IFAC Report

Symposium on Stochastic Control*

Symposium sur le Contrôle Stochastique

Symposium über Stochastische Steuerung

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Introduction

THE FIRST IFAC Symposium on "Stochastic Control" was held in the Bulding of the Eötvös Loránd University, Budapest, Hungary, from 25 to 27 September, 1974. It was organized by the Hungarian Academy of Sciences, the Bolyai Mathematical Society, the Scientific Society of Measurement and Control, the Hungarian John Von Neuman Computer Society and the Computer and Automation Institute of the Hungarian Academy of Sciences. The Symposium was sponsored by the Theory and Applications Committees of the International Federation of Automatic Control. The proceedings were supervised by Professor S. Csibi as Local Chairman of the National Organizing Committee.

Both theoretical and applied papers were presented in the symposium. It was, however, clear that theoretical papers dominated. This might have been expected because the application of modern stochastic control theory is still at a very modest stage while the theory has received an enormous boost recently with the works of Fleming, Wonham, Balakrishnan, Shiryaev, Benes and Varaya. Professor Åström has made significant contribution towards the application of stochastic control theory and it was a privilege for the audience to listen to a number of enlightening papers presented by him and his associates during the symposium.

There were about 200 participants from 24 countries. The program included 9 general lectures, 55 papers for presentation and 32 papers for discussion. Four general lectures, those of Professors Kushner, Khasminsky, Athans and Fu, were cancelled as the speakers were unable to attend the symposium. The loss was partially recovered by an unscheduled general lecture by Academician Pugachov that was arranged during the proceedings. Some of the papers could also not be presented or discussed due to the absence of the authors. The attendance at the general lectures and the technical sessions was very impressive. Papers were presented in two parallel sessions: Section A and Section B. This was inevitable as the duration of the conference was rather short. Quite frequently, papers presented in the two sessions at the same time were closely related and this must have caused a considerable problem of decision making on the part of the attendants.

In the following some of the highlights of the general lectures and some representative papers of the technical sessions are discussed.

General lectures

After the introductory addresses of Dr. Lozier, Professors Vamos and Kwakernaak, Professor Balakrishnan of the United States delivered the first general lecture on the modelling problem of stochastic dynamical systems. His contention was that the modelling of observation noise as Wiener process, in integrated form, is only a mathematical idealization and existing results in nonlinear filtering, likelihood ratios and related formulas are of doubtful utility in practical data processing. He discussed the approximation of Itô integrals by band-limited processes and presented the correct formula for the likelihood ratio that should be used in practical problems of detection and systems identification.

Professor Tsytkin of the Soviet Union surveyed various stochastic approximation algorithms used in adaptive and self-learning control systems. Different classes of algorithms were identified and presented in tabular forms. This classification is a useful and convenient reference for researchers in the field.

Professor Shiryaev of the Soviet Union gave a lecture on the weak and strong solutions of stochastic differential equations that arise naturally in stochastic control problems, and discussed sufficient conditions for their equivalence. The talk was purely mathematical and, among other things, dealt with strong solutions of stochastic differential equations with non-Lipschitzian coefficients—a problem of central importance in stochastic control theory.

Academician Pugachov of the Soviet Union surveyed various results concerning absolute continuity and singularity of two Gaussian measures under various conditions. The problem is important in information theory and sufficient conditions for absolute continuity verifiable from actual data constitute still a useful line of investigation.

Professor Åström of Sweden discussed the applications of stochastic control theory. Interestingly enough, this was the only general lecture with practical orientation to real engineering problems where stochastic control theory can be applied. The lecture was extremely clear and some potential areas of application were pointed out. The success of stochastic control theory will depend on meaningful applications of the existing results.

Professor Aoki of the United States discussed an unconventional but fascinating line of investigation. He pointed out the connection between stochastic control theory and mathematical economics and told the audience that the interaction between these two disciplines will enrich both immeasurably. His historical account of the interaction between control theory and economics and his analysis of the fundamental difference in the objectives of control engineers and economists will help systems scientists aspiring to work in economics.

