A HISTORICAL PERSPECTIVE ON EXPERIMENTAL ACOUSTIC PROCESSING SYSTEMS AT DRDC ATLANTIC

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Résumé

L'une des applications les plus anciennes de l'acoustique sous-marine consiste à la détection de sous-marins. Le Centre de recherches de l'Atlantique de Recherche et développement pour la défense Canada (RDDC Atlantique) mène, depuis 75 ans, les recherches canadiennes dans le domaine de la lutte anti-sous-marine (ASM) et du sonar. Une partie de cette recherche, toujours en cours au Centre de recherches de l'Atlantique, est dédiée au développement et la mise en œuvre de systèmes de traitement en acoustique maritime.

Mots clefs : sonar, traitement du signal

Abstract

An enduring application of underwater acoustics has been the requirement to detect submarines. Defence Research and Development Canada – Atlantic Research Centre (DRDC Atlantic) has been leading Canadian efforts in anti-submarine warfare (ASW) and naval sonar for 75 years. Part of this research has included the development and implementation of maritime acoustic processing systems, an effort which is still being undertaken at DRDC Atlantic.

Keywords: sonar, signal processing

1 Introduction

DRDC Atlantic, or the Defence Research and Development Canada – Atlantic Research Centre, formerly the Naval Research Establishment and then DREA (Defence Research Establishment Atlantic) has been conducting research and development work for the Royal Canadian Navy since 1940. One of the primary focuses of this research has been in the area of underwater acoustics, including naval sonar systems and acoustic signal processing.

Early sonar systems relied primarily on the ability of human operators to hear and interpret underwater sounds, either using passive listening systems such as hydrophones, or the echoes returned from active sonar systems. As sonar systems grew in power and complexity, new technologies for processing and interpreting sonar signals were required. Here, we present a brief historical overview of some of the advances made within the Canadian naval research establishment and associated industries [1, 2].

2 Sonar signal processing systems

2.1 Active sonar

Beginning in about 1964 signal processing work examined improvements to active sonar that might be made possible by signal design and sophisticated real-time computer methods to process the received signals, especially the detection of weak target echoes. The availability of new transistor technology enabled systems that were able to filter out weak and random returns, and present an operator with a display of computer-generated contact information for the first time. The results of this Computer-Aided Detection and Tracking (CADAT) were implemented in the AN/SQS-510 sonar (Fig. 1) and adopted by the navies of Canada, Portugal, and Belgium. In anticipation of upgrades to the Aurora Long Range Patrol Aircraft and the Canadian Towed Array Sonar System (CANTASS), acoustic processing systems continued to be developed for naval air and surface combatants to facilitate the management of data from increasing large numbers of sensors and relate that data to the tactical situation.

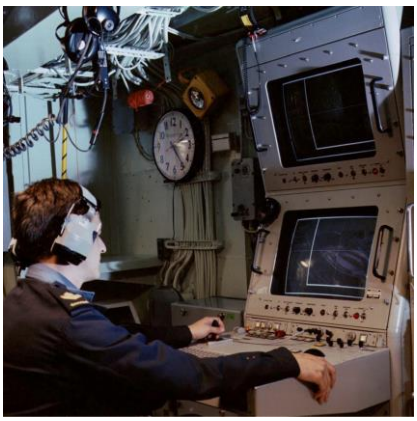

Figure 1: Operator's console for the AN/SQS-510 sonar system.

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The airborne processor was renamed IMPACT (Integrated Multistatic Passive / Active Concept Testbed) around 1995 to emphasis its capability for multistatic sonar (multiple acoustic sources and receivers). It was originally called XDAAP (eXperimental Development of an Airborne Acoustic Processor) in the 1980's and CASD (Concept Airborne Sonar Demonstrator) in the early 1990's. The IMPACT system was the first Canadian demonstration system designed for low frequency active sonar, and it was successfully demonstrated on several international Anti-Submarine Warfare (ASW) trials (Fig. 2). The work done on IMPACT played a significant role in the specifications for the CP-140 Aurora upgrade, MVASP, which was manufactured by General Dynamics Canada (GDC) with input from DRDC Atlantic.

