UTOFIA

NEWSLETTER #1

December 2015

Welcome to the first UTOFIA Newsletter: The project and it's background

The oceans present us with a wealth of opportunities from transportation to offshore energy to mariculture and fisheries. Mariculture is one of the fastest growing marine industries, contributing about half of all aquaculture production with enormous potential in European shelf seas still largely under exploited. Offshore wind farms will be generating increasing amounts of European electricity over the coming decades. At the same time, traditional fisheries are being challenged by dwindling fish stocks, leading to a strong drive for robust management plans as well as more efficient fishing technologies. In all of these activities, reliable and efficient observational methods need to be developed in order to implement knowledge-based innovations, sustainable management plans and public policies. The Blue Growth initiative of the European Commission is a long term strategy to support sustainable growth in the marine and maritime sectors as a whole, and it was within this framework that the UTOFIA project was conceived.

The UTOFIA Concept

The UTOFIA concept is to develop a new class of underwater imaging system based on LiDAR technology that will extend the range and improve the quality of images while at the same time provide the potential for video rate 3D information. The aim of UTOFIA is not only to develop this technology but also to do so within a competitive market.

UTOFIA targets technology that can overcome the limitations imposed on tradition imaging systems by the back scattering of light in turbid waters. Range-gated imaging is an image acquisition principle which extends dramatically improved the contrast of camera images in turbid waters and can also simultaneously capture 3D data. Today the principle is not widely used in underwater applications, as it relies on specialized optical components making systems large and costly.

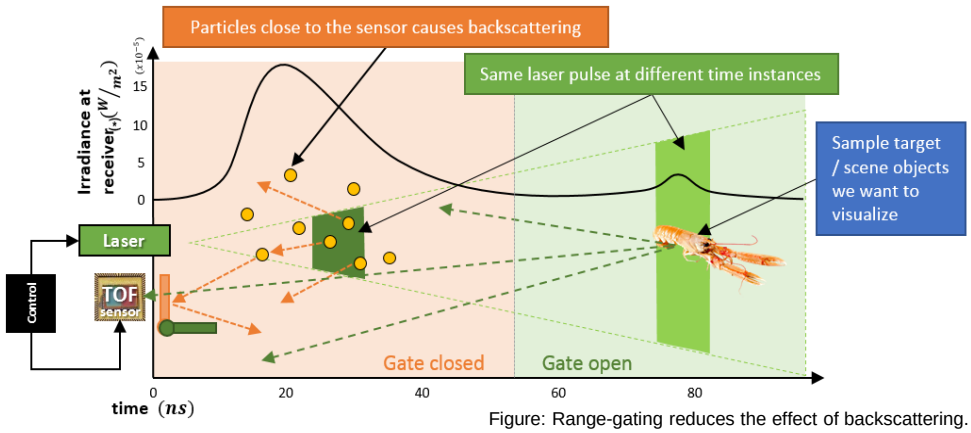


Figure: Range-gating reduces the effect of backscattering.

Recent technological developments have made it possible to achieve suitable range-gated sensors using semiconductors based image sensors. These LiDAR (or Time-of-Flight) sensors were originally developed to capture 3D images in air, and are now commercially available. The technology makes possible a significant (2-3 times) reduction in size, complexity and cost of underwater imaging systems, whilst, at the same time, improving imaging performance in these challenging environments.

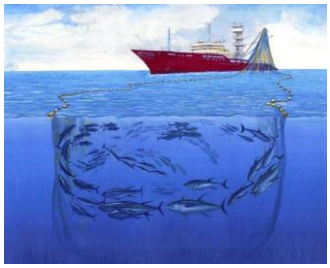
The UTOFIA Consortium

UTOFIA brings together a unique grouping of technological, scientific and engineering expertise spanning from design and technology to characterisation of environmental status and marketing. Coordination of the project is taken by SINTEF, one of the largest maritime research companies in Europe, with a long history in successful EU projects. The consortium is a world-class team comprising marine scientists (DTU, AZTI), technology providers (STF, BRI, ODOS, FHG) and end-users (SUBSEA) and therefore well placed to promote the technology to a range of end-users from public authorities, offshore industry, commercial fisheries and the marine science community.

