A Holistic Opto-Acoustic System for Monitoring Marine Biodiversities

Berichterstattung

Projektinformationen

SYMBIOSIS

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Projektwebsite

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Projekt abgeschlossen

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Periodic Reporting for period 2 - SYMBIOSIS (A Holistic Opto-Acoustic System for Monitoring Marine Biodiversities)

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Zusammenfassung vom Kontext und den Gesamtzielen des Projekts

Global fish stocks have experienced a range of pressures including overexploitation by the fishing industry, habitat loss and pollution. Unfortunately, authorities lack accurate biomass data on current stocks and the technological tools to monitor them, making appropriate responses difficult. SYMBIOSIS was developed a system for the long-term monitoring of fish biodiversity, with a prototype deployed in three offshore and nearshore environments. The project detected and evaluated the biomass of more than 10000 fish, including 2000 of the six species chosen as biodiversity indicators. “SYMBIOSIS provides up-to-date information about key fish stocks allowing authorities to make evidence-based decisions and legislation, such as whether to impose fishing bans,” observes project coordinator Roee Diamant from the University of Haifa, the project host. “Our innovation could also serve as an ecological research tool, for the study of fish behaviour for example.”

The SYMBIOSIS system detects, classifies and estimates the biomass of six key fish species: albacore tuna, dorado, swordfish, Atlantic mackerel, Mediterranean horse mackerel and greater amberjack. These were chosen based on social and ecological criteria, such as their commercial importance and availability within the study areas. Additional considerations included catering for a variety of body size and type, swimming velocities and schooling behaviours. The SYMBIOSIS stand-alone, optical-acoustic solution operates autonomously, conserving energy for more than a month thanks to a design based on a chain of progressive steps. Periodically the system transmits a short, narrowband underwater acoustic signal. Signal processing and a neural network pick up any reverberations, indicating possible moving targets. If a target is detected, 20 wideband signals are then emitted with their reverberations analysed by a combination of dynamic programming and machine learning techniques. Within a detection radius range of up to 500 m, these tools verify the moving target is a fish, calculate its size, and estimate its location and trajectory. If targets are moving towards the SYMBIOSIS mooring, multiple cameras and strobes are triggered to collect images for neural network detection and classification. The information about the number, size and fish species is compressed and sent to shore via a combination of acoustic and radio links. Each system component was tested separately in over 50 sea experiments. A prototype underwent 10 sea experiments before being deployed in 3 test locations: 1 month below a surface buoy in coastal waters 125 m deep in the Mediterranean Sea; 2 days at an offshore Mediterranean site in 1400 m deep water and 2 weeks in shallow water in a Red Sea reef. While SYMBIOSIS achieved most of its goals, it was unable to classify fish based on their acoustic signature. To achieve this the team are now building a larger database of acoustic signals from different fish, alongside new algorithms to accommodate greater diversity.

Hydroacoustic components developed by Evologics, such as an ultrashort baseline acoustic positioning system, are now being commercially produced. Demonstrations and sales already under way and optical components are being further developed. The system will be smaller to make it more marketable. Further improvements will include better energy efficiency and more powerful neural networks.

Arbeit, die ab Beginn des Projekts bis zum Ende des durch den Bericht erfassten Berichtszeitraums geleistet wurde, und die wichtigsten bis dahin erzielten Ergebnisse

The SYMBIOSIS project aims to detect, classify, and estimate the biomass of six key species of pelagic fish. This is a stand-alone system to be deployed over an offshore infrastructure, onboard a mooring or from a boat, and operates without human intervention. The outputs of the system are reports containing the number and size of pelagic fish-like objects detected within up to 500m radius from the platform. These reports are periodically shared via communication to shore. As a result, the system can acquire up-to-date information of key types of pelagic fish thereby allowing legislation and fishery authorities to make observation-based decisions regarding e.g. fishing bans.
The methodology chosen for the project is a combination of underwater acoustic technology and underwater optical technology.

The objectives of SYMBIOSIS were
Objective #1: Developing an autonomous energy-independent opto-acoustic marine biomass estimation prototype with the following capabilities:
1. Detection: Remote, non-invasive detection of fish stocks at distances of up to 500 m (acoustically) and 2-3 attenuation lengths (optically) with a false alarm rate less than 0.001 and a detection rate of 90%. The detection scheme will be robust
to different marine environments and will operate continuously.
2. Classification: Determining the type of the detected fish with a miss-classification rate of less than 5%.
3. Biomass Evaluation: Determining the biomass of the detected fish with an error of up to 10%.
4. Data Telemetering: Transmission of the processed acoustic and optical data from deep to surface to shore with 95% communications availability.
At the end of the project, system is fully developed including the acoustic-optic detection, classification and target characterization algorithms Modeled simulations. The different algorithms were verified by a series of more than 50 sea experiments.

