

A novel method of unmanned surface vehicle autonomous cruise

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Abstract

Purpose – This paper aims to propose a new method for combining global path planning with local path planning, to provide an efficient solution for unmanned surface vehicle (USV) path planning despite the changeable environment. Path planning is the key issue of USV navigation. A lot of research works were done on the global and local path planning. However, little attention was given to combining global path planning with local path planning.

Design/methodology/approach – A search of shortcut Dijkstra algorithm was used to control the USV in the global path planning. When the USV encounters unknown obstacles, it switches to our modified artificial potential field (APF) algorithm for local path planning. The combinatorial method improves the approach of USV path planning in complex environment.

Findings – The method in this paper offers a solution to the issue of path planning in changeable or unchangeable environment, and was confirmed by simulations and experiments. The USV follows the global path based on the search of shortcut Dijkstra algorithm. Both USV achieves obstacle avoidances in the local region based on the modified APF algorithm after obstacle detection. Both the simulation and experimental results demonstrate that the combinatorial path planning method is more efficient in the complex environment.

Originality/value – This paper proposes a new path planning method for USV in changeable environment. The proposed method is capable of efficient navigation in changeable and unchangeable environment.

Keywords Navigation, Path planning, Autonomous robots, USV, Dijkstra

Paper type Research paper

1. Introduction

Over the past several decades, unmanned surface vehicle technology has been greatly improved with the advance of computer capabilities (Ham *et al.*, 2015). It attracted much attention for their ability to perform dangerous and time-consuming missions for military and civilian purposes such as environmental monitoring, survey and inspection of marine structures after natural disasters or large-scale accidents (Murphy *et al.*, 2011).

To perform these missions using unmanned surface vehicle (USV), autonomous navigation is a central capability, as USV can move between a starting point and a target point without human intervention (Tann and Bucknall, 2013). Robot navigation involves solving the path planning or obstacle avoidance problem to generate a feasible path and to optimize this path with respect to certain criteria (Gu and Cao, 2011; Kim *et al.*, 2014). Obstacle avoidance is consisted of global

obstacle avoidance and local obstacle avoidance, and the problem of autonomous obstacle avoidance has been studied intensively in the past (Markus *et al.*, 2014; Chen *et al.*, 2013).

For local path planning, different algorithms bring different effect of obstacle avoidance in unknown environment. Artificial potential field (APF) is a typical path-planning algorithm for robots (Khatib, 1986). Although it is very suitable for low-level real-time control of robot due to its explicit physical implication and simple mathematical description (Zhang *et al.*, 2010; Shu *et al.*, 2014), there are still some problems in the original algorithm, and some substantial improvements were made. Bacterial potential field, which improves the APF with Bacterial evolutionary algorithm (Moensiel *et al.*, 2015; Byrne *et al.*, 2014; Pétrès *et al.*, 2012), ensures a feasible, optimal and safe path. For dynamic obstacles, Liu and Bucknall (2015) presented the novel

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web this rock identification key is designed to identify the following types of rocks and minerals basalt breccia coal conglomerate copper galena gneiss granite halite

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web book description structured in the form of a dichotomous key comparable to those widely used in botany the mineral key provides an efficient and systematic approach to