Estimation of Efficiency of a Tree Structured Hierarchical Wavelet Representation of Synthetic Database Applied to Non-Cooperative Target Recognition

Christian Brousseau
IETR, Université de Rennes
Campus de Beaulieu, 35042, RENNES Cedex, France
christian.brousseau@univ-rennes1.fr

***Abstract*—In this paper, problem of efficient representation of large database of target radar cross section is investigated in order to minimize memory requirements and recognition search time, using a tree structured hierarchical wavelet representation. Synthetic RCS of large aircrafts, in the HF-VHF bands, are used as experimental data. Hierarchical trees are built using wavelet multiresolution representation and K-means clustering algorithm. Criteria used to define these hierarchical trees are described and the obtained performances are presented.**

I. INTRODUCTION

Requirements for future air defence radar systems are detection, localization, but also identification of aircrafts. With the increasing resolution of modern radar systems, it is theoretically possible to store much information, according to aspect, elevation, pulse width, etc., of a complex target and use them in the field of target identification.

The advantage of the increasing resolution of radar systems is the opportunity to have more details characteristic of a specific target. The disadvantage is that these detailed characteristics require more and more computer memory to be stored, computer resources and increase the search time to NCTR (Non-Cooperative Target Recognition). It is therefore important to develop efficient methods to decrease the size of high resolution data of radar targets. One way to compress these data is to use tree structured representation using clustering algorithm coupled with a multiresolution wavelet representation to decrease the data size and the number of RCS signature [1].

In this paper, we investigate the problem of efficient representation of large database of radar range profiles in order to minimize memory requirements and recognition search time, using a tree structured hierarchical wavelet representation.

II. DESCRIPTION OF SYNTHETIC RCS DATABASE

A. Introduction

The synthetic RCS database has been developed during the MOSAR project [2] [3] with the support of the French Ministry of Defence (DGA).

To be able to use a small computer like a PC, the simulation of RCS has been made with the free Numerical Electromagnetic Code NEC2 which is based on the Method of Moments (MoM). In this case, the aircraft structure is considered as Perfect Electric Conducting (PEC) body. An example of wiregrid model is presented at Fig. 1. The synthetic database is constituted of eight mid-range airplanes: Airbus A320, BAe 146-200, Boeing 727-200, 737-200, 737-300, 747-200, 757-200 and Fokker 100. For each airplane, RCS has been determined as a function of angle aspect and polarization, in a frequency band between 20 to 100 MHz. Then, the range profile is estimated using an inverse Fourier transform from the frequency response. The synthetic database is finally constituted of around 300 000 range profiles. Figure 2 shows an example of estimated range profile.

III. APPLICATION OF TREE STRUCTURED HIERARCHICAL WAVELET REPRESENTATION TO DATABASE COMPRESSION

A. Introduction

Wavelet transforms and clustering algorithms have been found useful in a variety of applications. Wavelets provide the analyst with an approximation of the signal and a detail of the signal as well. Clustering deals with finding a structure in a collection of unlabeled data. But each of them has its own limitations [4]. Application of wavelets representation to NCTR application gives a low decrease of recognition search time but with a low degradation of probability of false identification. At the opposite, use of clustering algorithm gives a very low decrease of recognition search time but with an important degradation of probability of false identification.