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Emerging technology snapshot
Underwater Detection

Underwater detection technologies have a broad range of application, including the location and monitoring of subsurface infrastructure, mapping of undersea terrain, the study of aquatic biodiversity and supporting military operations such as the identification and tracking of submarines and other objects. There is an increasing demand for underwater sensing systems that are better performing, more energy efficient and longer-lasting, especially as more devices are deployed in extreme environments such as the Arctic.
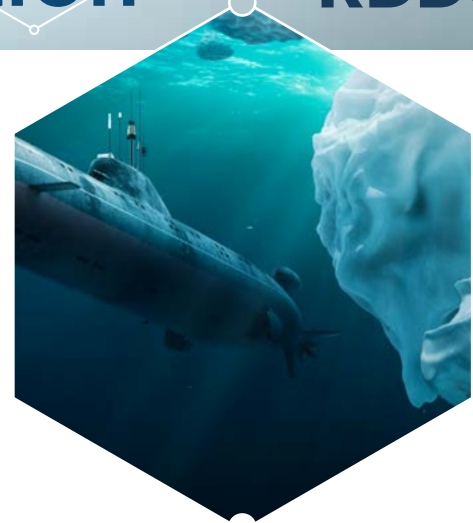
Enabling Science and Technology

Network Security

One of the fastest-growing topics in the literature is the development of technologies for securing underwater wireless sensor networks (UWSNs), particularly against malicious activities such as eavesdropping, denial-of-service attacks, jamming and other cyber-intrusions.

Internet of Underwater Things (IoUT)

Similar to the above-water version known as the "Internet of Things (IoT)", the IoUT is an emerging, global underwater network of connected objects and systems for applications as varied as seismic monitoring, oil pipeline leak detection, marine life observation and surveillance.

Energy Harvesting

Replacing sensor batteries in the middle of the ocean is a challenging and expensive task. Current research aims to substitute conventional batteries with a continuous, reliable and efficient power supply through novel underwater energy harvesting technologies.

Compressive Sensing

UWSNs accumulate and transmit massive amounts of data. Techniques that reduce energy consumption, improve performance and mitigate transmission errors are an active and growing area of research and development (R&D) worldwide.

Photonic Sensors

Photonic sensing for the underwater environment is a relatively nascent topic of study in the literature, but recent research indicates that it could surpass the performance limits of classical underwater detection and may lead to quantum-enhanced sensing applications.

"For national defence and security, accurate and rapid measurements of variations in microgravity open up new opportunities to detect the otherwise undetectable and navigate more safely in challenging environments. As gravity sensing technology matures, applications for underwater navigation and revealing the subterranean will become possible."

Dr. Gareth Brown, UK Defence Science and Technology Laboratory. *Sensor breakthrough paves way for groundbreaking map of world under Earth surface*, Feb. 23, 2022

Canada

Signals

Academic

As of 2021, China was by far the leader in underwater detection R&D, accounting for 44% of the scientific literature and more than 90% of the patents since 2017.

Government

Governments and large research technology organizations are increasingly interested in underwater detection technologies. Germany's Helmholtz Association, India's Institutes of Technology and France's CNRS are leaders in publication output.

Collaboration

DARPA, with several partners, is developing new sensor systems to detect and record the behaviors of marine organisms to help identify and characterize underwater vehicles in strategic waters.

Defence

The US Navy is funding a project at the University of Illinois to develop a single-chip, low-power, low-noise, high-resolution underwater imaging system modelled on the visual abilities of the mantis shrimp.

Corporate

A recent patent from South Korea's LIG NEX1 discloses an underwater magnetic field sensing device that claims a false detection rate close to zero and an ability to detect submarines at a depth deeper than existing magnetic-based systems.

"Raytheon is developing a novel system to detect manned or unmanned underwater vehicles in coastal waters that will leverage the sounds made by organisms found naturally in the environment… by detecting reflections of those sounds off of the underwater vehicle."

Alison Laferriere, Raytheon. *DARPA Wants to Turn Sea Life Into a Giant Submarine Detection Network*, Mar. 2, 2019

Impact

Social

Underwater sensing technologies also have disaster mitigation and humanitarian applications, such as real-time detection of tsunamis or the location and identification of sunken airplane wreckage.

Policy

Russia's aggression in Ukraine in 2022, combined with the growing economic and strategic importance of the Arctic, may alter the geopolitics of the North and result in a new urgency for both terrestrial and underwater detection technologies.

Economic

The global market for UWSNs is expected to reach US$2.4 billion by 2026. Growth will largely be driven by resource exploration, pipeline/cable monitoring and applications for surveillance and threat detection.

Environmental

Technologies ranging from sensor-equipped autonomous underwater vehicles to space-based detection systems are being used to detect underwater infrastructure failures in real-time, helping to limit the negative environmental impacts.

Defence

The US Army is funding a project by SubUAS to develop a multi-faceted surveillance system that can quickly identify small objects in riverine environments using a variety of sensor technologies.

"The introduction of autonomous, unmanned platforms with improving and digitally-fused sensors, integrated within cooperative systems, will enable wider surveillance of the ocean… these technologies could prove to be game-changers that tip the balance in favour of anti-submarine warfare."

Sebastian Brixey-Williams, Australian Strategic Policy Institute. *Prospects for game-changers in submarine-detection technology*, Aug. 22, 2020

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