Research on Target Detection Technology of Long Horizontal Array in Deep Sea

Abstract

A long horizontal array serves as a critical system for enabling long-range target detection and underwater surveillance. This study is based on a fiber-optic hydrophone array independently developed by our research team, with a focus on target detection applications involving deep-sea long horizontal arrays. By integrating deep-sea acoustic propagation theory and the spatial correlation characteristics of the array, this work investigates advanced underwater acoustic target detection techniques. First, a geometric calibration model is established using acoustic ray model theory, and a high-precision array shape correction algorithm is proposed, thereby providing a solid foundation for subsequent array signal processing. Next, a background equalization method is introduced, which leverages sub-band peak feature selection in beam-scan azimuth estimation to enhance both target resolution and the detectability of weak targets. Finally, a multi-channel fusion DEMON spectrum estimation algorithm is developed that exploits the spatial correlation of array signals. This approach effectively mitigates envelope signal distortion caused by conventional beamforming and significantly improves the quality of DEMON spectral feature extraction. These findings have been published in authoritative journals in the field of underwater acoustics, including Applied Acoustics and IEEE Sensors Journal.

Speaker Bio:

Zhang Weihua, Ph.D., Professor the College of Meteorology and Oceanography, National University of Defense Technology. He formerly headed the underwater acoustic signal processing group at the Deep-Sea Science and Technology Institute. Dr. Zhang has led dozens of national and ministerial-level research projects and received one First Prize for Scientific and Technological Progress from the China Computer Federation, one First Prize and two Third Prizes for Scientific and Technological Progress from provincial and ministerial authorities.

团队深海大孔径水平阵列目标探测技术研究进展介绍

大孔径水平阵列是实现远距离水下目标探测的重要设备。报告将聚焦深海大孔径水平阵列水下目标被动探测这一应用场景，重点介绍团队基于自主研制的海底光纤水听器阵列，结合深海声传播规律及阵列空间相关性开展水声目标探测技术研究的最新进展。研究中，团队首先基于射线模型理论构建了阵型校准模型，提出了高精度阵形校正算法，为后续阵列信号处理奠定基础；然后，提出了基于子带峰值特征筛选波束扫描方位角的背景均衡方法，提升了目标分辨力和对弱目标的探测效果；最后，提出一种利用阵列信号空间相关性的多通道融合 DEMON 谱估计算法，能够避免波束形成引起的包络信号畸变，提高 DEMON 谱特征提取质量。相关研究成果已发表于《Applied Acoustics》、《IEEE Sensors Journal》等水声领域权威期刊。

汇报人简介：

张卫华，男，博士，国防科技大学气象海洋学院研究员。曾任深海科学技术研究所水声信号处理团队负责人，主持国家及省部级科研项目数十项，获中国计算机学会科技进步一等奖 1 项、省部科技进步一等奖 1 项、三等奖 2 项。