Grupo de Control Predictivo y Optimización (cpoh)

Instituto Universitario de Automática e Informática Industrial (ai2)

Universitat Politècnica de València (UPV)

Spain

Summary of scientific and technological capabilities.

1. Presentation

The Predictive Control and Optimization Group (CPOH), is part of the Department of Systems Engineering and Control (DISA) of the Universitat Politècnica de València. Since 1995, the group is active in issues related to Predictive Control and Optimization methodologies applied to process control, mainly using artificial intelligence techniques. Currently, the group's activity is part of the Instituto Universitario de Automática e Informática Industrial (ai2-UPV).

All group members are doctors and professors of the School of Industrial Engineering. Their multidisciplinarity (the group is made up of Computer Engineers, Industrial Engineers and Automation and Industrial Electronics Engineers) gives you great flexibility to address and implement different nature projects in different areas from the point of view of systems engineering and automatic control.

Since this discipline is very horizontal, our research focused on automation, control and process optimization can be applied to solve scientific or technological challenges in different industrial areas. Thus, working in coordination with connoisseurs of the problem and forming multidisciplinary teams, we bring our technology and research results in sectors as diverse as petrochemicals, food, aeronautics and energy.

2. Areas of Research

Application of computational intelligence techniques in systems engineering and automatic control

The tools of artificial intelligence (evolutionary algorithms, fuzzy logic algorithms, etc.) are useful to solve complex problems that arise in the identification, modeling and process control areas and can answer questions about:

- How to optimally tune a multivariable predictive controller?
- How to adjust the parameters of a PID basis of multiple criteria (stability, robustness, performance, implementation ...)?
- How to find the worst case in a simulation to demonstrate that our control system is safe?
- How to know some parameters of our model based on first principles using plant data?
- How to optimally adjust the parameters of an inferential sensor?
- Can you use an evolutionary optimizer to control a process in real time?

In this area the CPOH group tries to demonstrate the feasibility and applicability of these tools to solve engineering problems. Both in the field of process control (advanced control, setpoint optimization, etc.) as in other areas of engineering related to modeling and identification of systems, algorithms and techniques developed allow more robust, manageable and low cost solutions than those achieved by conventional techniques. The variety and heterogeneity of the candidate challenges to solve, involves using the latest methodologies based on Evolutionary

Algorithms using techniques of parallel computing for implementation when the computational cost of the problem is high.

Model Based Predictive Control

Model Predictive Control (MPC), also known in the industry as multivariable control or advanced control is a control strategy that has been imposed in recent decades in the process industry as the best option for controlling a process with multiple inputs and multiple outputs satisfying a set of operational constraints. Linear MPC strategies, including in various commercial products are being successfully applied in recent years. Existing challenges are the design of algorithms to apply this technology to nonlinear processes, using nonlinear models for optimal process operation throughout its operating range.

On the other hand, outside the classical process industry (chemical, petrochemical, pharmaceutical, etc), the challenge is to implement these control techniques to other processes quite faster dynamics (robotics, avionics, space, etc.) where the speed of calculation of control actions is critical.

The CPOH group researches in developing new control MPC algorithms, always with the aim that they are applicable on the basis of:

- Improved calculation time predictive control algorithms.

- New methods of optimization applied to predictive control.

- New modeling techniques oriented to predictive control.

Multi-objective optimization techniques and systems for decision support

In many areas of engineering, the realization of optimal designs is now seeking a compromise between all the specifications that are to be met simultaneously. Engineering problems then become multi-objective optimization problems, where there is no single solution but a set of solutions in which each has advantages over the other, but where none is better in every aspect. Ultimately it is the designer who must opt for one of the possible solutions in line with their preferences in design.

The CPOH group researches in developing new multi-objective optimization algorithms based on artificial intelligence, new methods for the treatment of constraints and new systems to aid decision making. In this context the objectives of research and development that arise try to cover all aspects that make up a solution to a multi-objective problem:

- Development of new algorithms based mainly on evolutionary techniques or hybridizing these with conventional optimization techniques.

- New systems for decision support engineering design problems. Development of new mechanisms to include designer preferences in the optimization process. Development of tools "a posteriori" to assist the selection of solutions.

- Development of tools for analysis and visualization solutions of multiobjective problems.

3. Scientific and technological skills

We list below a number of capacities, both scientific and technology with which we can support you as a partner in the development of projects of Technological Innovation and R & D:

Development of systems for monitoring, measurement and control:

• Design of industrial automation systems.

• Programming of SCADA systems for supervision and monitoring of industrial processes.

• Development of distributed systems based on fieldbus and industrial automation systems.

• Tuning and adjustment of industrial PID controllers and MPC controllers (DMCplus-Aspen)

• Design of measurement and process monitoring.

• Design of measurement systems and equipment based on National Instruments Control: PXI and CompactRIO platforms.

• PLC programming: OMRON, Siemens, Telemecanique, etc.

Design, specification and development of software:

• Developing Applications with Matlab / Simulink.

• Developing Applications with NI-LabVIEW.

• Development of systems "Hardware in the Loop" (HIL) based on Matlab / Simulink, NI-LabVIEW and NI-VeriStand. Dynamic Simulation in Real Time.

• Development of applications in C / C ++.

• Developing client / server applications with Python and JavaScript.

Design and implementation of embedded systems (hardware / software):

• Design based on low-cost platforms (RaspberryPI, Arduino, BiggleBone, etc) systems.

- Design systems based on ARM platform.
- Design based on PC-104 platform systems.

Development of advanced control algorithms for industrial processes:

- Model-Based Predictive Control.
- Intelligent control systems (Genetic Algorithms, Neural Networks, Fuzzy Logic, etc).
- Applications for real-time control.

Development of algorithms for modeling, simulation and identification of processes and systems:

- Modeling and simulation of industrial processes.
- Identification of parametric models based on first principles.

Development of optimization algorithms to solve engineering problems:

- Optimal adjustment of design parameters (mechanical design, recipes, etc)
- Optimal operating point selection for industrial processes
- Optimization systems based on artificial intelligence: Genetic Algorithms, Differential Evolution.
- Multi-objective optimization algorithms for engineering problems.

4. Contact information.

You can find more information about ongoing projects, along with contact information on our website:

http://cpoh.upv.es/en