

Figure 1 shows an overview of the proposed method. In the exit trajectory calculation, the system calculates a trajectory from the target parking position to exit position while making multiple switchbacks at the minimum turning radius set by the system ("system turning radius"). The system turning radius is set considering the transition curve, etc., and is based on the minimum turning radius that the vehicle system can steer. In the process of calculating the trajectory of park out , candidate positions and attitudes for calculating the connectting trajcetory ("candidate connection positions") are set at locations that satisfy predetermined conditions. Since the candidate connection position is set in the middle of the park out trajectory, it means that if this position can be reached, the parking tarjectory to the target parking position can be calculated by following the parkout trajectory in the opposite direction. In computing the connection trajectory, the trajectory from the vehicle's position and attitude to the candidate connection position is calculated based on a geometric relationship with the constraint that it is greater than or equal to the system turning radius. If there is a reachable candidate connection position, the trajectory from the vehicle position to the target parking position is generated by adding up the possible connection trajectory and the possible park out trajectory.

Figure 2 and 3 is The effectiveness of the proposed algorithm was confirmed through simulations assuming an autonomous transport vehicle based on a golf cart. Figures 2 and 3 show a screen shot of the simulation results and the variation of curvature with distance, respectively. These results show that (1) the park out trajectory calculation is independent of the initial position, making it possible to handle multiple switchbacks. (2) In the connection trajectory calculation, the trajectory generation with transition curvature change became possible by using the similarity of the clothoid curve and circular arc as a basis for the calculation based on the geometric relationship.

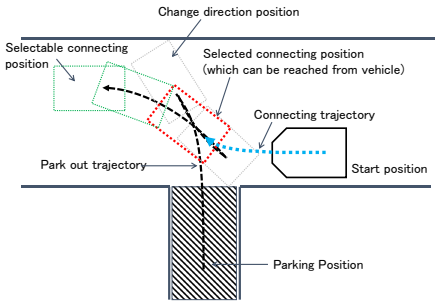

Fig.1 Overview of proposal algorithm

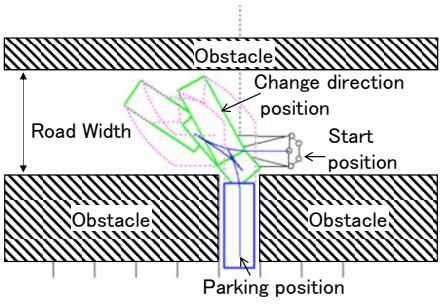

Fig.2 Simulation result

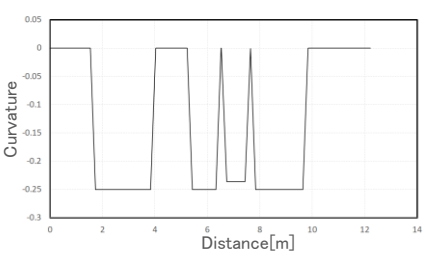

Fig.3 Transition of curvature