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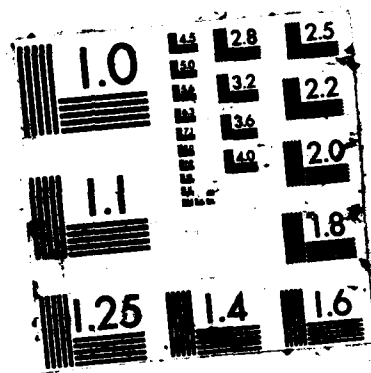
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ANNUAL TECHNICAL REPORT OF RESEARCH
ON
STATISTICAL TECHNIQUES FOR SIGNAL PROCESSING

Supported by Grant AFOSR 82-0022

Grant Year: November 1, 1985 - October 31, 1986

Report Date: December 20, 1986

Saleem A. Kassam
Principal Investigator

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19. ABSTRACT (Continue on reverse if necessary and identify by block number) This report summarizes research accomplishments in the 12 month period Nov. 1, 1985 - Oct. 31, 1986. Significant advances have been made in nonlinear filtering based on robust estimation, on nonparametric detection, and on a new noise model for signal-dependent and multiplicative noise. Reference is made to 11 publications. <i>Keywords include:</i>					
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**SUMMARY OF PROGRESS IN PREVIOUS YEAR (STARTING NOVEMBER 1,
1985) OF RESEARCH UNDER GRANT AFOSR 82-0022**

The grant year covered by this report began on November 1, 1985; it was the fifth year of continuing effort on the development of new "Statistical Techniques for Signal Processing". The progress made in the first four years of this effort has been documented in four previous annual reports (December 1982, 1983, 1984 and 1985). In addition, advances made over a five year period under a previous grant period (AFOSR 77-3154) have been described in five earlier annual reports.

Here we summarize our activity in this latest complete year of research effort. Some interesting and significant results have been obtained and reported during this period; these are listed as references [1]-[11]. Copies of references currently available will be forwarded shortly under separate cover.

The area of nonlinear edge-preserving robust smoothing continued to be an area of primary focus of our research. In [1] preliminary results have been given of our work on edge-preserving, impulsive-noise rejecting, frequency selective filters using combined temporal/rank-order data matrices. We have obtained very good success in combining frequency selectivity, which requires linear temporal filtering, with the nonlinear order-based treatment of time series for outlier rejection and edge preservation. We have been working on extending this study and are preparing a journal paper on this subject. We have also obtained very encouraging results on R-estimates of statistical theory in nonlinear filtering applications for edge-preserving smoothing of noisy signals. Specific results on modifications of the Wilcoxon rank



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statistic leading to filters using temporally close observation pairs in forming the set of Walsh averages and M-wise instead of pairwise averaged quantities are contained in [2,3]. These Limited degree Extended averaging Wilcoxon (LEW) filters possess some very good characteristics. These results in extended form are also shortly to be submitted for journal publication.

In other work related to nonlinear filtering we have obtained results on the application of trimmed mean and related order statistic techniques in radar constant false alarm rate (CFAR) detection processing [4]; these results are currently being prepared for journal publication. Paper [5] was revised this year, and contains a treatment of the statistical characteristics of some L- and M-filters in edge preservation and noise rejection. We have considered specifically the performance of the alpha-trimmed mean and the standard-type M-filter in noise suppression at signal edges. These results extend earlier results on median filtering.

The invited paper [6] was also prepared last year. It contains our new results on the use of conditional statistical tests in obtaining counterparts of the very simple and useful sign detector, for nonparametric detection of narrowband deterministic and random signals. This work is an example of how useful and elegant new statistical procedures can be obtained for signal processing problems which do not directly fit the standard formulations in statistical theory, by a proper interpretation of the problem and extension of available theory.

We have also in the past year formulated and applied in signal detection studies a new model for noisy observations. This model extends the common additive signal and noise assumption to one admitting signal-dependent and multiplicative noise terms as well. Such a model may be much more realistic in many practical situations. In [7,8] we have given preliminary results on locally most powerful detector structures

for the known signal detection problem in this generalized observation model. The results form a generalization of the common results on detection in additive noise. We have also made asymptotic and finite-sample-size performance comparisons with other common detectors, and have demonstrated that sizeable performance gains may be realized by using this model if it is indeed applicable, rather than the usual additive noise model. We have recently submitted a paper for journal publication on this subject, and are working on extending the results to the random signal case.

In one secondary area of our research we have published an interesting result [9] on coding of binary images. Our method exploits the two-dimensional statistical redundancy in such images but requires only the use of a one-dimensional coding algorithm applied separately in each of the two dimensions.

A book chapter was also published during this grant period on the subject of data quantization in signal detection [10].

In addition to the above we have put in efforts in revising previously submitted papers on robust detection, quantization, and statistical characterizations of nonlinear filters. The principal investigator is also completing a monograph/text on detection of signals in non-Gaussian noise [11]. Finally, we note that the Ph.D. dissertation research of a graduate student was almost completed during this year.

PERSONNEL SUPPORTED

**I. H. Song, Graduate Research
Assistant**

12 Months

**S. A. Kassam, Principal
Investigator**

**3.35 Months (15% Academic
Year, 2 Months Summer)**

Beyond the one graduate student supported by AFOSR, the principal investigator was also supervising one thesis student and two Ph.D. dissertation students who are working on areas of research directly related to this AFOSR research program.

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