A Path Planner for Unmanned Surface Vehicles: A Survey

Riccardo Polvara

***Abstract*—Developing a robust obstacle avoidance module is a foundamental step towards fully autonomous USVs. Until now, most of them move in the sea following way points paths, usually GPS-based, totally unaware about possible collisions against rocks, other vessels or also divers. In this paper, the actual state of the art regarding obstacle avoidance and the plan of a safe path between a starting point and a goal is summarized.**

***Keywords*—Path planner, USV, control, obstacle avoidance.**

I. Introduction

Marine robots represent one of the three big families in which mobile robotics could be divided, together with terrain and aerial robots. This kind of vehicles can be also distinguished in Unmanned Surface Vehicles (USVs) or Unmanned Underwater vehicles (UUVs) based on the fact they operate at the same level of the sea or under it. The interest toward this technology and the advantages that it can offers started in the last century, whit the developing of the COMOX torpedo concept by Canadians in 1944 as a pre-Normandy invasion USV designed to lay smoke during the invasion [1].

Sponsored primarly by the US Navy, multiple platforms were developed and deployed in the late 1990s with the scope of reconnaissance and surveillance missions. Between these, an example is given by the Owl MK II, a Jet Ski chassis equipped with a low-profile hull for increased stealth and payload capability, a sonar and a video camera. The military community has expressed strong interest in the use of USVs fir a variety of roles, including force protection, surveillance, min warfare, anti-submarine warfarem riverine operations and special forces operations. This interest has been focused primarly on the development of the Spartan USV by the US Space and Naval Warfare System Center in san Diego since 2003.

Multiple unmanned marine vehicles have been built also outside the USA; for example, Yamaha in Japan developed the Unmanned Marine Vehicle High-Speed UMV-H and the Unmanned marine Vehicle Ocean type UMV-O, involved in bio-geo-chemical monitoring. Other examples are the Canadian Barracuda, the Dolphin MK II, the Seal USV and the SARPAL AMV, all developed by the International Submarine Engineering Ltd (ISE),the Stingray used by the Israeli navy, the Delfim and Caravela developed by the Portuguese Dynamical Systems and Ocean Robotics lab. and finally the Springer developed by the University of Plymouth.

Most of the vessel cited beforeare dual-purpose vehicles, able to function in the conventional manned mode or in the unmanned one. Sometimes the installation of remoting kit allows the craft to be operatoed in fully manual mode, in autopilot-augmented mode or in remote-contrl mode. In this way the ship not only retains full manual capability but that capability is augmented and extended in an affordable and low-risk manner.

Riccardo Polvara is a PhD student with the Marine Science and Engineering School, University of Plymouth, Plymouth, England. E-mail: riccardo.polvara@plymouth.ac.uk

II. Obstacle Detection

III. Path Planner

A. Global Path Planner

B. Local Path Planner

IV. Conclusion

Appendix A
Proof of the First Zonklar Equation

Some text for the appendix.

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