Restyling CPCLAB:
How to enhance our Chemical Process Control LABoratory

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A process control laboratory is a facility dedicated to studying and experimenting with the control of industrial processes by providing students and researchers with hands-on experience in various control techniques, from basic feedback loops (like PID) to advanced strategies (like model predictive control, MPC). A comprehensive process control laboratory should include both hardware devices and software tools. It is concerned with various key features: theoretical aspects, such as process modeling and simulation, control system analysis, advanced control strategies; practical experiences with instrumentation, real-world applications, and PLC and SCADA integration.

The present work gives a brief overview of the recent actions of our research group at University of Pisa aimed at enhancing our long-standing Chemical Process Control LABoratory (CPCLAB). Our lab aims at strengthening the theoretical knowledge acquired by students within the courses of basic and advanced process control in Chemical Engineering MSc program. Students analyze the dynamic behavior of processes and controllers, understanding how different control strategies affect system performance. Advanced techniques like MPC, neural networks, optimization, and soft sensors are widely investigated. Finally, CPCLAB is the venue in which MSc and PhD students carry out the research activities related to their thesis.

CPCLAB provides students with a wide set of up-to-date simulation software tools to model different processes and controllers, allowing them to experiment with different algorithms in a safe and controlled environment. The most used licensed programs are: UniSim Design for rigorous process simulation and control, SimaPro for life cycle assessment and sustainability analysis, and PowerFactory for electrical power systems.–In addition, MPC-code and SIPPY are our two open-source Python toolboxes, oriented to model predictive control and system identification, respectively. They are now widely applied and tested, and they promoted international academic collaborations, such as the EU projects FrontSeat and DAEDALOS.

Hardware is still on the way, as we are just acquiring a set of educational devices to let students have practical experiences in designing, implementing, and tuning controllers for various processes. This will also give students the opportunity to learn about sensors, actuators, and other common instrumentation. It is evident that CPCLAB cannot provide direct real-world scenarios, but the investigated techniques are applied to test-bench industrial processes. The integration with industrial PLCs and SCADA systems for process control, automation, and data acquisition remains beyond our current scopes. Nevertheless, students may learn these aspects by visiting and operating the pilot plant *IdroLab* located in Cecina at Consorzio Polo Tecnologico Magona.

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