Directional AUTOBUOY

An Array System for Deep Ocean Acoustic Directionality Measurements

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A deployable, self-contained, programmable acoustic acquisition system (Directional AUTOBUOY) together with multi-element arrays and data processing algorithm has been designed. When in use, this system is free floating and neutrally buoyant and has the capability to collect large data sets at up to 5 given depths to 6000 meters. Depending on tape recording speed, a total of 8 or 16 hours of analogue data in the frequency range 0-2500 Hz or 0-1200 Hz can be collected from 12 sensors on a single deployment. The processing algorthms are designed to optimize the resolution of the particular measurement objective for further data analysis.

A deployable, self-contained, programmable acoustic data acquisition system (Directional AUTOBUOY), capable of acquiring data through vertical and horizontal arrays, and data processing algorithms have been designed. Directional AUTOBUOY (reference 1) with a 238 meter, 12 element vertical array and a corresponding processing algorithm have been used to measure deep ocean vertical noise directionality. While Directional AUTOBUOY has had limited use, it has all the reliable operating features of the smaller two element AUTOBUOY (reference 2) developed by NUSC and used reliably in more than 60 data acquisition deployments.

When in use, this system is free floating and neutrally buoyant at a given depth. Because it is translating with the water mass at depth, there is no flow induced self noise generated. This feature, together with its capability to collect large data sets at up to 5 depths to 6000 meters on a single deployment, makes it an ideal platform for measuring stationary acoustic processes as a function of depth. In particular, the low noise characteristics, make it highly attractive for application of super gain techniques. In addition, once the system is deployed, the deployment vessel can be used as a source ship or can be made available for other tasks.

Directional AUTOBUOY is a slightly buoyant streamlined cylindrical vehicle with instrumentation pressure vessels containing a 14 channel analogue tape recorder and system program control circuitry (figure 1), light and heavy fluid tanks for buoyancy control, a recovery package consisting of a flashing light and RF beacon which are activated when the system returns to the surface, and syntactic foam blocks which provide the bulk buoyancy for the system (figure 2). An array is attached to the vehicle and its elements connected to the 14 channel tape recorder. Arrays of arbitrary design which can be made neutrally buoyant by attachment of synthetic foam modules as necessary can be used. The number of array elements is not limited to the number of tape recorder channels as various multiplexing techniques may be applied.

The system is deployed from the ship and descends to a preprogrammed depth, sensed by a depth gauge, whereupon a descent weight is released and a vehicle velocity sensor provides signals to control the valving of the light and heavy fluids until neutral buoyancy is achieved. The tape recorder, under program control, is turned on continuously or intermittently to record data for a preset time interval. At the end of this time interval, the recorder is turned off and a fixed amount of heavy fluid is released so that the system will ascend to the next programmed depth. When the next depth is sensed the previous data collection cycle is repeated.

In all, data can be obtained at up to 5 depths on one deployment. A total of 8 hours of data (0-2500 Hz) from twelve sensor imputs can be obtained on each deployment; 16 hours (0-1250 Hz) of data can be collected if the tape recorder speed is reduced accordingly. One channel is reserved for recording time code and a second channel records the signals from engineering sensors (e.g., depth gauge, vehicle velocity sensor, temperature sensor). The low dynamic skew of the tape recorder results in interchannel phase errors of less than 5^{0} at 500 Hz on reproduction.

Processing algorithms reduce the recorded acoustic data for further analysis (references 3, 4 and 5). Several computer programs have been developed to implement the algorithms in the general purpose computer (UNIVAC 100 system) and modifications are being made for real-time operative with a mini-computer to permit processing large amounts of data at low cost. During processing (figure 3), digitized signals from the recorded 12 sensor channels go through the array processor via FFT to form the cross-spectrum matrixes. Computation then continues for determining the conventional array beamforming outputs and optimal beamforming outputs at various steering angles. The algorithm also is able to determine the dominant coherent signal sources by analyzing the eigenvalues and eigenvectors of the cross-spectrum matrix. The discrete noise signals are resolved by utilizing Prony's method so the angular resolution of arrivals is not limited by the physical size of the array aperture. All these algorithms have been tested with simulated noise fields and actual sea data.