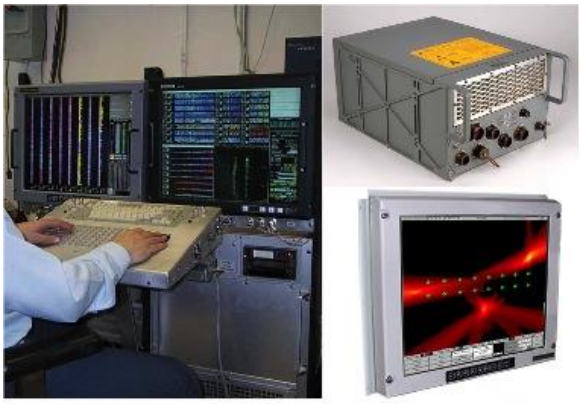

Figure 2: Left: IMPACT – airborne concept demonstrator; right: MVASP processor (top) and display (bottom).

2.2 Towed array processing

Following CADAT, acoustic processing system development for surface warships was undertaken in tandem with the introduction of a new paradigm in surveillance, towing a linear array of acoustic receivers (or antenna) by a surface warship. The Experimental Towed Array Sonar System (ETASS) was developed to convince scientists and naval officers that such a system could be used to advantage (e.g., no active sonar transmissions that would reveal the whereabouts of the warship, and taking advantage of the excellent acoustic propagation characteristics in the deep ocean sound channel) without sacrificing military flexibility. An important part of this project was the development of high dynamic range digital beamforming techniques, along with the creation of displays that would allow an operator to interpret all the data from these arrays. ETASS demonstrations began with research trials aboard CFAV Quest and ended with a Canadian naval vessel (initially HMCS Fraser, later HMCS Nipigon) dedicated full time to the development of tactics and future modifications to the production CANTASS (Canadian Towed Array Sonar System), which when it entered service was among the most advanced surface ship towed array sonars in the world.

2.3 Sonar system test bed

The System Test Bed (STB) is a repository of software components that began in 1996 and has been used to support various sonar system development projects at Defence Research and Development Canada (DRDC) Atlantic. STB provides active and passive sonar processing and display functionality for sensor, feature, contact, track and environmental data. The STB has been designed to provide flexible, portable, reusable, scalable components for a wide variety of sonar applications. The STB functionality is split among common functional components designed to maximize generic functionality and minimize application specific functionality. System integrators assemble only the components needed to provide the desired capability to satisfy user requirements.

2.4 Current systems

The current developmental shipboard system built using STB technology is called MAPS (Maritime Acoustic Processing System) (Fig. 3). MAPS is an integrated hull mounted sonar, sonobuoy and towed array sonar processing and display system that has been installed on the HALIFAX CLASS frigate as a Mission Fit since 2011. MAPS has served to inform the statement of requirements for the current Underwater Warfare Suite Upgrade and the upcoming Canadian Surface Combatant. In addition to MAPS, a variety of other STB applications have been developed over the years to satisfy the unique S&T objectives of individual sonar related projects. These S&T applications have enable real-time processing and display during experimental trials, where new algorithms and displays are continually conceived, tested and refined.

Figure 3: MAPS – shipboard concept demonstrator.

3 Future work

STB continues to provide a test-bed for the development and testing of new signal processing algorithms, displays, and data fusion concepts for future sonar processing systems These activities are being extended by starting new projects to better integrate emerging data sources and decision aid technologies, integrated and predictive situational awareness

and course of action analysis, into the next generation underwater warfare systems. These efforts will enable DRDC Atlantic to investigate and develop innovative technologies for improving long range detection, localization, tracking and identification of underwater threats.

Remerciements/Acknowledgments

The photo credit for Figure 1 is to Bob Reynolds, DREA staff photographer, Figures 2 and 3 Don Glencross, DRDC Atlantic staff photographer.

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