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Technical sessions

There were three sessions on control theory and two sessions on differential equations. These sessions had close similarity and several interesting papers were presented in that category. The important paper of Y. Bar-Shalom *et al.* could not be presented as none of the authors was present. K. J. Åström of Sweden analysed the self-tuning regulator problem for systems with non-minimum phase. He was asked for examples of practical situations of interest where non-minimum phase occurs. In reply, Professor Åström provided some examples but admitted that his experience in those problems is still limited. Twin brothers J. L. and J. C. Willems of Belgium and The Netherlands respectively presented stabilizability criteria by analysing directly the stochastic differential equation rather than the associated covariance equation. K. Yamada of Japan tried to extend the concept of duality of estimation and control to non-linear systems. A. Firla of Poland discussed an interesting control problem with averaged control energy constraints. L. Ljung of Sweden talked about his fascinating work on proving convergence of estimates of controller parameters by studying the stability of a related ordinary differential equation.

There were three sessions on statistics and two sessions on recursive processes. Unfortunately, the paper of A. Segall *et al.* on estimation of point processes could not be presented as none of the authors was able to attend the symposium. The concept of generalized innovation discussed by E. Mosca of Italy was intriguing. There was an interesting discussion on the paper of S. G. Tzafestas of Greece. H. Takata of Japan presented a new technique on nonlinear estimation of discrete systems based on the assumption that the optimal estimation is performed with a power series about all observations in the past and the present time.

There was one session each on queueing and fuzzy systems. L. Shaw of the United States discussed optimization of two service systems described by linear stochastic difference equations with the performance interval terminating at the first passage of the state out of a given region. The solution can be applied to traffic flow and other queueing systems. The paper by P. Barnev *et al.* of Bulgaria was presented in the session on fuzzy systems. The other paper by M. Sugeno *et al.* of Japan was highly praised by the participants but it could not be presented because of the absence of all the authors. The session was characterized by one of the liveliest discussions of the symposium.

On the side of applications, there were two sessions on computer applications and two sessions on applications in technology. Unfortunately, the session on applications in economy had to be cancelled. The paper of U. Borisson and R. Syding of Sweden on self-tuning control of an ore crusher was a worth-while effort of applying the theory of self-tuning regulators developed by Åström and his associates. The parameters of the ore crusher model are rarely constant. It was, however, shown numerically that the use of exponential forgetting in the parameter estimation performed in the algorithm gives a very good regulator for the crusher. In the sessions on computer applications, some diverse uses of stochastic optimization methods in computer science were presented.

Conclusion

It is impossible for a single author to discuss the whole proceedings as parallel sessions were held. Colleagues have assisted the author in writing on the sessions he could not attend. In the technical sessions only a few lectures have been mentioned. The bias in selection only shows the limited understanding of the other papers. Sincere apologies are offered to those speakers whose names could not be mentioned due to lack of space and also due to lack of confidence in writing about those works which the author did not understand completely. The interested reader can glance through the list of papers presented at the end of this report and decide for himself on the papers of his interest. The preprints of the proceedings are available on request from the following address

"KULTURA",
Hungarian Trading Company for Books and
Newspapers,
1389 Budapest 62,
P.O. Box 149,
Hungary.

The Hungarian hosts organized the symposium very efficiently and were instrumental in making it a success. The chairmen conducted the sessions remarkably well with the aid of able secretaries. On the whole, the symposium was very interesting with many diversified topics discussed, enlightening general lectures presented by renowned authorities and stimulating discussions among the participants. The interest and current activities of the participants indicate the need for holding more conferences on "Stochastic Control" in the future.

STOCHASTIC CONTROL SYMPOSIUM

Budapest, Hungary, 25-27 September, 1974

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