Classification of Targets in SAR Imagery using Deep Neural Networks

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This abstract introduces an approach for classification of targets in synthetic aperture radar (SAR) imagery through the use of deep convolutional neural networks. Convolutional neural networks (CNNs) have been a focal point in machine learning to analyze many kinds of data such as speech or imagery. CNNs have been primarily used as a way to classify images such as handwritten digits (MNIST) as well as a generic image classifier. Through the use of a laptop based radar designed from the Massachusetts Institute of Technology (MIT) open courseware, we can acquire SAR data of a stationary target using the Range Migration Algorithm with this radar. A given scene or target area can consist of many different objects, or in the case of SAR, an image can register many shapes of detected objects corresponding to different targets in the image. Given an adequate range resolution, multiple objects can be detected by a radar of which could have varying radar cross sections. Through the use of a Deep neural network, we can classify a target based on it's radar cross section and adequately label detected targets within a SAR image.

As a means of image classification, Convolutional Neural Networks (Also known as Deep Learning) primarily builds upon the representation of pixels within an image to identify an object in an image. CNNs in SAR imagery research have been applied to automatic target recognition algorithms (ATR) as well as ship-iceberg detection algorithms (C. P. Schwegmann, W. Kleynhans and B. P. Salmon, International Workshop on Remote Sensing with Intelligent Processing (RSIP), Shanghai, 2017, pp. 1-2.) to name a few. CNNs are carried out through a set of stages, beginning with a set of images to use as training, followed by a validation step and finalized through testing the network on a set of test images. Most of what the CNN carries out is 2D convolution in order to pinpoint the pixel representations (features) of an image and then are stored in a hidden layer which extracts these features. This hidden layer is used to best fit a combination of features to a given image class. Using these stored features, one can validate the non-linear nature fo the algorithm with a validation set of images for classification prior to testing on the test set. CNNs are not without their issues as typically for proper classification, a large amount of data is required for proper analysis and computational processing of the network can be complex enough to require high-power computing (HPC) machines.

The approach this abstract introduces is a way to apply a a supervised machine learning technique to SAR Imagery acquired by a laptop based radar. To address the issue of acquiring a set of test data, we will propose a technique of augmenting training data by acquiring SAR imagery of minimum two class of objects from the radar and replicating the data with noise variations and image processing techniques to create a synthetic set of training data. This synthetic data will be used in the CNN algorithm to train the classifier to learn the pixel representation of these two classes and applied to unmodified test data collected by the radar.