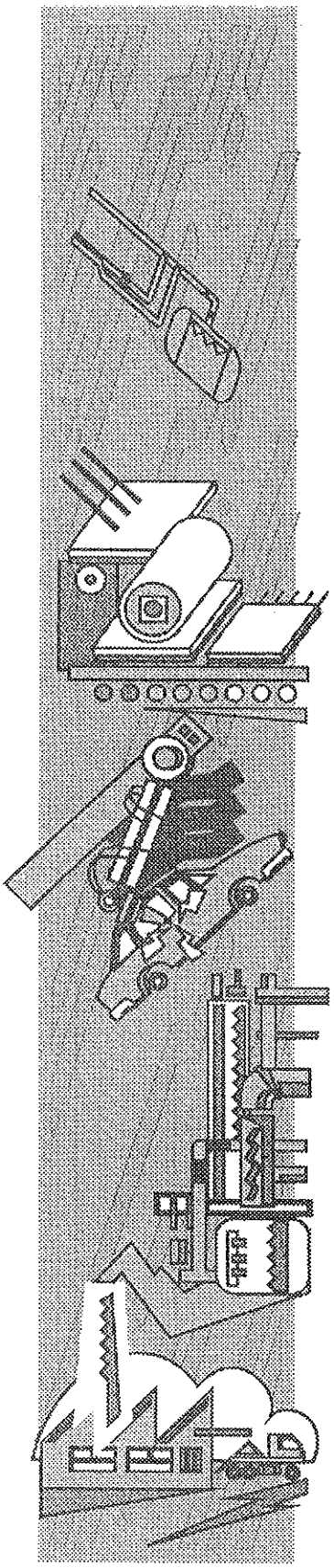

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IRTICS'93

Proceedings

WORKSHOP on Integration in Real-Time Intelligent Control Systems

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Miraflores de la Sierra
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Organized by:

Instituto de Ingeniería del Conocimiento (IIC-Spain)

Aim of IRTICS'93

Nowadays, the necessity of using together several techniques in order to improve the benefits of real-time intelligent control systems has become a constant in most industrial environments. Expert Systems, Neural Networks, Modelization, etc., can solve problems but, in many cases, a solution that partly involves different techniques leads to synergic effects.

So, cooperation among different approaches has become a crucial area of interest in this environment, being the objective to get common frameworks where the best of each technique can be used as effectively as possible.

This certaintity moved us to the present workshop on *Integration for Real-Time Intelligent Control System, IRTICS'93*, that we are sure is a good opportunity of examining many of the possibilities that exist, or will exist, in this direction.

Acknowledgements

It is impossible to mention, in a few lines, all the people and institutions that have made *IRTICS'93* possible: without any of them the present workshop would have been only a nice idea.

Firstly, we should mention the Commission of the European Communities that, through the ESPRIT Programme, has given us the chance of carrying out the HINT project, origin of *IRTICS'93*. Mr. J.M. Gil, Spanish ESPRIT representative, as well as Mr. Renato Campo and Mr. M. Arentoft, have encouraged us to go on this direction when things seemed to be too hard. In his part, Mr. P. Corsi has personally participated in the idea and we are very glad to have him with us at *IRTICS*.

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A very special reference to Mrs. I. Alarcón has to be made. She is working very close to us since a few years ago and, apart from demonstrating a lot of patient, has even interrupted her own work in order to help us at the organization of the workshop.

Also, many other people of our group have helped, starting by Mrs. M. Rey and also Mr. M. Campos, Mr. P. Serrahima, Mr. P. Gómez, Mr. F.J. Alonso, Mr. J.A. Aguilar, Mr. J.M. Domínguez and Mrs. M. Romero. In fixing all the organization details, we have to mention the important support that we have received from Mrs. T. Pertusa and Mrs. E. Morales, and, in the edition of the proceedings, A. Lozano, B. Castilla and B. Peris have also been essential. Without them all, IRTICS'93 would has doubly been possible.

Finally, we have to thank the Universidad Autónoma de Madrid, UAM, for all the help that they have given us, starting by allowing us to use this beautiful place at Miraflores, *La Cristalera*, where *IRTICS'93* is taking place.

We have left the IIC at the end, because we have so much to thank to it, and to Mr. J.L. Becerril, its Director, that we can only say: Thanks again.

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List of Invited Talks

List of Contributions

Real-Time Diagnosis for a Large Gas Turbine Based on a Deep Model of the Controller

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Abstract

The ESPRIT project 6862 TIGER addresses the development of a real-time knowledge based diagnosis system for two gas turbines: a large scale industrial gas turbine and an auxiliary power unit for aviation. The project will combine the qualitative model based with the rule based diagnosis approach.

This paper describes the rule based approach taken in the development of a real-time diagnostic system for a large scale gas turbine. Deep models will be automatically extracted from the deterministic knowledge embedded within the controller ladder logic diagrams. Heuristic knowledge will be extracted from the domain expert and engineering manuals.

1. Introduction

One of the objectives of the TIGER project is to develop a rule based system that continuously acquire data from the gas turbine controller, identify possible malfunctions, search for their cause and suggest corrective actions.

Heuristic knowledge acquisition is the major bottle-neck in rule based system development. It is a time-consuming task to extract knowledge from a domain expert and incorporate it into a large knowledge base. Furthermore, the availability of domain experts impose further restrictions and limitations which may affect the success of the task. Therefore, the TIGER diagnosis system will also use deep models extracted from the process controller ladder logic and control loops. A study has shown that these models contain design and engineering knowledge in a more usable form compared to that held in the minds of the designers themselves [Caldeira-Saraiva 91]. Thus, the objective of this work is to build an automatic translator from ladder logic description language to expert rules that can be used to make intelligent diagnosis of the turbine based on the deterministic knowledge embedded within the Process Control *contact network*.

One of the major drawbacks with classic expert system technology is the prohibitive and often unbounded response time which makes it difficult to meet real-time constraints. The chosen expert system, Kheops [Ghallab 88], tackles this problem by compiling the knowledge at the chaining and control level by rewriting a set of declarative rules into a deterministic network whose traversal gives an upper-bound on the response time of the system. Given the value of all attributes in the input space, a typical Kheops reasoning consists of deducting the value of all attributes in the output space by propagation through the Kheops network.

This papers describes the target process and the knowledge acquisition task.

2. The process

The Fife Ethylene Plant is a 650000 tones a year gas cracking facility located in South East Scotland, and jointly owned by Exxon Chemical Company and Shell Chemical Company. The major product of the facility is high grade ethylene for use in the plastic and butyl rubber industries in both the UK and on the continent. The feed stock is ethane gas obtained from the Shell/Esso off-shore facilities in the North Sea. The process is continuous with the ethylene products being transported by both ship and pipeline top end users in the UK and on the continent. The gas turbine is a 28 mega-watt General Electric Frame Five two shaft supplied by John Brown Engineering, this is used to drive the primary

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