

## Unified Control Technology Changes the Game

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### Summary

Unified Control Technology Corporation, headquartered in Princeton, New Jersey, is developing a new generation of advanced process control (APC) technology that is well-suited for a wide range of processes, including renewable energy production. In particular, Unified Control Technology

UCT offers a new unified MPC that uses PV-based MPC to overcome the limitations of traditional setpoint method of MPCs. The MPC permits both the regulatory controllers and the advanced controllers to operate in harmony. The new controller is modular in nature and can be networked for both hierarchical and distributed control of an entire production chain. In addition, the controller is capable of complete cycle control from startup, to normal operations and shutdown.

(UCT) improves the reliability of production and energy efficiency, while reducing the cost to implement and maintain APC. In fact, UCT boasts that it can potentially increase benefits by 50 percent, while reducing the cost of APC deployment and maintenance by as much as 50 percent in terms of time and manpower.

UCT's approach represents a ground-up makeover of the design and use of APC. The company uses a process value-based model predictive control (PV-MPC), called Core Process Models, to overcome the shortcomings inherent with current setpoint-

based MPC technology. UCT offers a unified MPC solution that requires minimal plant testing and is free of both PID tuning effects and model-dependent tuning. Consequently, the modular robust MPC (MR-MPC) application is easy to design, build, implement, and maintain.

In addition, UCT's modular MPC can be networked for both hierarchical and distributed control for an entire production chain. This allows complete cycle control from start up, to normal operations, to shut down.

### APC Provides Exceptional Value, But...

Most companies recognize the value that APC delivers to their bottom lines. In fact, APC users claim that it provides the best value of any advanced application. Companies now deploy APC throughout their organizations at an accelerating rate. This rapid growth in popularity is a



testament to its benefits. Many companies are expanding their use of the technology by applying it to a wider range of applications; including smaller applications that were difficult to justify in the past.

Not surprisingly, the heavy process industries, where the technology was first developed for process manufacturing, are the most prevalent users. However, other industries are adopting APC quickly to improve their operations as well.

### **Too Much of a Good Thing**

Despite the rapidly growing adoption, many issues related to traditional APC remain problematic. For instance, the technology still requires significant domain expertise to implement and maintain. As the number of deployments increases and the number of skilled workers decreases, it is getting more difficult for companies to maintain the required level of domain expertise to support and sustain its advanced applications.

In addition, current APC technology has some inherent limitations due to the nature of its design. Traditional APC technology is sensitive to process changes, disturbances, and equipment degradation that cause its performance to diminish after initial implementation. Without substantial effort to vigilantly monitor, tune, update, and revamp, the application falls into disuse.

### **Current APC Technology Shortcomings and a New Approach**

APC, as practiced today, is still reminiscent of the practices of last 30 years in terms of piecemeal solutions involving PID controllers and, more recently, model predictive controllers. Current APC technology is built on a foundation of regulatory controllers, mainly PID controllers. The current state of APC represents a struggle between how to design and operate regulatory control loops and how to develop and operate MPCs that use them. Presently, no clearly defined method overcomes the differing requirements of these two control levels. Consequently, for every MPC project, inevitably two conflicting choices arise as to open up or not to open up one or more PID control loops. Each choice involves a cost/benefits decision and, in practice, it is not always easy to ascertain the optimal choice.

UCT resolves this difficult decision with its unique method of unifying the two control levels. UCT allows a regulatory control loop to remain intact and at the same time embed it within its open control architecture. This permits the regulatory control loops to continue to perform disturbance

rejection at the fastest frequency closest to the source, while ensuring that the process value and the set point do not deviate due to control valve saturation. This has the added benefit in that the unmeasured disturbance effects get compensated closest to the source and eliminate the propagation of model mismatch error beyond the regulatory control loops. Additionally, embedding the regulatory control loops prevents internal breakdown of models used in the MPC. This improves the quality of control and stability of operation.

The current combined PID-MPC layered system approach has inherent limitations in that at or near control valve saturation, MPC will induce instability due to model mismatch. Despite efforts to linearize valve behavior near saturation, an MPC will fail to predict control variables reliably because of unmeasured disturbances. Consequently, the control valve remains saturated and during this time, the MPC is predicting future controlled variables values with essentially a broken model. With this kind of model mismatch error and persistent deviation of the regulatory control loop process value from its set point, the MPC will make inconsistent and large moves just when small and consistent moves are needed.

In contrast, the unified method of solution incorporated within UCT permits both the regulatory controllers and the advanced controllers to operate in harmony, allowing each to perform what it does best. This allows the regulatory controller to remain near its setpoint and the MPC to operate without internally broken models. UCT includes its own built-in method of tracking the setpoint to the process value whenever the control valve saturates; the controller doesn't rely on external anti-windup control actions.

UCT's method of control unification is generic and independent of the method of regulatory controller, thus allowing the use of existing PID controllers. The method of unification permits both the regulatory controller and the MPC to operate within their respective scope and without negatively impacting each other whenever either experiences a limit violation. However, for improved performance, UCT includes its own embedded regulatory controllers. In addition, UCT can retrofit and unify existing MPC and regulatory controllers.

More importantly, UCT's modular MPC can be networked for both hierarchical as well as distributed control for an entire production chain. UCT provides a unique method of stabilizing processes of any size and complexity by including an explicit stability criterion within its MPC. The stability

criterion is generic and independent of process and therefore can be used to network them together, while retaining the same stability characteristics and without requiring a change in tuning.

UCT delivers additional capabilities that include complete cycle control from start up, to normal operations, to shut down. With its unique asymmetrical control actions, production rate can be accelerated to the maximum value for safe and on-spec product quality control. However, in response to process upset conditions and/or shutdown, the production rate can be decelerated quickly and safely, just as you can apply the brakes to slow down an automobile. These additional capabilities arise from extended application of the basic elements of the technology. As another instance of these additional capabilities, UCT can help reduce alarms by applying predictive alarming control by avoiding future dynamic violation from within its MPC.

### **Last Word**

UCT offers a new MR-MPC that uses Core Process Models to overcome the limitations of traditional setpoint method of control models. An obvious benefit of the Core Process Models is that they tend to remain linear much more so than SP-based models, as they are not affected by nonlinear control valve action. More importantly, the use of Core Process Models in conjunction with embedded regulatory controllers eliminates propagating model mismatch errors from unmeasured disturbance effects beyond the regulatory control level. As a result, model mismatch error of non-regulatory control-related variables, such as product quality, is unaffected and improves overall controller performance.

UCT's modular MPC (MR-MPC) can be networked for both hierarchical and distributed control for an entire production chain. The additional capability of complete cycle control, from startup to shutdown, is an attractive feature that many manufacturers will find compelling.

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