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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 January 1st, 1997 to April 1st, 1997. The principal investigators of this grant are Professors Grimson, Viola and Willsky of MIT. Dr. John Fisher of MIT serves as an additional advisory investigator.

At the beginning of this quarter we submitted an overview of our research agenda. This was in response to a conversation between P. Viola, J. Fisher, G. Lukes, and V. Velten which occurred at the MSTAR demonstration held at Lincoln Laboratory. At that time G. Lukes requested that we refine the scope of the grant. Regarding that overview we have completed the following during this quarter:

1. Implementation the baseline algorithm described in *Standard SAR ATR Evaluation Experiments using the MSTAR Public Release Data Set*.
2. Completed classification experiments using the algorithm originally developed by Paul Viola and his student Jeremy De Bonet on the entire MSTAR Public Release Data Set (2987 target chips).
3. Submitted two papers describing our approach in detail to the SPIE Aerosense Conference which will be held in April.

Implementation of the WPAFB baseline algorithm proved necessary as the data set for which the results were reported did not have complete intersection with the data set we had available (namely the MSTAR public release data set). Specifically, the following vehicles are not available in the public data: 1) BTR70 (s/n c7[0,2,3]

	BMP2-C21 @ 17^o		BTR-C71 @ 17^o		T72-132 @ 17^o		not classified	
BMP2-9563 @ 15^o	0.837	(0.903)	0.053	(0.005)	0.011	(0.005)	0.099	(0.087)
BMP2-9566 @ 15^o	0.858	(0.847)	0.063	(0.015)	0.005	(0.015)	0.074	(0.122)
BTR70-C71 @ 15^o	0.042	(0)	0.853	(0.898)	0.005	(0)	0.100	(0.102)
T72-812 @ 15^o	0.021	(0.041)	0.053	(0)	0.858	(0.795)	0.068	(0.164)
T72S7 @ 15^o	0.021	(0.047)	0.126	(0.010)	0.779	(0.921)	0.074	(0.021)
BRDM2 @ 15^o	0.174	(0.285)	0.174	(0.332)	0.132	(0.029)	0.520	(0.354)
D7 @ 15^o	0.542	(0.529)	0.137	(0.153)	0	(0.223)	0.321	(0.095)
T62 @ 15^o	0.626	(0.524)	0.121	(0.117)	0.068	(0.264)	0.185	(0.095)
ZIL131 @ 15^o	0.379	(0.274)	0.168	(0.310)	0	(0.314)	0.453	(0.102)
ZSU-23-4 @ 15^o	0.474	(0.394)	0.089	(0.095)	0.021	(0.453)	0.416	(0.058)
2S1 @ 15^o	0.616	(0.493)	0.179	(0.234)	0.079	(0.069)	0.126	(0.204)

Table 1: Confusion matrix for the flexible histogram approach (template-based results in parentheses) at 90% detection rate.

2) M109 3) M110. During this time we interacted with Stephen Worrell to ensure a faithful implementation of the baseline template approach. This gives us the ability to directly compare results to a baseline algorithm on a common set of data. Furthermore we will continue to use this baseline (and any subsequent refinements) as new data is included in our experiments (e.g. T-72 variants).

Upon completion of the baseline implementation we began a series of experiments testing our non-parametric multi-scale statistical models for classification. These experiments were fairly extensive in that they include the entire initial public MSTAR data release. As shown by the ROC curves and the confusion matrices our results compare quite favorably with the baseline method.

The first of the two papers submitted to SPIE describe these results in more detail while the second describes an adaptation of the algorithm for SAR-to-SAR image registration. Both of these papers are attached to this report.

In the next quarter we anticipate the inclusion of SAR-specific multi-resolution trees into our research. Specifically, we will be examining at multi-resolution sub-aperture trees computed from coherent SAR imagery as an alternative to the oriented wavelet pyramid we are currently using. This change is appropriate as the use of a coherent sub-aperture representation potentially captures the anisotropic nature of the scattering commonly associated with man-made objects.

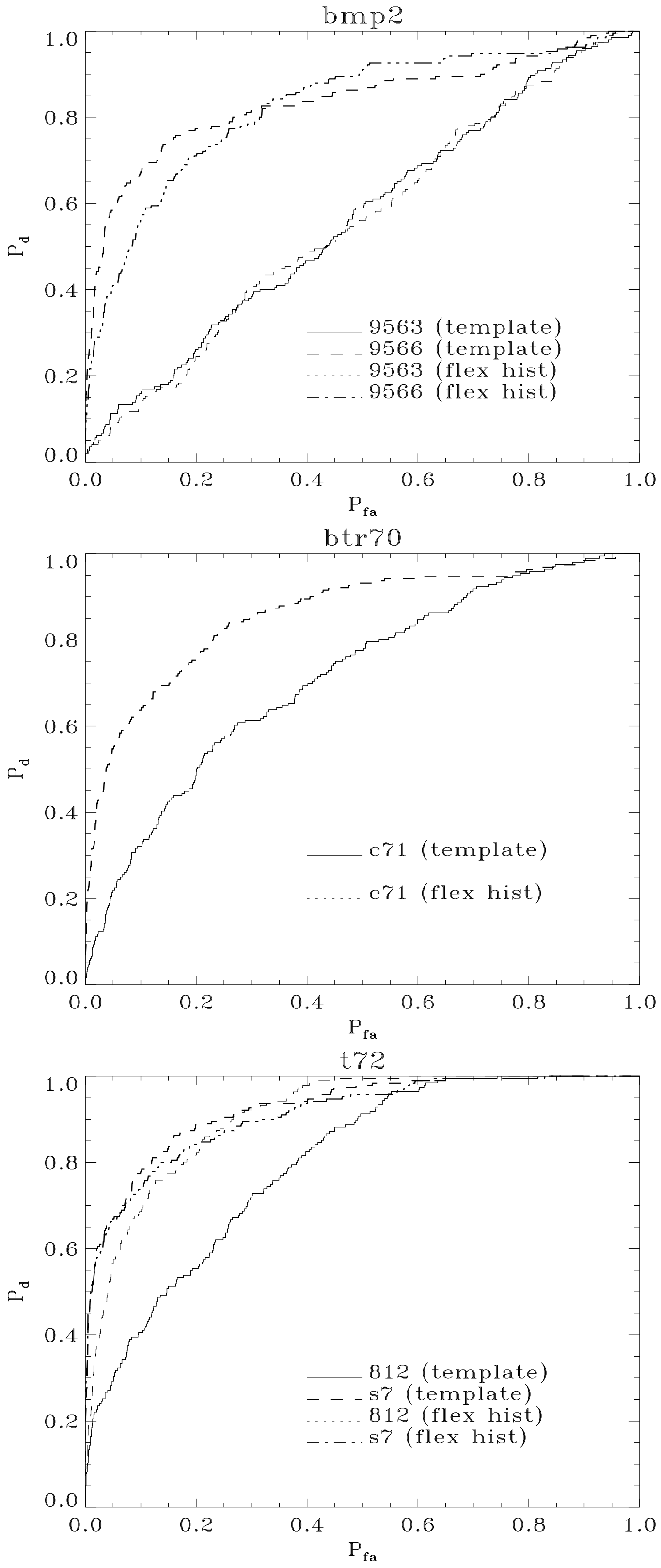

Figure 1: ROC curves for BMP2 (top), BTR70 (middle), and T72 (bottom) vehicle types comparing the flexible histogram and template matching approaches.