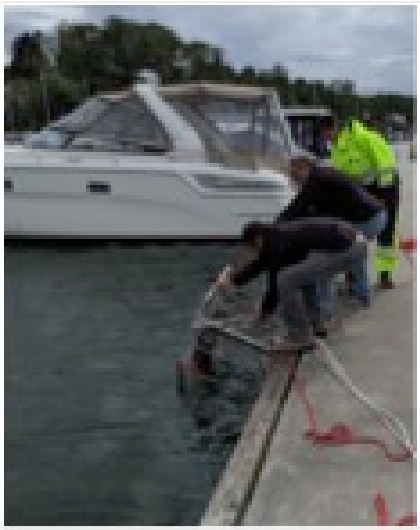
Objective #2: Integration of the developed units and implementation of a prototype system that is fully autonomous under the points of view of power supply, information processing and data telemetering.
At the end of the project, a prototype system was implemented and tested in parts and as a whole in realistic conditions. TRL6 level of readiness was achieved.

Objective #3: Demonstration of the capabilities of the developed prototype on-board three mooring platforms representative of different sea and ocean environments.
At the end of the project, three long term deployments were performed involving three different platforms: ship, over mooring, and from own mooring. During these deployments, the system was fully operated and obtained tracks of hundreds of pelagic fish.

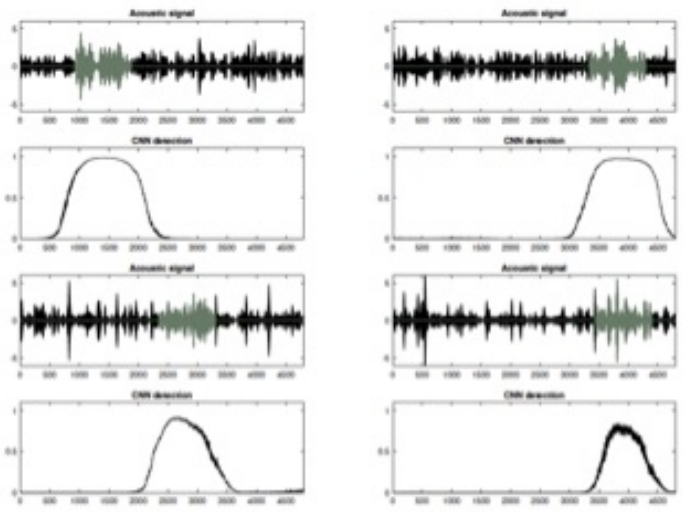
Fortschritte, die über den aktuellen Stand der Technik hinausgehen und voraussichtliche potenzielle Auswirkungen

(einschließlich der bis dato erzielten sozioökonomischen Auswirkungen und weiter gefassten gesellschaftlichen Auswirkungen des Projekts)

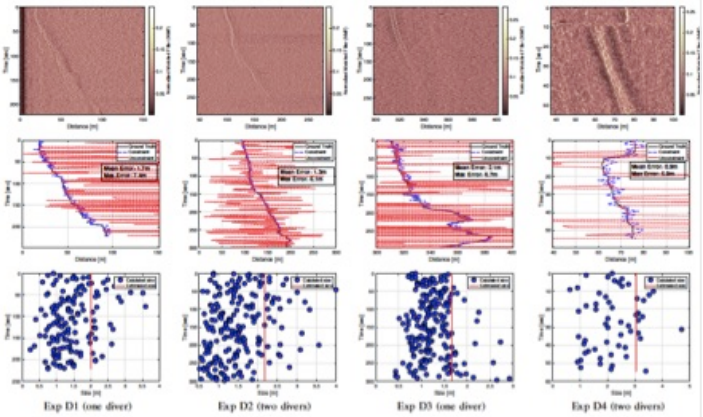
SYMBIOSIS showed a high potential in acoustic and optic detection of fish. Different than current solutions that involves detection using a narrow beam or through anecdotal sightings and reports and thus cannot really monitor the entire area, SYMBIOSIS allows omni-directional detection up to a range of 500m. This enables the collection of data about the presence, composition (diversity), abundance, behaviour (e.g. migration) of the SYMBIOSIS key species of pelagic fish. Further, the SYMBIOSIS hardware was built for long-term autonomous monitoring. This enables enhanced knowledge regarding the movement and behaviour of fish, and their school formation. The project thus has the potential to become a standard in marine monitoring. The project has already led to commercial benefit in terms of the development of software defined USBL elements, optical cameras with extended detection range, acoustic detection of mobile targets, and acoustic localisation for wideband signals. The impact of the project is demonstrated by the identified 50 press releases identified for the project. SYMBIOSIS already made several advancements beyond the state-of-the-art. These activities have led to 6 peer-reviewed publications in key journals, with 5 more publications in a review process. And the work has been presented in 7 main conferences.