The UTOFIA-Team at the Kick-Off Meeting in Oslo in Feb. 2015

Expected Impacts and Applications

Surveying oceans safeguards a healthy and sustainable marine food supply. Marine resources now contribute 15% to the overall animal protein consumed worldwide. In 2011 this sector contributed 7B€ total value to the European economy, and has a considerable growth potential, particularly with regards to mariculture. Natural marine resources must however be managed to protect them from pollution and overfishing. A necessity for good management is high quality and real time data on e.g. fish abundances and marine habitat status. Pre-screening of catches in purse seine fisheries and development of selective and efficient fishing gears are potential applications.



Purse seine fishing (FAO)

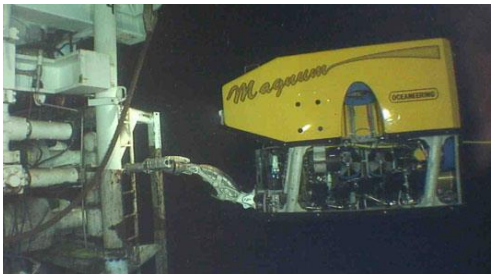
There is also a fast growing need for monitoring underwater facilities, due to rapid development of underwater renewable energy plants, expansion of fish farms, increasing requirements for surveying infrastructures like dams, water reservoirs, harbour facilities, underwater pipelines, offshore platforms. While sonar is the predominant technology for observing the subsurface oceans at large distances, for detailed underwater observations, video cameras remain the primary sensor technology due to their lower cost and higher resolution.

They are especially valuable for direct visualization e.g. species identification, habitat mapping, inspecting subsurface structures. But a major drawback is their limitation in turbid waters, where light scattering reduces range and image quality. Marine resource management depends not only on counting species, but also on assessing size and abundance. This needs acquiring of simultaneous 3D data, making it possible to measure absolute size of marine life, spatial relationship to their habitat, enhancing precision of fish stock monitoring, ecology assessment, promoting responsible management.

Removing marine litter from the seabed or evaluating impact of human activities on natural habitats requires the extensive use of Remotely Operated Vehicles (ROVs). The limited imaging range of conventional video cameras in low visibility waters requires that these ROVs must be very close to the bottom, observing just a small part of the seabed. By extending the imaging range, ROVs can maintain longer distance and image larger parts of the seabed at once. This makes operations safer and faster; collision risk is lowered, and larger areas of the seabed are covered per image.

Prototypes

Prototypes developed in UTOFIA will create the basis for a new type of commercial underwater inspection systems utilising 3D time-of-flight technology. This will open up a new underwater imaging modality, resulting in an expanding market for underwater surveillance. UTOFIA markets are in marine science, public-sector environmental monitoring, commercial fisheries for species and size distribution, all kinds of aquaculture, subsea technologies for inspection and deployment of structures such as off-shore wind farms, oil pipe-lines and artificial reefs. On a longer term the systems can act as an important facilitator of new subsea robots.



UTOFIA: Field tests by SINTEF

During the first few months of UTOFIA, the consortium has demonstrated that even the early prototype can provide 2.5 x range extension and 3D data. The goal of UTOFIA is to provide a compact and cost-effective underwater imaging system for turbid environments that extends the imaging range by 2-3 times and provides 3D information. In the early months of the project, we have put together a first prototype to test the initial capabilities of the system (Figure 1).

