Inverted Astronomy: High Resolution Seabed Imaging from the Ocean Surface.
A proposal by Fugro

1. Company information

Fugro is the world's leading Geo-data specialist, collecting and analysing comprehensive information about the Earth and the structures built upon it. Through integrated data acquisition, analysis and advice, we unlock insights from Geo-data to help our clients design, build and operate their assets in a safe, sustainable and efficient manner. Fugro employs approximately 10000 employees worldwide. Turnover in 2019: Euro 1.6B. Fugro employs about 300 R&D staff in Europe, US and Australia. Services Provided worldwide. Mapping the Oceans for engineering, environmental or other civil purposes is a core competency of Fugro. The company has been part of the search for the Malaysian Airliner MH370, and surveyed in this project a prior unchartered area of the ocean significantly larger than the area of The Netherlands, at water depths of 6km and more. For more details on the company see www.fugro.com. While we can determine a position on the earth's surface at any location with centimetre precision, and while mankind knows details from the surface of Mars, many parts of the deep ocean are still unknown or only vaguely chartered. We refer to projects like Seabed 2030 and related information.

2. Problem

In 2009, NASA's Lunar Reconnaissance Orbiter (LRO) was launched and has since provided us with hundreds of very high resolution images of the Moon. The contributions of this, and other lunar satellites have made it possible to map the entire surface of the Moon to a resolution in the order of a couple of meters. However, only about twenty percent of the seafloor has been mapped with modern imaging systems, to a resolution of about 100 meters. As the industry is drawn more towards services to support installation and maintenance of intercontinental cables but also occasional deep-ocean wreck searches, the need for cost-effective high resolution seabed images rises.

State of the art technology in this field is a type of sonar that utilizes a fan of narrow acoustic beams sent from a vessel moving along a straight line. These beams can have carrier frequencies up to 30 kHz, and can reach depths of over 7 km. The beams are transmitted and received by 'multibeam echosounders', and require large ocean going vessels to carry them. It is therefore very costly, and is only able to achieve a resolution of 50 - 100m. To achieve a higher resolution, towed deep-sea vehicles or Autonomous Underwater Vehicles are used. These vehicles still need the support of a large ocean going vessel, which greatly increases the cost and complexity of the operations.

Problems that arise when trying to make high resolution seabed images are similar to the problems astronomers have been facing for years; when trying to characterize the seafloor from the ocean's surface, we have to look through a non-homogenous medium. Due to temperature differences and ocean currents, the water between the observer and the object is constantly changing properties in unpredictable ways. This can be compared to the turbulent atmosphere, which has been limiting the ability to achieve very high resolution images in modern astronomy. The ocean waters also carry a lot of small particles with them, which scatter and absorb acoustic waves not unlike the way light scatters from interstellar dust.

Of course there are also differences. The most obvious being that the seabed does not emit much energy like almost all astronomical observation objects do. All the energy that is received will have to be generated at the surface and reflected from the ocean floor. Still, the similarities lead us to believe that techniques used in optical physics and astronomy could provide meaningful new insights into the way we tackle the problem of producing high resolution seabed images.

Limitations in budget and in precise positioning technology would see the use of one or multiple Autonomous Surface Vehicles (ASV) to make high resolution seabed images. Fugro challenges the physicists and astronomers of Leiden to think of possible solutions for the problem of high resolution seabed imaging from the sea surface (or above it), considering these limitations; what techniques practiced in modern physics and astronomy could be used for this purpose? What new solutions can the minds of modern science provide for this growing problem? How do we map the ocean seabed to the same extend we did the surface of the Moon in a cost effective manner?