Large Scale Under-actuated AUV Path Planning Based on Evolutionary Algorithm

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ABSTRACT

Autonomous Underwater Vehicle (AUV) is a new type of underwater carrying platform with autonomous navigation capabilities. The first problem that needs to be solved during autonomous navigation is the global path planning problem. In this paper, a marine environment model with ocean currents is established based on the electronic chart data of the S-57 standard. Then proposes a global path planning method for large-scale under-driven AUV based on an improved evolutionary algorithm. Considering the influence of ocean currents, the improved algorithm can more quickly find a safe navigation path with the least energy consumption.

KEY WORDS: Path planning; evolutionary algorithm; AUV.

INTRODUCTION

Autonomous Underwater Robot (AUV) is a new type of underwater carrying platform with autonomous navigation capabilities. In recent years, with the advancement of science and technology, AUV has gradually developed from small scale to large scale. Because the large scale AUV has the characteristics of high speed and large inertia, it is very difficult to understand its mobility and manipulation. At present, tracking a complex navigation path has become the main method for testing the mobility and manipulation of AUVs.

The first thing that must be solved to test AUV performance is the path planning problem. Path planning problems are mainly divided into global path planning and local path planning. Among them, global path planning refers to planning a path starting from a known starting position, bypassing obstacles, reaching a predetermined end position, and meeting certain optimization conditions within a certain environment. In recent years, scholars around the world have proposed various solutions to the problem of path planning. It is mainly divided into A* algorithm (Chabini, 2002), artificial potential field method (Montiel, 2015) and other ordinary path planning methods, as well as PSO algorithm (Besada-Portas, 2013) and evolutionary algorithm (Alvarez, 2004; Nikolos, 2003) and other intelligent path planning algorithms.

In the large-scale and complex marine environment where the influence of ocean current is considered, the ordinary path planning method takes more time and space as the problem scale increases, which greatly reduces the efficiency of search. At the same time, it is very difficult to integrate other problems into ordinary algorithms. This paper uses the real marine environment information to study the global path planning of AUV. First, an environment modeling method based on electronic chart information is proposed. Secondly, an improved evolutionary algorithm is proposed, which can complete the search of the navigation path with the minimum energy consumption while ensuring the safety of navigation. It avoids the problem that the algorithm converges to the local optimal solution. The Dubins curve was used to optimize the obtained path under the consideration of AUV dynamic constraints. Finally, under the environment of known obstacles and ocean currents, the effects of the classic evolutionary algorithm and the improved algorithm under different parameters are compared.

MODELING THE ENVIRONMENT

The electronic chart contains detailed marine geographic information, including land, water depth, ports, and navigational obstacles, and the S-57 standard vector electronic chart has the advantages of rich information and small storage space. So in this paper, the path planning is based on the electronic chart of the S-57 standard.

Geospatial Data Abstraction Library (GDAL) is an open-source library that uses abstract data models to transform and process chart data. First, use GDAL to read the electronic chart in the S57 standard format and parse all the information stored in it. Then, filter out information that has nothing to do with path planning. Finally, the geometric objects in vector form are saved in an easy-to-read data format, which provides a basis for subsequent improvements in the efficiency of path planning algorithms.

The marine geographic information parsed by the above method is a complex vector graphic. Although it can accurately express the geographic environment information, it cannot be applied to most path planning methods. Therefore, we rasterize the obtained chart information and transform complex geometric relationships into grid points that are easy to process. First, establish a two-dimensional space coordinate system, and select