HYDROACOUSTICS
4, 23-26 (2001)

DETECTION OF OBJECTS BURIED IN THE SEAFLOOR WITH A 3D SEDIMENT SONAR

Dieter Brecht, Broder Fedders
Forschungsanstalt der Bundeswehr für Wasserschall und Geophysik
Federal Armed Forces Underwater Acoustics and Marine Geophysics Research Institute
Klausdorfer Weg 2-24, 24148 Kiel, Germany
DieterBrecht@bwb.org / BroderFedders@bwb.org

We present the concept of a new experimental Sediment Sonar System and preliminary results from the first sea trials. The planar (2-dim) array produces 3-dimensional images of the upper sediment layer. These can be used for detection and classification of buried objects by means of image processing methods. Since the system is ship mounted, it provides a high degree of flexibility with respect to search rate, target/bottom type selection and aspect angle diversity. Besides the classification of objects in different environments the system allows the application and investigation of new signal processing methods like motion compensation, autofocus and synthetic aperture. During the first sea trials, several objects like spheres and cylinders as well as exercise mines were analyzed. Preliminary examples are shown.

INTRODUCTION

Hazardous objects like mines, dumped WW2 ammunition and bombs are a dangerous threat to environment as well as navy operations in shallow coastal waters. On sandy or muddy bottoms, these objects are mostly buried into the sediment and therefore hard if not impossible to detect with conventional systems. Modern Sediment Sonars like the one presented here will allow the detection and classification of buried objects and may become an important tool for future minehunting as well as environmental cleansing operations.

In this paper, we present the concept the new <u>ex</u>perimental <u>se</u>diment <u>so</u>nar demonstrator system EXSESO. First of all we outline the design of the system and its specific features, targeting on classification in different environments and investigation of signal processing algorithms. The second part then shows an exemplary sonar image from the first experiments in the year 2000. The target object which is shown in the example is a minelike cylinder which is mostly buried in sand.

1. CONCEPT OF THE DEMONSTRATOR SYSTEM

In August 2000, first sea experiments with a new developed experimental sediment sonar (EXSESO) demonstrator were successfully completed at FWG. The system can be used for detection and classification of sedimented mines and other objects which are buried in the seafloor and therefore invisible for conventional sidescan sonars. The Detection/classification success depends on a variety of 'environmental' parameters. Future research goals are therefore to investigate the influence of bottom type, object type (shape, size, material), burial depth, aspect/grazing angle. The sonar is operated in an quasi-operational mode from a research ship which allows to investigate a large variety of different environments and scenarios.

The demonstrator (Fig. 1) consists of a 20 kHz Projector which insonifies a sector of 12° (azimuth) x 30° (elevation) and a 6 x 18 elements phased array receiver. The receive beam has a width of 3°x3° and can be steered electronically in both dimensions. The whole unit is mounted below the bottom of the research vessel "Planet" and can be mechanically steered between 0° (vertical) and 90° (horizontal) in across-track (elevation) direction. Fig. 2 shows a scenario with a 45° tilt angle. At 16m water depth, the 30° transmit sector corresponds to a visible swath of 12m width which is sufficient for ship navigation. While passing the target at different distances, a set of sonar images can be collected which correspond to different grazing and aspect angles. Based on the three dimensional data, different image processing and classification algorithms can be applied and investigated.

The resolution of 3° x 3° x 10cm (range) is sufficient for classification. Nevertheless, the along-track resolution may be further improved by synthetic aperture (SA) methods. Promising SA, motion compensation (MC) and autofocus algorithms can be applied and investigated in practice. Another issue is the validation of simulation models which have been developed in the past in order to predict the detection performance of sediment sonar systems.

During the first sea trials in September 2000, some scientific experiments have already been conducted with different targets. Besides operationally relevant objects like mines, the focus was put on concrete filled spheres and cylinders. Figure 3 shows an example of a concrete filled cylinder (length 160cm) which was 'flush' buried in sand. The body of the cylinder was almost (3/4) buried, but not completely covered by sand. The sonar image shows the data of a beam with 60° grazing angle. The intensity (reverberation level) is plotted as a function of range (distance) and along-track position (respective ping number). The signature of the cylinder is clearly visible against the reverberation of the surrounding sediment. In the corresponding sidescan images which were taken from the same object, the target could not be identified since it did not contrast significantly from its environment and obviously missed any shadow.