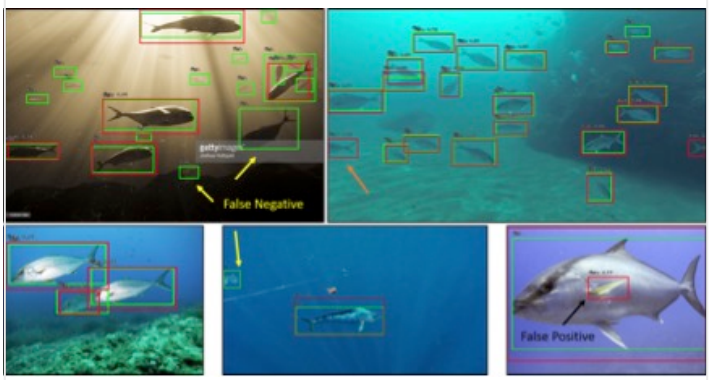


Testing of the system in a lake

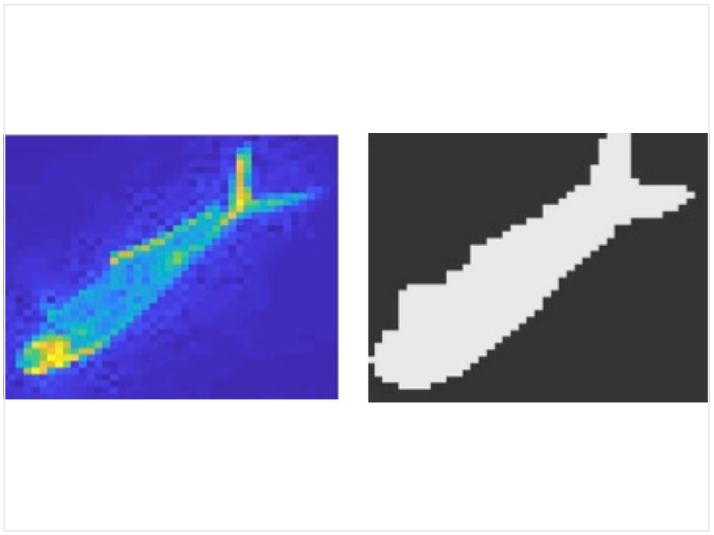


Example of acoustic detection





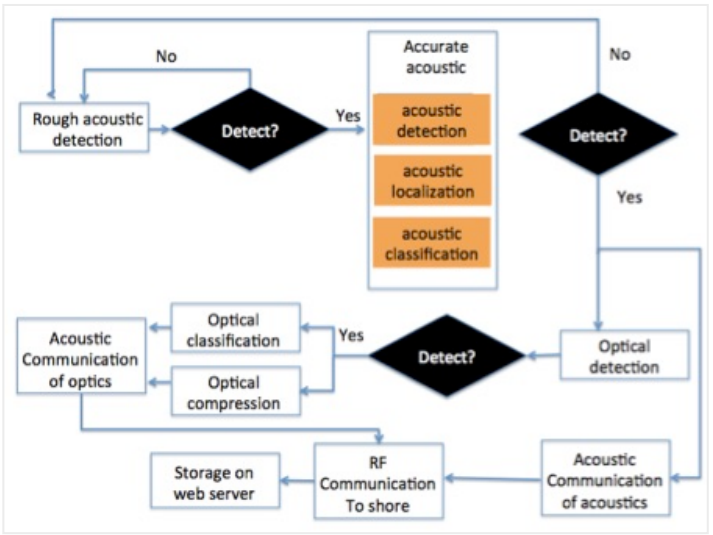
Example of detection of mobile targets

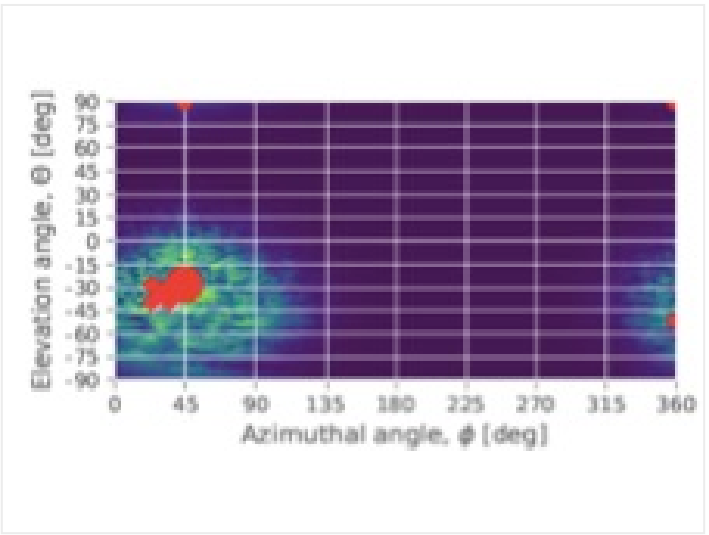


Example of optical detection

Example of image compression

A scheme of the symbiosis unit





Block diagram of the SYMBIOSIS process

Example of acoustic localisation results

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Permalink: https://cordis.europa.eu/project/id/773753/reporting/de