Target Detection and Classification for Laptop Based SAR Radar using Support Vector Machines

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This abstract introduces an approach for target detection and classification in synthetic aperture radar (SAR) imagery. In particular, this is done for a linear frequency modulated continuous wave (FMCW) laptop based radar through the use of machine learning algorithms such as support vector machines (SVMs) to detect targets of interest and classify the decision region of the target. The radar is based on a design from the Lincoln Laboratory at the Massachusetts Institute of Technology (MIT) open courseware. SVMs are a two-class (binary) classification algorithm that separates two sets or classes of data between a hyperplane, isolating differing regions and minimizing the possibility of misclassification. In the case of SAR radar, we want to differentiate the desired target area from noise or other distracters so that we can classify our target of interest from other elements of the image. Noise tends to occur naturally due to the point-by-point algorithm in acquiring a SAR image. In this case, we want to be able to determine the location of a given target(s) of interest within differing scenarios of noise either environmental or naturally from the radar, and classify the segments of the image data.

Previous work has shown that SVMs with Gaussian kernels outperformed other more conventional classifiers in determining class information (i.e. which class a set of data belongs to). Gaussian kernels in SVMs allow for a local bound region that classifies two different classes. In particular, SVMs have been used to classify a variety of data including SAR multisensory imagery as well as other remote sensing imagery. Earlier work also relied on the SVMs to classify other kinds of pattern recognition applications such as handwritten digit recognition, speech/face identification as well as automatic target recognition (ATR). In particular, SVMs have been used to detect information in a SAR image from speckle noise (J.P. Dubois and O. M. Abdul-Latif, World Academy of Science, Engineering and Technology, 12, 2005, 139-143).

An approach in target detection for a laptop based radar is introduced to classify SAR imagery. We use pattern recognition algorithms to perform detection of targets embedded into an environment. In particular the use of SVMs will be able to take the readings of a SAR image and classify all detected targets into two classes, the target of interest vs. everything else. The premise is that based on the environment, targets of interest exist such as a specific crop in a field of different crops in which we can use SVMs to classify targets detected in a SAR image. In theory this should also be applicable to multiple kinds of data such as landmines or crops or even reading for ground-based or sky-based radar. Since SVMs are a binary classifier, we can group multiple targets of interest together in one class vs. everything else or potentially do one-vs-one classification in which we are interested in two different targets. To do this, we will train SAR data through an appropriate training set online for different types of experiments and apply it to data gathered from experiments using the laptop based radar. SVMs will be used to determine training parameters which we apply to gathered data classify the targets and make the decision for the target of interest.