**Synthetic Aperture Radar (SAR) Polarimetry Techniques for Nondestructive Evaluation (NDE)**

In this dissertation, several advancements in the field of synthetic aperture radar (SAR) polarimetry are described. First, a calibration technique for a dual-polarized antenna is developed, allowing polarimetric calibration to be performed through the measurement of specific square- or circular-waveguide loads, resulting in improvement in measurement accuracy when performing polarimetric SAR measurements. Imaging experiments are performed using a fabricated dual-polarized antenna and calibration loads, validating the efficacy of this calibration procedure. Second, a technique is developed enabling SAR polarimetric measurements to be made using a single polarization configuration, making use of the unique polarization pattern of a radially-polarized antenna. This technique possesses the full capabilities of previously used polarimetric SAR techniques, while at the same time vastly simplifies the necessary hardware and the calibration procedure. To this end, a specialized SAR imaging algorithm is developed, and imaging experiments are performed that demonstrate the effectiveness and accuracy of this technique compared to traditional SAR polarimetry methods. Third, a SAR 3D polarimetry technique is developed, by which targets can be characterized by their 3D features such as relative orientation about all three axes of rotation. A SAR imaging algorithm is developed for this purpose, and imaging experiments are performed to demonstrate the efficacy of the method. The advancements made in this work open the door for SAR polarimetry to be used in a much more diverse set of applications. Fourth, SAR polarimetry was applied to the detection and characterization of fiber misalignment in carbon and glass fiber polymer (CFRP and GFRP) composites. CFRP and GFRP samples are manufactured with fiber misalignment, and two different polarimetric SAR techniques, one of which is SAR 3D polarimetry, are used to detect the misalignment and determine the specific misalignment angles in each sample.