A small aperture, 12 element, circular horizontal array has been designed to incorporate the low self noise characteristics of AUTOBUOY and super-gain processing technique for retaining a reasonable beamwidth.

This new proposed array will have the capability of measuring azimuthal directionality of the noise field in all directions simultaneously while collecting data at each of the programmed depths.

REFERENCES

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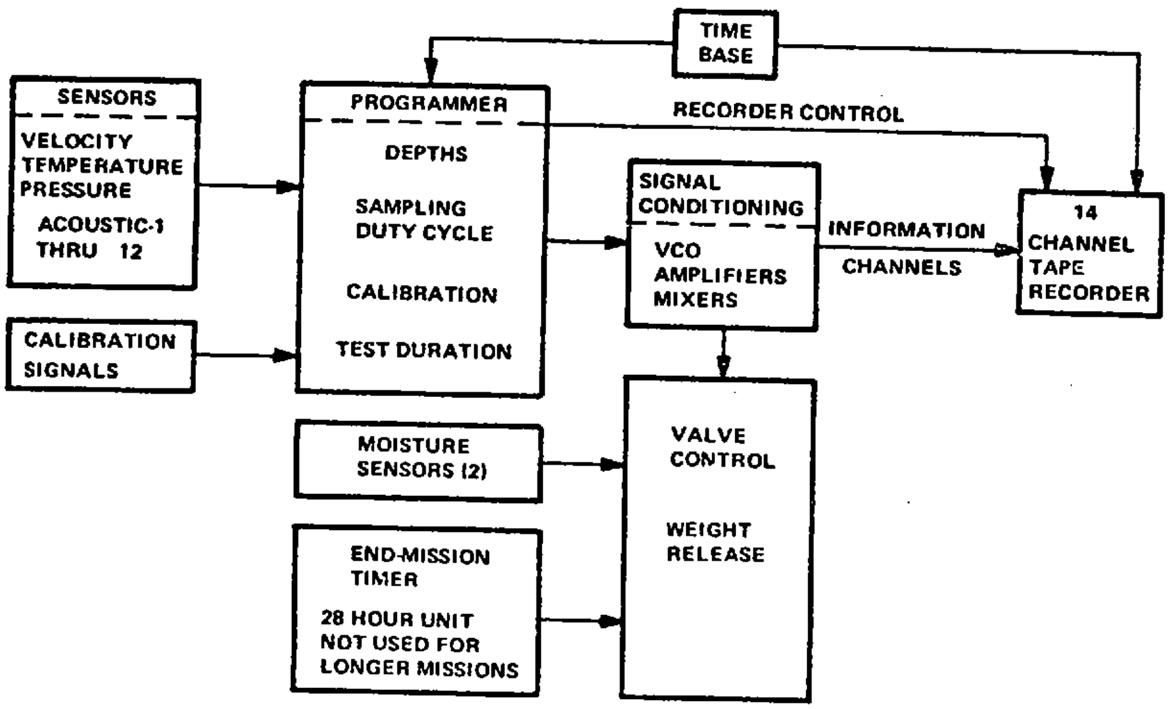

