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Quarterly Technical Report for Grant F33615-97-1-1014

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A Unified, Multiresolution Framework for Automatic Target Recognition

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This is a quarterly progress report summarizing accomplishments in the research program supported by US Air Force Wright Patterson Laboratory Grant # F33615-97-1-1014. It covers the period from July 1st, 1997 to Dec 1st, 1997. The principal investigators of this grant are Professors Grimson, Willsky and Viola of MIT. Advisory investigators include Professor Shapiro, Dr. Wells and Dr. Krim of MIT.

During this quarter we welcomed Dr. John Fisher to our research team. He recently completed a Ph.D. at University of Florida under the direction of Prof. Jose Principe. Dr. Fisher is very experienced both in Sythetic Aperture Radar and Automatic Target Acquisition. He brings a great deal of practical know how to our group in addition to his research credentials. We expect Dr. Fisher to make a immediate impact on the way we do experiments and on the direction of our research.

During this quarter we also responded to a request from Mr. George Lukes to write an overview of our research agenda. Our letter addressed Mr. Lukes' concerns about the initial levels of expenditure for this grant as well as his concern about the focus of our work. Based on comments both from Mr. Lukes and Mr. Vincent Velten we are now refocusing our efforts in two ways.

- First, we are in the process of defining a detailed experimental methodology. It is our intent to demonstrate in a detailed and reproducible fashion the value of our new theoretical techniques on data taken from the publicly available MSTAR dataset. As part of that effort, implementation of a baseline classifier for the MSTAR dataset has begun.

- Second, we have chosen to narrow the range of our research agenda. Our research efforts in this grant will be limited to the study of non-parametric multiscale modeling of SAR imagery and phenomenology. This agenda differs significantly from research supported under other grants in two significant ways. One, the statistical models for cross-scale structure are not Gaussian. This limitation is inherent in previous approaches. Our non-parametric has already demonstrated that it is much more flexible. Two, we will study the relationship between these models and the phenomenology of SAR ATR.

Since our last report several significant advancements have taken place.

We have published a paper in the vision track of a well known neural networks conference "Advances in Neural Information Processing". The paper details our formal statistical model for imagery which is quite general and can be applied both to visible light (EO) images and SAR imagery. Because of space limitations our work on SAR is not discussed in complete detail. We are planning to publish the details of our SAR models at the "Technical Conference on Algorithms for Synthetic Aperture Radar Imagery V" held at SPIE.

Since non-parametric multi-scale statistical model for imagery is quite general we have begun to explore its applicability to other problems related to SAR ATR. We have begun experiments to determine if this model can be used for segmentation of SAR imagery. In Figure 1 we show our model's capability to segment a target chip into three distinct regions: target, shadow, and background.

We have also explored the applicability of our multi-scale non-parametric SAR model to the detection of anomalous regions in SAR imagery. Our current model can be trained to discriminate between target and clutter, or to discriminate between targets. Used in a more unsupervised mode it can find anomalous regions. These regions are typically unique–sometimes they are targets other times roads or buildings. Detection of anomalous regions may have many applications, for example in change detection. These anomalous regions may also be useful for registration of SAR images.

We have demonstrated that the detection of anomalous regions is of sufficient reliability that the regions themselves can be used as features for input to other algorithms. We have tested this hypothesis in a SAR image registration task. The image registration problems assumes we are given two SAR images of the same area measured at different times or from different looks. From each the anomalous regions are extracted. There are typically 10-30 regions extracted. Matches between these regions lead to registration of the images.