

Development of a Route Search Algorithm for Future Lunar and Planetary Rovers Based on a 2D Voronoi Diagram

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In recent years, national space agencies and commercial companies have been promoting the use of rovers for large-scale lunar investigations (Jones, 2023). Reducing travel distances is important that the rovers can move safely and efficiently in an environment with limited resources and a distribution of obstacles.

Yanatori (2022) developed a tool for route search using Voronoi diagrams. However, this tool has been observed to generate detoured routes, indicating a necessity for enhancements to facilitate the identification of more efficient routes. The objective of this study is to modify the route search algorithm proposed by Yanatori (2022) in order to identify shorter routes. Observations of the route search algorithm in Yanatori (2022) have revealed instances where the route from the initial point to the goal point has become detoured. To address this issue, a novel methodology is proposed, which involves the selection of specific points on the Voronoi boundary to shorten the route.

In this study, we developed a series of algorithms. Initially, we applied the wave front method (Watanabe and Murashima, 1996) for the route search algorithm. This study utilized an algorithm that expanded outward in a circular pattern from the start point and goal point until it reached the Voronoi boundary. Subsequently, we attempted to shorten the route from the start point to the goal by selecting the point on the Voronoi boundary that is closest to the goal and the point that is closest to the start point.

The objectives presented in this study were achieved by modifying the route search algorithm, thereby successfully shortening the route from the start point to the goal. In the route search algorithm by using the wave front method, the selected point was the shorten point to boundary. The second and third route search algorithms reduced distance of the route, resulting in 429 px and 425 px, respectively. This study demonstrates an enhancement in comparison to the 573 px obtained by Yanatori's route search algorithm. In this study, the Wave front method was employed to rectify the bug in Yanatori's tool, which generated detours. Furthermore, an inclination for the route to approximate the generator was identified in the third algorithm. This phenomenon can be attributed to the algorithm's failure to account for the distance from the generator. To address this issue, a proposal is put forward to set the generator's size to 1.5 to 2 times larger than the actual values. This is despite the fact that the route appears to approach the generator, as a sufficient distance is maintained.

The objective of this study was to enhance the route search algorithm of Yanatori (2022), with the aim of generating shorter routes. The proposed method is distinct from Yanatori (2022) in that it emphasizes the selection of specific boundary points, thereby resulting in a more efficient route.

Keywords: Route search, Voronoi diagram