WiMUST Report Summary

Project ID: 645141
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Periodic Reporting for period 2 - WiMUST (Widely scalable Mobile Underwater Sonar Technology)

Reporting period: 2016-02-01 to 2017-01-31

Summary of the context and overall objectives of the project

The WiMUST (Widely scalable Mobile Underwater Sonar Technology) project aims at expanding and improving the functionalities of current cooperative marine robotic systems, effectively enabling distributed acoustic array technologies for geophysical surveying with a view to exploration and geotechnical applications. Recent developments have shown that there is vast potential for groups of marine robots acting in cooperation to drastically improve the methods available for ocean exploration and exploitation. Traditionally, seismic reflection surveying is performed by vessel-towed streamers equipped with hydrophones acquiring reflected acoustic signals generated by acoustic sources (either towed or onboard the same vessel). In this context, geotechnical surveying for civil and commercial applications (e.g. underwater construction, infrastructure monitoring, mapping for natural hazard assessment, environmental mapping, etc.) aims at seafloor and subbottom characterization using towed streamers of fixed length that are extremely cumbersome to operate and difficult to steer with accuracy along desired paths. The vision underlying the WiMUST proposal is that of developing advanced cooperative and networked control / navigation systems to enable a large number (tens) of marine robots (both at the surface and submerged) to interact by sharing information as a coordinated team (not only in pairs). Such teams of autonomous robots equipped with acoustic sensors can replace conventional, long streamers, thus physically decoupling the acoustic source from the receivers (hydrophones) and affording the latter the capability to follow desired paths accurately, in the presence of external environmental disturbances.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

"Work Packages (WP) 2 ended during the first period of the project, all other WPs of the project were active during the second period.

As for WP1 Management, its activities are progressing regularly with no major issues to be highlighted.

As for WP3 Distributed Sensor Array, out of the four tasks of the WP, the first two:
*) T3.1 Adaptive Distributed Sensor Array (DSA)
*) T3.2 Strategies for Optimal Array Geometry Performance
have regularly ended during the second period as planned in the Grant Agreement.

The objective of WP4 is to afford the WiMUST vehicles accurate relative navigation and control capabilities, ensuring inter-
vehicle collision avoidance exploiting the WP5 results and yielding a virtual structure to accurately position each hydrophone streamer. The WP is organised along 3 Tasks. During the second period, progress has been made on all three tasks. As for T4.1 for cooperative navigation and control purposes, the overall WiMUST system was divided into two entities: “Anchor Nodes” and “Follower Vehicles”. The first are responsible for providing the means to better localize the latter. An anchor node can be a ship that carries the sparker and modems or simply a surface vehicle. Building on this architecture a cooperative navigation solution taking into account the communication constraints is being developed. As for Task T4.2 a tracking controller was developed to allow a vehicle to track a given trajectory. As for Task 4.3 work is progressing on the model identification, and motion control of the WiMUST Folaga AUVs; the task will also include work on autonomous robotic catamarans to tow the seismic sparkers of the WiMUST system.

The objective of WP5 is to equip the WiMUST system with a principled information-theoretic based mission planner combining high-level mission-relevant tasks with novel intelligent approaches linked to survivability criteria. The WP is organised along 3 tasks. The first one ended in the first period. As for Tasks T5.2 and T5.3 the progress has been regularly in the period. The primary objective of Task T5.2 is to provide to the WiMUST Mission Planner algorithms capable of computing the so called "empowerment" of the AUVs used by the consortium. The combination of the vehicles’ empowerment with mission-relevant goals will be considered in Task 5.3.

The two tasks composing WP6 on communications have ended in the period. Task 6.1 Short range communication aimed at the development of communication algorithms and procedures to support seismic data transfer from AUVs to surface station and service data (e.g. synchronisation data) exchange between all WiMUST vehicles. Another objective was to develop algorithms and procedures for synchronization of AUVs clocks for accurate distance measurements between vehicles moving in formations. All such objectives have been successfully achieved. Task T6.2 Long range communication aimed at the development of communication algorithms and procedures to support long range communication between WiMUST underwater assets in different operative and environmental conditions, as well as development of algorithms and procedures to synchronize their clocks with sufficient accuracy (in the order of tens of microseconds) using underwater acoustic link (no atomic clocks). The task ended with the production of a deliverable at month 25.

WP7 on integration has been active in the period. The main activities included:
* Streamer and their boards mechanical and electrical integration on the AUVs
* Modems mechanical, electrical and SW integration
* Mission, NGC SW integration (through ROS)
* Catamaran sparker mechanical, electrical and SW integration
* Integration week in November 2016 aiming at:
  1 validating the hardware integration navigation and formation control algorithms
  2 acquiring data with modems for navigation post-processing, seismic data with the AUV streamers and, data with CINTAL’s Dual Accelerometer Vector Sensor (DAVS).

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**Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)**

"The project activities have impact on both research in the area of cooperative marine robotics and related industrial applications. In the long term, the WiMUST consortium expects that the use of “Autonomous Immersed Nodes” for recording seismic data at sea will become the dominant technology. In order for this to become reality, however, many technical, industrial and business hurdles need to be addressed. The WiMUST project is addressing technology that will ultimately be able to overcome some of the technical obstacles, while keeping in mind the industrial and business constraints. The most
challenging technical issue is that of measuring the position of hundreds of recording nodes spread out over an area of several square kilometers, at a sample interval of about 10s and with an accuracy of better than 10m. Not only must the position be recorded continuously, but also the positions of the nodes must be communicated back to the Command and Control system and necessary position corrections be sent to the underwater network. WiMUST is contributing to the study of technical solutions to this problem. The use of "Autonomous Immerged Nodes" for recording seismic data is expected to impact also on smaller scale, higher resolution surveys. In such scenarios there will be savings on towing leads (and the winches that go with it) and mechanical additions to the vessel (outriggers, cable guides) compared to the current situation.

Related information