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Defence Innovation Network Grant Scheme: Pilot Project

MOVING VESSEL COLLISION AVOIDANCE FOR AUTONOMOUS UNDERWATER VEHICLES

PROBLEM

Autonomous underwater vehicles (AUVs) such as the REMUS 100 (www.hydroid.com) are useful tools for high-resolution marine survey. They can navigate very accurately underwater, but they are slow-moving vehicles with limited energy and power. Most AUVs have no ability to sense the environment around them, particularly in regards to detecting moving vessels. AUVs also surface occasionally for communication and to obtain a GPS position fix, and at such times they typically drift with the prevailing current, with minimal projection above the surface. This makes AUV navigation in seaways and harbours particularly hazardous, and excludes them from routine activities in such areas unless extensive preparations have been made and an escort is provided. An AUV-compatible system that could sense oncoming vessels, determine whether they pose a risk of collision, and allow the AUV to avoid them would be valuable.

This project aims to determine whether an acoustic sensing system combined with an artificial intelligence-based processor could be useful for collision avoidance. The motivation for acoustic sensing is that, while AUVs sit low in the water and have limited optical visibility of their surroundings, most vessels are noisy. They radiate large amounts of acoustic energy into the water at audio frequencies, so they are not difficult to detect. They are, however, difficult to characterise and different vessel types may require different collision avoidance behaviours. For example, an AUV could dive a few metres underwater to avoid a dinghy with an outboard motor, but a different strategy would be necessary to avoid a cargo ship coming into the harbour, because the keel of the ship could come within a few metres of the seabed. This project is therefore intended to identify novel approaches to detecting, classifying and localising surface vessels with the objective of developing a low-cost, low-power system that would allow an AUV to determine when vessels are likely to present a collision hazard and manoeuvre to avoid collisions.

NEED AND RELEVANCE TO DEFENCE

Defence is acquiring AUVs at present and expects to acquire increasing numbers in future. Without an autonomous collision avoidance capacity, Defence will be restricted as to when and where it can deploy these vehicles and will be forced to expend significant effort to ensure that they do not collide with vessels. More generally, an advance of this type would benefit all AUV users, since collisions with vessels are among the most frequent causes of damage to AUVs.

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RESEARCH QUESTION

What are the best sensors to detect acoustic energy from surface vessels?

What are the most appropriate sensor placements on AUVs?

How can different classes of vessel be recognised (identified) from detected signals?

How can the speed and heading of vessels best be estimated?

How can closest points of approach be estimated from acoustic data collected from sensors on AUVs?

If collision is imminent, how should an AUV respond?

EXPECTED OUTCOME

An AUV with a trusted autonomous vessel collision avoidance capability will be able to operate unescorted in seaways and harbours. This will reduce the demand for operator supervision and mitigate the need to exclude vessel traffic from waters in which AUVs are operating.