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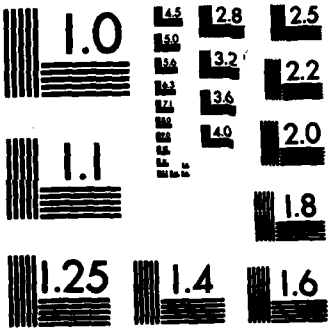

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Robustness, minimax estimation and control, stochastic games.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes progress on the referenced contract for the fiscal year 1982. This progress includes results in a number of problems concerned with minimax robustness in communication and control.

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ANNUAL PROGRESS REPORT

for

Office of Naval Research

Contract N00014-81-K-0014

Reporting Period:

October 1, 1981 - September 30, 1982

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February 16, 1983

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2. Summary of Progress During Reporting Period

The primary direction of progress on this project during the reporting period has been toward the development of general formulations for robustness problems in communications and control. Generally speaking, a robust procedure is one which is insensitive (in terms of performance) to deviations from an assumed model. One of the most successful approaches to robust design is a game theoretic one in which a procedure is sought to have the best worst-case performance over a relevant class of models neighboring the assumed (i.e., nominal) model. Thus, the primary design philosophy in this area has been minimax, and the current progress has been directed toward general minimax results for these robustness problems. A brief description of the results obtained during the reporting period is contained in the following paragraphs. More complete details of these results can be found in the publications listed at the end of this discussion.

Many of the robustness problems that have been studied in the past such as robust location estimation and robust matched filtering exhibits a common structure which, although reasonably tractable, does not fit within the classical minimax theory. This common structure has prompted the study of a general class of minimax problems, examples of which include most of the previously studied

formulations of robustness. The formulation of this general problem and the characterization of its solution is found in a series of papers [11], [22], and [23]. This formulation has been applied to several aspects of the problems of robust observer and regulator design for linear stochastic systems in [10], [20], and [21]. These results, which are for finite-length observations and time-varying systems, generalize our earlier work dealing with the steady-state versions of these problems (various aspects of the steady-state regulator design problem are reported in [4], [17], and [18]).

Another aspect of our work during this period has dealt with the problem of robust stationary linear filtering for uncertain spectral models. An extensive numerical study reported in [6] and [24] indicates that conventional minimum mean-square-error filters can be undesirably sensitive to deviations from assumed spectral models, but that minimax filters are much less sensitive (i.e., they are more robust). Thus, we have studied several aspects of minimax linear signal estimation for stationary models. This work includes a study of robustness in the general discrete-time stationary signal estimation (i.e., Wiener-Kolmogorov) setting which incorporates filtering, prediction, and smoothing as special cases [9]. Also a general class of such problems has been treated by considering spectral uncertainty classes of a general type generated by Choquet capacities. This latter work includes a study of minimax smoothers for such models [5], an extension of the underlying capacity theory which allows for the expansion of the utility of such models [7], and a demonstration that the commonly-used p-point spectral uncertainty class is of this type [8].

Other work conducted during this reporting period includes: the preparation of three invited survey papers and presentations on various aspects of the robustness results which have been developed in part under this support [2], [15], [19]; a study of the solution to a minimax problem arising in jammer design [1], [12]; an investigation of robust matched filtering for observed point processes [13], [14]; and a study of an alternative to minimax design that is useful for parametric hypothesis-testing problems [3], [16].

3. Publications Reporting Research Supported by ONR Contract N00014-81-K-0014. (October 1, 1981 - September 30, 1982)

A. Journal Articles

[1] T. Basar, "The Gaussian Test Channel with an Intelligent Jammer," IEEE Transactions on Information Theory, vol. IT-29, pp. 152-157, January 1983.

*[2] S. A. Kassam and H. V. Poor, "Robust Signal Processing for Communication Systems," IEEE Communications Magazine, vol. 21, pp. 20-28, January 1983.

[3] B. H. Krogh and H. V. Poor, "The Segment Method as an Alternative to Minimax in Hypothesis Testing," Information Sciences, vol. 27, pp. 9-37, 1982.

[4] D. P. Looze, H. V. Poor, K. S. Vastola, and J. C. Darragh, "Minimax Control of Linear Stochastic Systems with Noise Uncertainty," IEEE Transactions on Automatic Control, vol. AC-28, June 1983, to appear.

[5] H. V. Poor, "Minimax Linear Smoothing for Capacities," Annals of Probability, vol. 10, pp. 504-507, May 1982.

[6] K. S. Vastola and H. V. Poor, "An Analysis of the Effects of Spectral Uncertainty on Wiener Filtering," Automatica, vol. 19, May 1983, to appear.