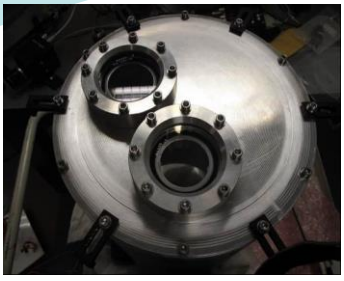


Fig. 1: UTOFIA prototype.
L: Complete system.
R: Detail of camera/illumination windows.

2.5 meter farther imaging range

By using "range gated imaging", the system is capable of seeing through turbid waters. Normal cameras are limited in both range and quality but this principle allows the user to see farther and better. This can enable better identification, visualization and understanding of the measured environment.

To demonstrate initial capabilities, we built a target (Figure 2) which we put at the bottom of the Oslofjord (Norway) in water with significant mud contamination.
We captured images of the target using our first prototype (Figure 3) and compared them with a GoPro camera with external green illumination (Figure 4). It can be seen that we obtain a better and clearer image at 7.5 meters than the GoPro camera does at 3 meters. This has potential for faster, better and more cost-effective data acquisition subsea.

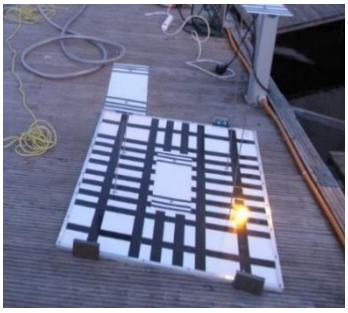


Figure 2: Target used for testing.

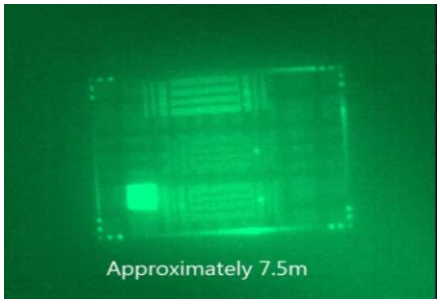


Figure 3: Image captured of test target with UTOFIA camera. Target can clearly be seen at 7.5 distance, 2.5 x longer than normal cameras.

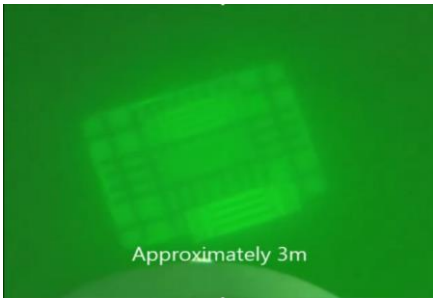


Figure 4: Image captured with GoPro camera for comparison. Target is almost invisible at 7.5 meter distance, where UTOFIA sees it clearly. At 3 meter distance, the target starts to appear for the GoPro camera.

3D information

Marine resource management depends not only on counting species, but also on assessing size and abundance. This cannot be done reliably today using a single video camera due to perspective effects.
Using the UTOFIA prototype, we have captured images of schooling fish in an underwater lab facility (Figure 5). By developing algorithms for interpreting the sensor data, we are capable of measuring the distance to different segments of image (the distances are color encoded in Figure 4).
This has potential in marine resource management and subsea navigation by enabling precise size measurements of observed objects, automatic shape recognition and advanced image processing

