Abstract

An Autonomous Underwater Vehicle (AUV) should carry out complex tasks in a limited time interval. Since existing AUVs have limited battery capacity and restricted endurance, they should autonomously manage mission time and the resources to perform effective persistent deployment in longer missions. Task assignment requires making decisions subject to resource constraints, while tasks are assigned with costs and/or values that are budgeted in advance. Tasks are distributed in a particular operation zone and mapped by a waypoint covered network. Thus, design an efficient routing-task priority assign framework considering vehicle's availabilities and properties is essential for increasing mission productivity and on-time mission completion. This depends strongly on the order and priority of the tasks that are located between node-like waypoints in an operation network. On the other hand, autonomous operation of AUVs in an unfamiliar dynamic underwater and performing quick response to sudden environmental changes is a complicated process. Water current instabilities can deflect the vehicle to an undesired direction and perturb AUVs safety. The vehicle's robustness to strong environmental variations is extremely crucial for its safe and optimum operations in an uncertain and dynamic environment. To this end, the AUV needs to have a general overview of the environment in top level to perform an autonomous action selection (task selection) and a lower level local motion planner to operate successfully in dealing with continuously changing situations.

This research deals with developing a novel reactive control architecture to provide a higher level of decision autonomy for the AUV operation that enables a single vehicle to accomplish multiple tasks in a single mission in the face of periodic disturbances in a turbulent and highly uncertain environment. The system incorporates two different execution layers, deliberative and reactive, to satisfy the AUV's autonomy requirements in high-level task-assign/routing and low-level path planning.

The proposed architecture encompasses a Task-Assign/Routing (TAR) approach as a high-level decision maker and a local Online Real-time Path Planner (ORPP) as a low-level action generator. This model can simultaneously plan the complete mission by accurate organizing the tasks to ensure a productive mission; while providing dynamic manoeuvre in dealing with uncertain variable environment. The ORPP operates concurrently, back feed the environmental condition to higher level TAR, and system makes decisions according to the raised situation. Static-dynamic current map data, uncertain dynamic-static obstacles, vehicles Kino-dynamic constraints are taken into account. The system has a cooperative and consistent manner in which the higher level mission planner handles mission scenario and gives a general overview of the terrain by cutting off the operating area to smaller beneficial zones for vehicles deployment in the feature of a global route (sequence of tasks).

On the other hand, path planning is an excellent strategy for guiding vehicle between two points, which accurately handles environmental changes when operating in a small scale area. Splitting the large area to smaller sections (carried out by higher level) solves the weakness of path planning methods associated with large scale operations. This leads to problem space reduction and significant reducing of the computational burden for the path planning; thus, re-planning a new trajectory requires rendering and re-computing less information.

Numerical simulations for analysis of different situations of the real-world environment is accomplished separately for each layer and also for the entire ARMSP model at the end. Performance and stability of the model is investigated through employing meta-heuristic algorithms toward furnishing the stated mission goals. It is demonstrated by analysing the simulation results that the proposed model provides a perfect mission timing and task managing while guarantying a secure deployment during the mission.