EFFECT OF A NOVEL UNDERWATER ROBOT ON FISH BEHAVIOUR AND WELFARE IN SEA CAGES

AQUA EXCEL 2020

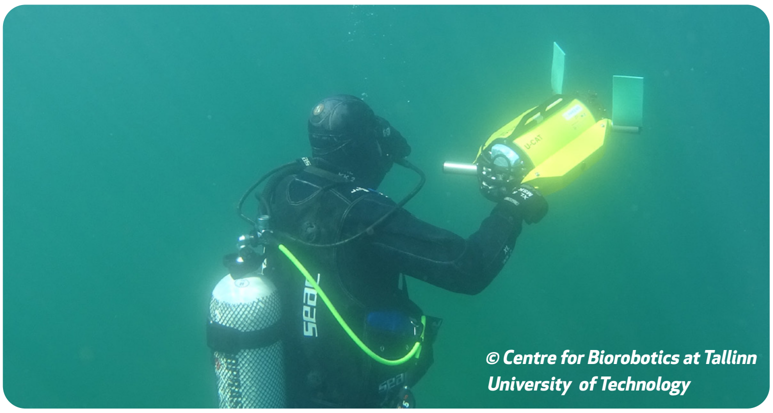
© Centre for Biorobotics at Tallinn University of Technology

SUMMARY

This output describes the effects of using a "turtle robot" (U-CAT) for surveillance in sea-based aquaculture farm cages, on the behaviour and welfare of the fish. The results showed that the U-CAT only negligibly stressed the fish, allowing close-up and clear footage of fish and sea cage conditions. In comparison, fish avoid intruding divers and commonly used thruster-driven underwater robots. This output will be of particular interest to aquaculture farmers, underwater robot producers, and researchers interested in monitoring fish behaviour.

KNOWLEDGE NEED

Monitoring of sea cages is important for aquaculture farmers to track the behaviour and welfare of their fish, and to assess the condition of cages. Human divers and underwater vehicles controlled by operators on land are typically used for this monitoring. Both types of intruders are costly, and disruptive and stressful for the fish. The usual underwater technology is propeller-driven, which is noisy and disruptive for the fish in the cages, making accurate monitoring difficult. There is a need for an alternative robot that can monitor fish in sea cages with minimal disturbance.



© Centre for Biorobotics at Tallinn University of Technology

POTENTIAL IMPACT

- Improved underwater robot designs to provide more affordable, scalable and effective solutions for fish and sea cage monitoring.
- Robotic technology such as the U-CAT for surveillance allows continuous monitoring without interruption. This allows quicker responses, greater predictability, better fish welfare and lower mortality.
- Quick and efficient identification of damaged sea cages resulting in improved security and sustainability.
- Reduced need for human divers, leading to increased safety and welfare of aquaculture employees.
- Better understanding of best practice surveillance robots and the key characteristics they should have for effective and non-disruptive fish monitoring.
- Better public awareness of sustainable aquafarm management, and increased trust from consumers.
- Inspire advances in agriculture, environmental monitoring and animal health and welfare, where the use of animal-robot interactions can be applied.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 7- Aquatic Animal Health and Welfare; Goal 4.
To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

UNDERLYING SCIENCE

This study investigated if a small, bio-mimetic robot that moves slowly using soft flippers causes less stress to fish than commonly used, larger thruster-driven robots or human divers. Tallinn University of Technology (Estonia) developed a small and manoeuvrable "turtle" robot, called U-CAT - Underwater Curious Archaeology Turtle, which was originally designed for underwater archaeology and shipwreck investigations. U-CAT has a mechanical advantage over other commonly used underwater robots as it is highly mobile, and its flipper-driven system generates a weaker wake. It can use its fins to rotate around and it can get close to the sea cage and nets to take clear video shots. The U-CAT is capable of coping in underwater environments, including currents and waves. It was also investigated whether the colour and locomotion mode of the robot had an effect on the fish reaction. The U-CAT was tested on salmon (*Salmo salar*) and Scottish cleaner fish in sea cages.

RESULTS

The results show that the fish in cages remained closer to the U-CAT compared to the larger, thruster-driven robots more commonly used in commercial settings. However, it is not yet clear which aspect from the U-CAT's design causes the different behaviour response.

The study did not find conclusive evidence that the locomotion mode, colour, sound or speed of the U-CAT had a substantial effect on animal behaviour. The researchers conclude that the hydrodynamic or visual cues from different locomotion patterns and colours are not crucial design parameters. It could equally be that the decisive factors altering fish behaviour are more rudimentary cues, such as size and speed of the vehicle. The robot's turtle-like appearance doesn't seem to play any role, meaning robot designs can take other forms. The results also show that both small and large underwater robots disturbed fish much less than a human diver. Results from this study highlighted that the standard inspection procedure by commercial divers is highly disturbing for the fish, removing the opportunity to observe fish in their natural state.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Aquaculture farmers
APPLICATION: Improved monitoring of health, welfare and behaviour of fish in sea cages, as well as the condition of the sea cages.

END-USER 2: Technology producers
APPLICATION: Improved knowledge about new technological solutions for monitoring e.g. sea cages, fish in cages, climate threats etc. on the aquaculture sector.

END-USER 3: Aquaculture researchers
APPLICATION: Monitoring of fish with minimal disturbance to better understand fish behaviour.

END-USER 4: Aquaculture marketing and lobby groups
APPLICATION: Use of robots to monitor fish in sea cages allows for improved welfare of the fish, thus helping to improve the public perception of aquaculture.

STATUS

Technology Readiness Level (TRL) 6 - technology demonstrated in relevant environment.

- The U-CAT is a handmade prototype and has been verified through testing. There are currently two U-CAT robots, developed by the Tallinn University of Technology, Estonia
- The U-CAT is currently used by researchers for field work.
- The U-CAT has several sensors and could be tailored for end-user requirements.

AT A GLANCE

TITLE: Effect of a novel underwater robot on fish behaviour and welfare in sea cages

KNOWLEDGE TYPE: Exploitable scientific result

WHERE TO FIND IT: Contact details below

STATUS: Published in *Royal Society Open Science*. DOI:10.1098/rsos.191220

TNA FACILITY USED: SINTEF ACE, Norway

CONTACT DETAILS: Maarja Kruusmaa, maarja.kruusmaa@taltech.ee; Asko Ristolainen, asko.ristolainen@taltech.ee. Tallinn University of Technology, Estonia

PATENTS OR OTHER IPR EXPLOITATIONS: IP belongs to Tallinn University of Technology, Estonia

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652831. This output reflects the views only of the author(s), and the European Commission cannot be held responsible for any use which may be made of the information contained therein.