[7] K. S. Vastola and H. V. Poor, "An Extension of the Huber-Strassen Derivative," manuscript submitted for publication to Annals of Probability.

[8] K. S. Vastola and H. V. Poor, "On the p-point Uncertainty Class," manuscript submitted for publication to IEEE Transactions on Information Theory.

[9] K. S. Vastola and H. V. Poor, "Robust Wiener-Kolmogorov Theory," manuscript submitted for publication to IEEE Transactions on Information Theory.

[10] S. Verdú and H. V. Poor, "Minimax Linear Observers and Regulators for Stochastic Systems with Uncertain Second-Order Statistics," IEEE Transactions on Automatic Control, vol. AC-28, 1983, to appear.

[11] S. Verdú and H. V. Poor, "On Minimax Robustness: A General Approach and Applications," manuscript submitted for publication to IEEE Transactions on Information Theory.

B. Conference Papers

[12] T. Basar, "The Gaussian Test Channel with an Intelligent Jammer," Abstracts of Papers for the 1982 IEEE Int. Symp. on Inf. Theory, June 21-25, 1982, Les Arcs, France, pp. 77-78 (1982).

[13] E. A. Geraniotis and H. V. Poor, "Minimax Filtering Problems for Observed Poisson Processes with Uncertain Rate Functions," Proc. 20th IEEE Conf. on Decision and Contr., Dec. 16-18, 1981, San Diego, CA, pp. 600-606, 1981.

* invited paper

[14] E. A. Geraniotis and H. V. Poor, "Robust Hypothesis Testing for Observed Poisson Processes with Uncertain Rate Functions," Proc. 1982 Conf. on Inf. Sci. and Syst., March 17-19, 1982, Princeton University, Princeton, NJ , pp. 320-322, 1982.

*[15] S. A. Kassam and H. V. Poor, "A Survey on Robust Filtering," Abstracts of Papers for the 1982 IEEE Int. Symp. on Information Theory, June 21-25, 1982, Les Arcs, France, pp. 73, 1982.

[16] B. H. Krogh and H. V. Poor, "An Alternative to Minimax for Designing Binary Decision Rules," Proc. 21st IEEE Conf. on Decision and Control, December 8-10, 1982, Orlando, FL, 1982.

[17] D. P. Looze, H. V. Poor, K. S. Vastola, and J. C. Darragh, "Minimax Control of Linear Stochastic Systems with Noise Uncertainty," Proc. 1982 American Control Conf., June 21-25, 1982, Arlington, VA, pp. 689-693, 1982.

[18] D. P. Looze, H. V. Poor, K. S. Vastola, J. C. Darragh, "On Linear-Quadratic-Gaussian Control of Systems with Uncertain Statistics," in System Modeling and Optimization: Proceedings of the 10th IFIP Conference on System Modeling and Optimization, August 31-September 3, 1981, New York, NY. (R. F. Denick and F. Kozin, eds.) Springer-Verlag: Berlin, 1982, pp. 417-423.

*[19] H. V. Poor, "Distance Measures in Robustness," Abstracts of Papers for the 1982 IEEE Int. Symp. on Information Theory, June 21-25, 1982, Les Arcs, France, pp. 73-74, 1982.

*[20] H. V. Poor and S. Verdú, "An Approach to Some Minimax Problems in Communication and Control," Abstracts of Papers for Optimization Days, École Polytechnique de Montréal, May 11-13, 1983, to appear.

[21] S. Verdú and H. V. Poor, "A General Approach to the Estimation and Control of Linear Systems with Noise Uncertainty," Proc. 1982 Conf. on Inf. Sci. and Syst. March 17-19, 1982, Princeton University, Princeton, NJ, pp. 330-335, 1982.

[22] S. Verdú and H. V. Poor, "General Results on Minimax Robust Filtering," Abstracts of Papers for the 1982 IEEE Int. Symp. on Information Theory, June 21-25, 1982, Les Arcs, France, p. 124, 1982.

[23] S. Verdú and H. V. Poor, "On the Inverse Minimax Filtering Problem," Submitted for presentation at the 1983 IEEE International Symposium on Information Theory, St. Jovite, Québec, Canada, September 26-30, 1983.

C. Theses and Reports

[24] K. S. Vastola, Topics in Robust Statistical Signal Processing, Ph.D. Dissertation, Department of Electrical Engineering, University of Illinois at Urbana-Champaign, September 1982. (Published as Coordinated Science Laboratory Technical Report No. R-965.)

*invited papers


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