Vision Based Obstacle Detection and Mapping for Unmanned Surface Vehicles

Abstract

Detecting and mapping obstacles in maritime environments with high accuracy and robustness are two important issues for unmanned surface vehicles (USV) in real-life applications, such as surveillance and navigation. Solutions based on vision (cameras) are more cost-effective than its counter-part, radar, and what's more vision can compensate the blind area of radar at short distances.

This thesis addresses the tasks of improving the accuracy and robustness of vision based obstacle detection and mapping in open sea.

For obstacle detection, first, we present a novel image (monocular vision) based algorithm, in which the obstacle patches are separated from the sea patches using the proposed patch's distinctiveness measure, named as global sparsity potentials (GSPs). Then, an approach by fusing 2D and 3D clues for further enhancing the performance is proposed in a binocular vision system. In this approach, the 2D and 3D information are combined in a weighting model, which gives more weights to the 2D detecting results when obstacles are far away, while gives more weights to the 3D detecting results when obstacles are nearby.

For obstacle mapping, to the best of our knowledge, we are the first to handle this task for USV. We develop a monocular vision system based on the theory of motion parallax. Integrating image with GPS and compass information, static obstacles can be detected and ranged in our framework, which results in an obstacle map. To achieve more accurate and robust performance, multiple pairs of frames are leveraged to synthesize the final ranging results in a variance based weighting model.

Since there are few available public datasets for USV, we evaluate the efficiencies of the proposed algorithms on our own datasets. Experimental results verify that our methods are highly accurate and robust as compared to other methods.

The thesis concludes with limitations to the presented research, and with suggestions to further studies in this line.