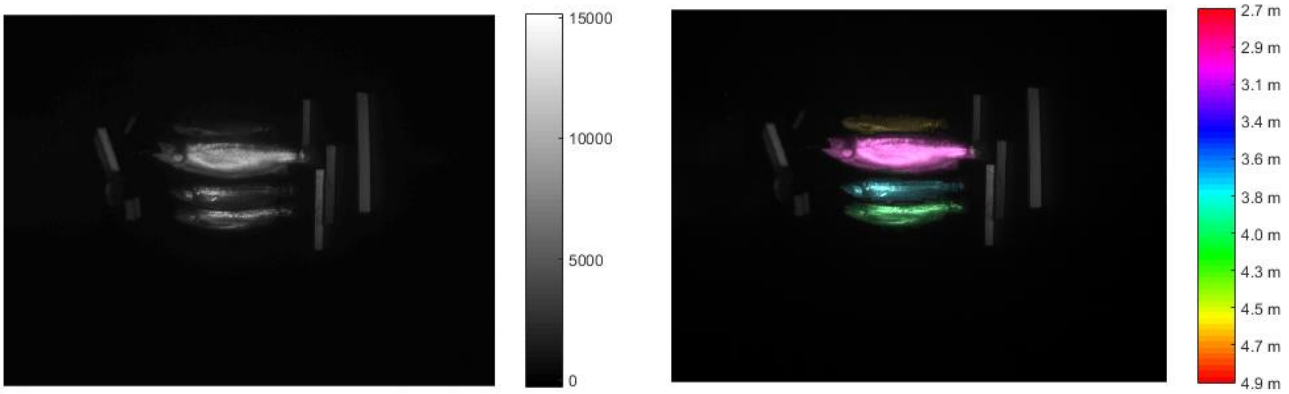
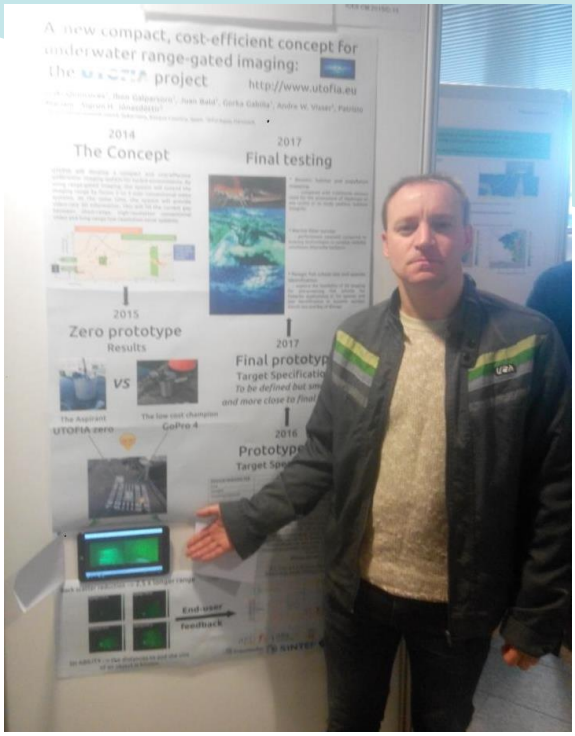


Figure 5: Regular image as usually acquired by cameras (left) and camera image with color-encoded depth information (right). In the top image it is difficult to ascertain the precise size of each fish, and which fish is behind which fish. By also directly measuring the distance to each fish, both precise size and relative fish position can easily be obtained.

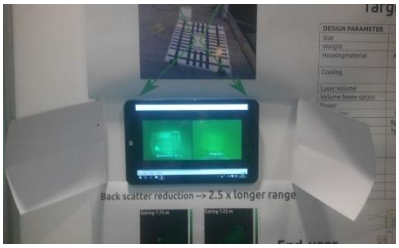
UTOFIA: Presented at ICES ASC 2015 by AZTI

The UTOFIA Project was presented at the ICES Annual Science Conference 2015 held at Copenhagen DGI-Byen Congress palace.

The ICES Annual Science Conference is a meeting point for members of the ICES family, both old and new, to see how far we have come in our journey. The ASC showcases and shares our science with the global marine science community. One of the important and unique features of ICES is its capability to cover the entire spectrum from monitoring to data provision to science and advice. The ASC reflects this range in the 734 people that joined the ASC in 2015, coming from 37 countries. The week offered 19 theme sessions, with a total of 326 oral presentations and 118 posters.



UTOFIA was represented to the session Ecosystem monitoring in practice by an interactive poster showing the first results of our project with a video comparing the vision of a GoPro camera with the first UTOFIA prototype.



Detail of the video showed in the poster at ICES ASC2015