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Methodology to Achieve Non-Cooperative Target Identification Using High Resolution Range Profiles

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Abstract : Non-Cooperative Target Identification has become a key research domain in the Defense industry since it provides the ability to recognize targets at long distance and under any weather condition. High Resolution Range Profiles, one-dimensional radar images where the reflectivity of a target is projected onto the radar line of sight, are widely used for identification of flying targets. According to that, to face this problem, an approach to Non-Cooperative Target Identification based on the exploitation of Singular Value Decomposition to a matrix of range profiles is presented. Target Identification based on one-dimensional radar images compares a collection of profiles of a given target, namely test set, with the profiles included in a pre-loaded database, namely training set. The classification is improved by using Singular Value Decomposition since it allows to model each aircraft as a subspace and to accomplish recognition in a transformed domain where the main features are easier to extract hence, reducing unwanted information such as noise. Singular Value Decomposition permits to define a signal subspace which contain the highest percentage of the energy, and a noise subspace which will be discarded. This way, only the valuable information of each target is used in the recognition process. The identification algorithm is based on finding the target that minimizes the angle between subspaces and takes place in a transformed domain. Two metrics, F1 and F2, based on Singular Value Decomposition are accomplished in the identification process. In the case of F2, the angle is weighted, since the top vectors set the importance in the contribution to the formation of a target signal, on the contrary F1 simply shows the evolution of the unweighted angle. In order to have a wide database or radar signatures and evaluate the performance, range profiles are obtained through numerical simulation of seven civil aircraft at defined trajectories taken from an actual measurement. Taking into account the nature of the datasets, the main drawback of using simulated profiles instead of actual measured profiles is that the former implies an ideal identification scenario, since measured profiles suffer from noise, clutter and other unwanted information and simulated profiles don't. In this case, the test and training samples have similar nature and usually a similar high signal-to-noise ratio, so as to assess the feasibility of the approach, the addition of noise has been considered before the creation of the test set. The identification results applying the unweighted and weighted metrics are analysed for demonstrating which algorithm provides the best robustness against noise in an actual possible scenario. So as to confirm the validity of the methodology, identification experiments of profiles coming from electromagnetic simulations are conducted, revealing promising results. Considering the dissimilarities between the test and training sets when noise is added, the recognition performance has been improved when weighting is applied. Future experiments with larger sets are expected to be conducted with the aim of finally using actual profiles as test sets in a real hostile situation.

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