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PROJECT EXAMPLE: MILLS CROSS-BASED 3D SONAR ANTENNA

Starting situation

In the sonar area there are many different versions of multi-beam echo sounders and sidescan systems for mapping and searching for objects. Few of them, however, are capable of surveying a volume without movement and carrying out a three-dimensional reconstruction for the creation of a virtual environment. For work under water they depend on clear water and good visibility. If this is not the case, divers, for example, have to feel their way around their environment. In operations where remote-controlled tools are used, such as ROVs (Remotely Operated Vehicles), clear visibility is also usually necessary. If this is not the case, or if mud is churned up by contact with the ground, the operation has to be interrupted until visibility is restored.

Objective

The aim of the project carried out in collaboration with the Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (Project E/SR2I/BA163/7F173) was to develop a sonar system which allows rapid volumetric imaging while using just a minimum of electric transmission and reception channels. The sonar system also had to have an especially high resolution in the axial and lateral direction.

Solution

The focus was, therefore, on the development of a sonar system based on the so-called Mills Cross antenna arrangement, whereby a transmission and a reception antenna are positioned in a T-shape. While the transmission antenna vertically scans the volume in several angles, the second antenna receives the reflected signals and, due to its being turned at 90°, calculates the beams in the horizontal direction. The intersection of the two beams provides the information from one spatial direction. By rotating all of the transmission angles and calculation of all the receiver angles, the volume can be completely reconstructed.

A total of 128 especially shaped transducer elements are used per antenna, allowing a large opening angle in the respective elevative direction. This provides a possible measurement range of 30° x 30°, at a line resolution of 0.5° x 0.5°. The centre frequency of 1.7 MHz allows a high axial resolution. The individual transducer elements are based on the concept of medical sensors with damping and adaptation layers. The thus achieved high bandwidth of 930 kHz is used to carry out a frequency coding of individual signals. This means that several transmission beams can be scanned at the same time. The scanning times thus no longer represent idle times. With this method it will be possible to reconstruct up to five volumes per second and represent them to the operator as a virtual reality.

The 3D sonar antenna, however, also opens up many other possible application areas. This includes in particular the possibilities for object recognition and identification, the inspection of underwater installations or the surveying of archaeological sites.

Contact

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1 *Pictures from left to right: Sound-radiating surface with T-arrangement of the transmission and reception antenna. Sonar system in test measurements in the IBMT measurement basin. Test object and reconstructed measurement result of the 3D sonar antenna.*