Figure 1. AUTOBUOY Control and Sensor Systems, Block Diagram

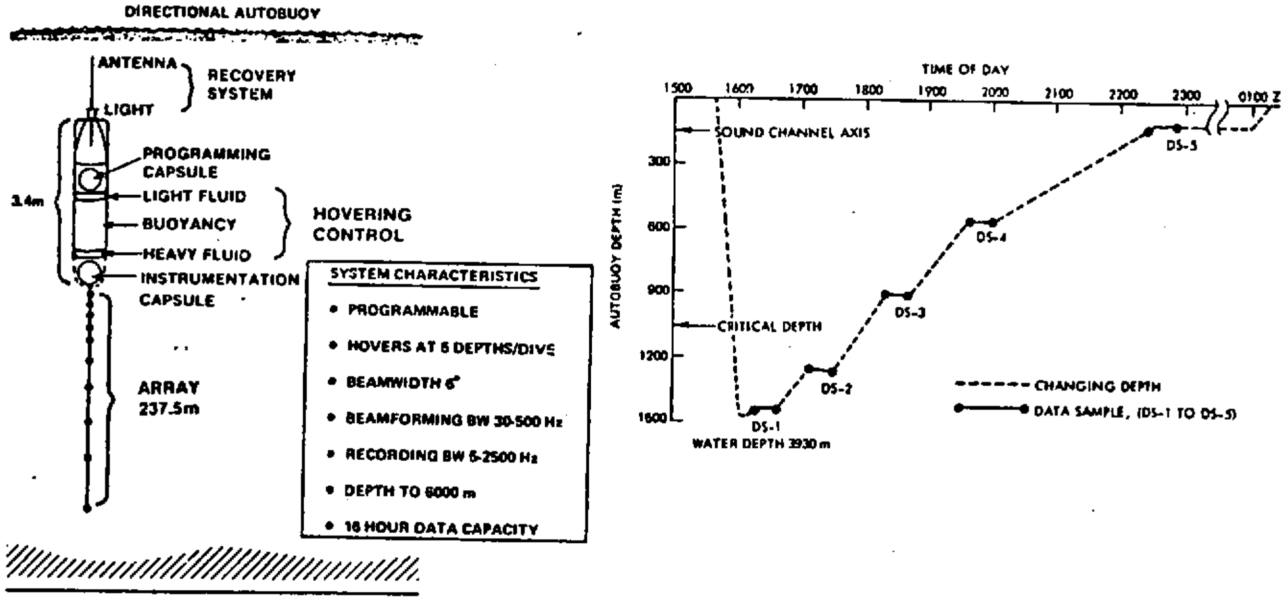

Figure 2. Directional AUTOBUOY Characteristics and Deployment

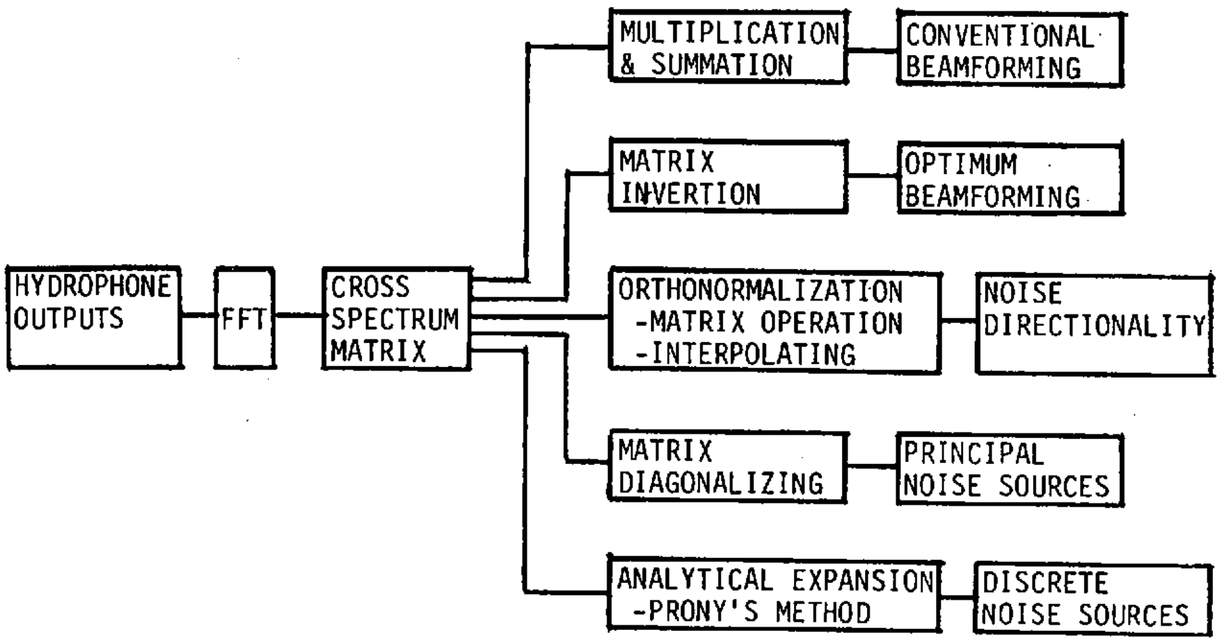

Figure 3. Processing Algorithms