

A Preliminary Test on Agent-based Docking System for Autonomous Underwater Vehicles

Son-Cheol Yu*

Research Institute of Mechanical Technology, Pusan National University, Busan, Korea

This paper addresses an automation method of underwater tasks using AUV (Autonomous Underwater Vehicles). An AUV has a small agent vehicle to connect to an underwater docking station which is connected with operators. If the agent docks, the operator can fully monitor and control the AUV as an ROV (Remotely Operated Vehicles). Under human supervision, it can carry out complicated tasks such as underwater manipulations. If the agent undocks and is recovered, the AUV navigates as an untethered vehicle. In order to evaluate the proposed docking system, an experimental agent and a docking device were developed. For efficient and reliable docking, a visual landmark and a smart cable-based docking method were developed. A preliminary docking test was carried out at an indoor tank to evaluate the proposed docking system.

INTRODUCTION

Risky and complicated underwater tasks, such as underwater structures' maintenance, have been manually performed by divers and ROV (Remotely Operated Vehicles). These tasks are dangerous for humans and ROV require heavy deck supports, such as tether maintenance using a specific mother ship.

Automation of the tasks using AUV (Autonomous Underwater Vehicles) can be an alternative. They have excellent mobility and hardly need the deck support. They have been successfully automated for simple tasks such as wide area data collection, and challenging for complicated tasks' automation. However, their intelligence and reliability have not yet reached a sufficient level to undertake the tasks.

Human intervention in or monitoring of the tasks can be an interim solution. During the task, if a communication link between the AUV and an operator is secured, they can carry out the tasks under human supervision. They will gradually be able to improve their performance. In the end, they will have automated most risky tasks.

For this link, there are 2 feasible underwater methods. One is an acoustic link, and the other is a tethered link. The acoustic allows free movement of vehicles, but its linking reliability is too poor and data transmission speed is too slow to use for the link. On the contrary, the tethered allows reliable linking and fast data transmission, but it restricts the AUV's movement. The mentioned link requires these 2 methods' advantages.

There has been very little research regarding the solution of this link problem. A SWIMMER vehicle (Evans, 2001, 2003) is the most representative. This large AUV loads a heavy duty ROV. Usually, it moves as an AUV.

If the link is necessary, it docks to a docking station and launches the ROV for the task. This linking method is practical, but it requires a huge docking station, which needs heavy installation and maintenance load, to dock the AUV.

Applying AUV to the tasks has another problem. Most complicated tasks require sufficient buoyancy and power source to sustain the vehicle during tasks. This scales up the vehicle size, and

the large size significantly decreases the vehicle's maneuverability. Also, a large vehicle's powerful thrusters often stir up seabed silt, resulting in loss of vision, which is crucial for the tasks.

CONCEPT OF AGENT-BASED DOCKING SYSTEM

In order to solve these problems, we propose an agent-based docking system. As shown in Fig. 1, an AUV has a small agent to dock to a docking device which is connected with an operator. If the communication link is necessary, the agent docks and the operator can fully control and monitor the AUV as it carries out complicated tasks, such as valve control in oil rigs. If the link is unnecessary, the agent is recovered and the AUV moves as an untethered vehicle. The proposed method allows reliable and fast linking without sacrificing the advantage of an AUV's mobility.

The following describes the docking processes. To begin, the AUV detects the docking device by acoustic sensor, from a long distance, and approaches it. When it is several meters away, it stops and launches the agent. Fig. 2 and Table 1 show a developed agent vehicle. The agent is connected to the AUV with a smart cable (Yu, 2004), which provides a whole cable contour 3-dimensional shape as well as both ends' relative position. It also acts as a communications link between the AUV and the agent.

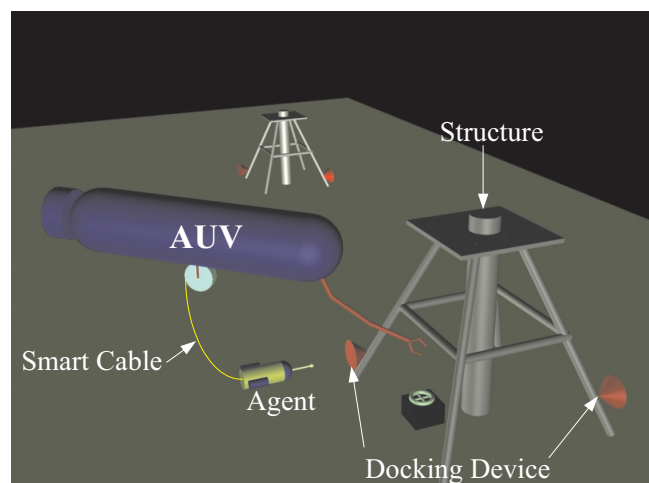


Fig. 1 Proposed docking system

*ISOPE Member.

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