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Inverse synthetic aperture radar (ISAR)is an imaging technique that shows great promise in classifying airborne targets in realtime under all weather conditions. The success of classifying targets using ISAR is predicated upon forming highly focused radar images of these targets. Efforts to develop highly focused imaging computer software have been challenging, mainly because the imaging depends on and is affected by the motion of the target. Computationally intensive motion compensation algorithms have been developed to remove the unwanted degrading effects of target motion. Those particular motion compensation algorithms which require the use of a space-domain focal quality indicator, e.g., entropy, to determine image sharpness as processing proceeds pay a severe computational penalty due to the large number of two-dimensional fast Fourier transforms (2D-FFTs) which must be computed. This is due to the fact that the actual processing of ISAR data is primarily done in the spatial frequency domain and not in the space-domain where the final ISAR image is displayed. If a focal quality indicator could be developed to measure image sharpness in the spatial frequency domain, then the computational burden introduced by the numerous 2D-FFTs could be greatly relaxed. This paper describes the use of a new focal quality indicator called the burst derivative measure for determining ISAR image sharpness in the spatial frequency domain. Tests have been performed on simulated as well as actual ISAR data using both the burst derivative measure and the entropy measure. Results indicate that the burst derivative measure, when used in conjunction with the entropy measure, can greatly reduce the number of 2D-FFTs presently required in these motion compensation algorithms.

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ISAR Motion Compensation Using the Burst Derivative Measure As A Focal Quality Indicator

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ABSTRACT

Inverse synthetic aperture radar (ISAR) is an imaging technique that shows great promise in classifying airborne targets in real-time under all weather conditions. The success of classifying targets using ISAR is predicated upon forming highly focused radar images of these targets. Efforts to develop highly focused imaging computer software have been challenging, mainly because the imaging depends on and is affected by the motion of the target. Computationally intensive motion compensation algorithms have been developed to remove the unwanted degrading effects of target motion. Those particular motion compensation algorithms which require the use of a space-domain focal quality indicator, *e.g.*, entropy, to determine image sharpness as processing proceeds pay a severe computational penalty due to the large number of two-dimensional fast Fourier transforms (2D-FFTs) which must be computed. This is due to the fact that the actual processing of ISAR data is primarily done in the spatial frequency domain and not in the space-domain where the final ISAR image is displayed. If a focal quality indicator could be developed to measure image sharpness in the spatial frequency domain, then the computational burden introduced by the numerous 2D-FFTs could be greatly relaxed. This paper describes the use of a new focal quality indicator called the burst derivative measure for determining ISAR image sharpness in the spatial frequency domain. Tests have been performed on simulated as well as actual ISAR data using both the burst derivative measure and the entropy measure. Results indicate that the burst derivative measure, when used in conjunction with the entropy measure, can greatly reduce the number of 2D-FFTS presently required in these motion compensation algorithms.

I. INTRODUCTION

Potentially the most powerful means to rapidly classify airborne targets at long range under all weather conditions is through the use of some type of imaging radar [1,2]. Researchers [3-9] at a number of institutions have developed a variety of techniques to process and display radar images. As a specific example, scientists and engineers at the Naval Command, Control and Ocean Surveillance Center (NCCOSC) in San Diego, California have developed stepped-frequency microwave ISAR processing and imaging systems as well as the required attendant algorithms. Two of these algorithms, employed by the authors at NCCOSC, are used to compensate for the translational and the rotational motion of the target. In this paper we will refer to these algorithms as the translational motion compensation (TMC) and the rotational motion compensation (RMC) algorithms.