Chapter 96
Underwater Swarm Robotics:
Challenges and Opportunities

Matthew Joordens
Deakin University, Australia

Benjamin Champion
Deakin University, Australia

ABSTRACT

Underwater swarm robotics today faces a series of challenges unique to its aquatic environment. This chapter explores some possible applications of underwater swarm robotics and its challenges. Those challenges include the environment itself, sensor types required, problems with communication and the difficulty in localisation. It notes the serious challenges in underwater communication is that radio communications is practically non-existent in the underwater realm. Localisation also becomes problematic due to the lack of radio waves as GPS cannot be used. It also looks at the platforms required by underwater robots and includes a possible low-cost platform. Also explored is a method of swarm robotics control known as consensus control. It shows possible solutions to the challenges and where swarm robotics may head.

INTRODUCTION

Swarm robotics is the study of how large number of relatively simple physically embodied agents can be designed such that a desired collective behavior emerges from the local interactions among agents and between the agents and the environment. (Şahin, 2005)

Underwater swarm robotics then, consists of a number of small underwater robots that are aware of each other's location and that work together for a common goal.

From the above definition we see that the agents cooperating in the swarm are themselves both simple and of lower individual cost than one complex robot that is able to complete the required task on its own. They are designed either to replace a single large and complicated agent, or to achieve a goal that it is not possible for a single agent, however complicated, to perform. The advantage of using a swarm over

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a single agent is that if any one of the agents in a swarm becomes inoperative, the remaining swarm can still complete the task. This dictates that the agent in a swarm must be of lower cost so that its demise does not greatly affect the task or the budget. (Faigl, Krajnik, Chudoba, Preucil, & Saska, 2013)

BACKGROUND

For centuries explorers have crisscrossed this globe on which we live with great success. Today we can map almost all of the Earth's land masses. But this only accounts for about 29% of the surface of the Earth. For the remaining 71% relatively little is known. In 1953 Mount Everest, the highest point on the surface of the earth, was reached. 1960's saw an even greater accomplishment, that of descending into the Marianas trench. At about 11 km in depth, the Marianas Trench is the deepest point on the Earth. As the pressure in water increases by one atmosphere for every 10m, to get to this depth a submarine had to be designed and built to withstand pressure from the surrounding water of about 11,000 times the pressure at sea level. It is this pressure that limits a lot of exploration of the seabed. Vessels used to carry people down to these extraordinary depths and pressures are just as extraordinarily expensive. Because of the expensive and dangerous nature of underwater exploration, little of what the oceans hold have been explored. Recreational Ocean divers can reach depths of only 40 m and for only a few minutes at a time. (Richardson, 2008) Commercial divers have been known to reach depths of 300 m and that is as far as an unprotected but fully life supported person can reach. To explore further down requires the use of submarines and robots.

Exploration at shallower depths can also benefit from the robot. Oil rig and pipe line inspection are two examples where robots can help.

Robots are becoming more and more prominent in undersea exploration as they are cheaper than submarines and keep human beings out of harm's way. Most robots are actually remote-control vehicles used for visual inspection, such as the exploration of the Titanic at a depth of 3840m.(Ballard, 2008)

Figure 1. ROV Hercules examining the stern of Titanic during a 2004 expedition from the NOAA ship Ronald H. Brown(Network)