INTELLIGENT SYSTEMS AND HYPERMEDIA

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Background and Mission

The research group operates in the area of applications of fuzzy logic, neural networks and genetic algorithms and applications of hypermedia. All these methods facilitate the use and processing of several kinds of information and knowledge, together with offering possibilities of modelling and imitating a human’s way of controlling difficult processes. The group aims at developing industrial applications that utilise the advantages and possibilities of intelligent methods.

Intelligent methods have been applied in control, modelling and fault diagnostics of several industrial processes and have also been utilised as intelligent sensors in cases where actual measurements are not possible. Example processes are a paper machine, pulp digesting, pulp bleaching, a lime kiln, a TMP refiner, and rotary dryers and granulators used in minerals processing, fermentation processes, and processes in electronics manufacturing and the solar collector field. Hypermedia has been applied mostly for training purposes and in the development of training materials. In this area, Internet offers an excellent dissemination channel nowadays, and research is directed towards its utilisation. Also the use of hypermedia together with simulation, and as a part of the automation system interface, is under research; here once again the training dimension is important.

The group is involved in many international activities. It is actively involved in an ERUDIT Network of Excellence (Membership in the Steering Committee) that concentrates on the applications of fuzzy logic and uncertainty modelling. In addition, the group is participating in a TMR-project (led by Plataforma Solar de Almeria, concerning the control of its solar collector field) and in an ALFA-project (Intelligent Robust Control). Student exchange is carried out with ten European universities.

Scientific Progress

The group has co-ordinated the extensive national Toolmet project, financed by Tekes, which is included in the technology program called “Adaptive and Intelligent System Applications”. The group’s own work has resulted in several contributions. A control system based on linguistic equations has been developed for a rotary lime kiln and tested in the process environment. The dynamic LE simulator was used in the controller tuning. A prototype demonstrating the operation principles for the web break indicator in paper machines has been implemented. A prototype for a real time fuzzy expert system for X-ray solder joint inspection has been developed and tested. Linguistic equa-
tion models for the modelling of continuous digester operation, based on an intelligent cooking liquor analyser, have been generated. A Quality Forecasting Tool (QFT) for electronics production has also been developed and tested.

A co-operative project for hardware realisation of linguistic equation systems has started with the University of Rome “Tor Vergata” and co-operation in the area of designing fuzzy systems has begun with University of Dortmund.

A neural network system for analysing the temperature distributions at the top of a blast furnace was evaluated with the analysis of long-term mill data. A fuzzy control strategy for the quality control of the refiner line was finalised and tested in the process environment. Paper quality modelling with linguistic equations continued together with Tampere University of Technology. Trend analysis methods for a fermentation process were tested. New projects concerning intelligent control of blast furnace and converter processes and fault diagnosis in steel production have been started.

A rotary dryer study has concentrated on modelling the drying phenomena using neural networks and linguistic equations. Different control schemes have been tested in a pilot scale apparatus. This research resulted in one doctoral thesis and one licentiate thesis.

Hypermedia training studies proceeded towards the utilisation of the Internet and the building of a virtual laboratory.

The group arranged the international TOOLMET 99 Symposium in April 1999. The group also arranged a workshop concerning intelligent systems in chemical and biochemical industries in Aachen, September 1999. Special and invited sessions were arranged at the ESIT’99 and EUFIT’99 conferences.

**Exploitation of Results**

The linguistic equation controller of the lime kiln has been developed and tested in a commercial system environment. Commercial exploitation of the fuzzy TMP-plant controller has been finalised. The application generation system based on linguistic equations has been developed towards a toolbox.

A fuzzy system for x-ray testing has been in a continuous use. The product based on the prototype system for analysing the temperature distributions for a blast furnace is also being marketed world-wide.
Future Goals

The linguistic equation system is developing towards a hybrid system structure and will be combined with other approaches. It is already used in nearly all research projects and each application brings along needs for further development. Possibilities for hardware implementations of the linguistic equation approach will be studied in relation to their application to image processing and intelligent sensors. Also new openings are the use of linguistic equations in paper quality modelling (process analysis), in product formulation in pharmaceutics (case based reasoning) and in steel mill fault diagnosis.

New projects started in process control applications will continue. Bleaching control and control of air content in fibre flows are two examples from the paper industry. Blast furnace and converter control, together with smelt shop optimisation and control come from the steel industry. The interest in chemical industry is also increasing.

The research in the future will also be directed to the solving of problems in the electronics industry and the group is starting new co-operative projects there.

The area of hypermedia applications will continue in the direction of Internet applications. The pilot scale rotary dryer of the laboratory will be used in building a training environment involving experiment design, actual process experiments, and the virtual training environment utilising simulation.

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Doctoral Theses


Selected Publications


