



Controleum – an independently extensible control system

While the extensibility of many software systems has been greatly improved during the past two decades, non-trivial control systems remain to be a category of software systems that are remarkably difficult to design for independent extension.

Support for independent extension is the ability to introduce a new component without performing a global integrity check. Avoiding a check relies on anticipating, what kind of extensions are required in the future and designing a suitable interface and coordination mechanism, so that conflicts among mutually unaware components can be resolved automatically. Typical control system components, are concerned with the way in which actuators are controlled. Combining mutually unaware control system components that share interest in the same actuators, are likely to lead to complex conflicts, thus making control systems a particularly challenging kind of system to design for independent extension.

This thesis presents two new software technologies, that may help improve the extensibility of control systems: First the concept of dynamic links is introduced and Decouplink, an implementation of dynamic links for Java, is presented. Dynamic links allow objects to be connected, even though their types are not related. Without compromising independent extensibility dynamic links allow for new kinds of extensions, that are not possible using traditional object-oriented programming.

Second the concept of an extensible controller is introduced and an implementation is presented. The extensible controller is a software component designed to automatically resolve conflicts among mutually unaware components in a control system. The solution is based on the idea that independent components implement different kinds of control concerns. Hard concerns are constraints that must always be met, while soft concerns describe desirable goals, that may be prioritized by the systems user. The extensible controller uses a genetic algorithm to continuously resolve conflicts among independently developed control concerns.

Both new software technologies are used to design and implement Controleum – an extensible control system for climate control in greenhouses. It is shown that Controleum can be independently extended with support for new climate control requirements.

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