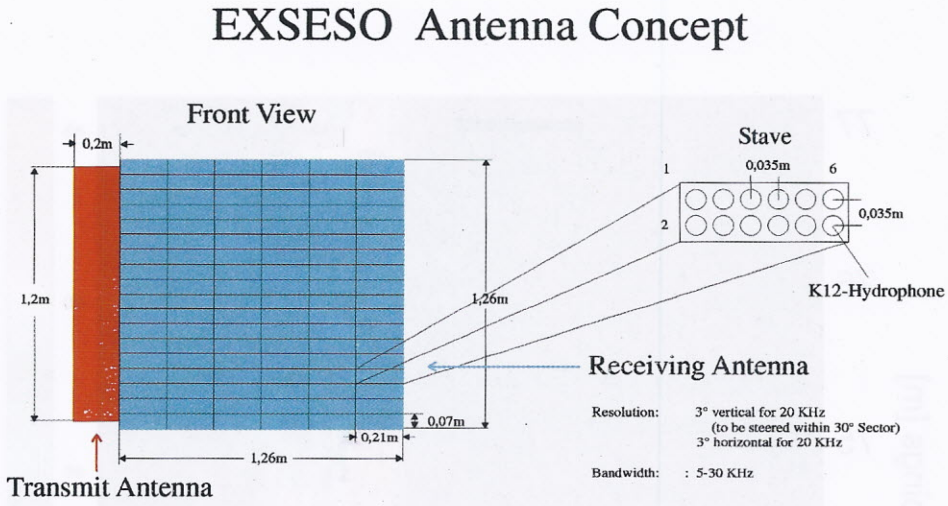

Fig. 1: Design of the EXSESO sediment sonar demonstrator

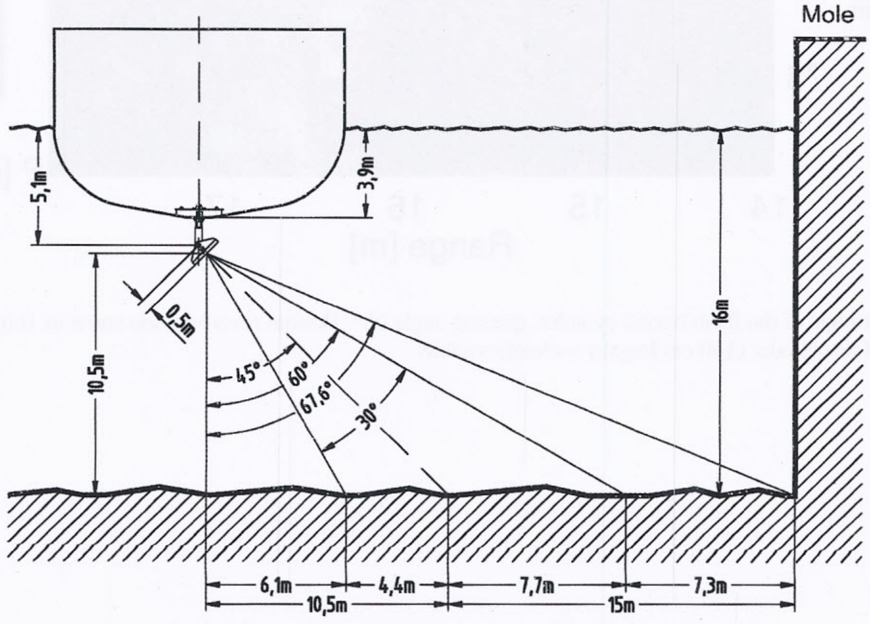

Fig. 2: Experimental setup. The sediment sonar is mounted below the research vessel.

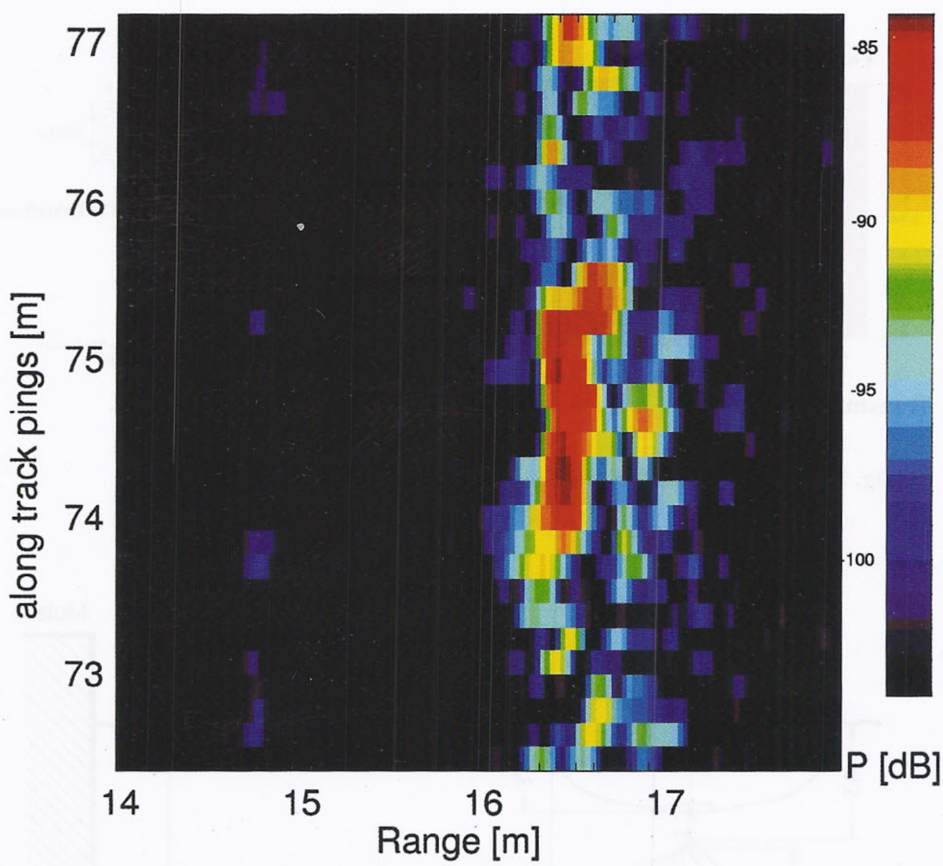

Fig. 3: Image of the flush buried cylinder, grazing angle 60°. Bottom reverberation starts at 16m range. The cylinder (160 cm length) is clearly visible.