Control Theoretic Approaches for the Harvesting of Idle Computing Resources

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Résumé

When Control Theory technique were used for decades to control industrial plants, it is now used for the regulation of high performance computing systems (HPC). The complexity of HPC systems, runtime variations and unpredictability, coupled with the dynamic nature of computing tasks that constantly come and go, require cautious runtime management to better use the computing resources and guarantee an acceptable Quality-of-Service to the end users. Such a regulation problem arises in the context of the computing grid middleware CiGri, that aims at harvesting the idle computing resources of a set of clusters by the injection of low priority jobs. In this work, we present the system along with the sensors and actuators used to maximize the cluster utilization by submitting low priority jobs to the unused resources, and control the file server's load in the presence of external disturbances. Then, we give an overview of the controller designs used in previous works : a simple proportional-integral controller (PI), Adaptive PI, and Model-Free Controller (MFC). All these techniques differ in their nominal performance, precision, setup complexity, guarantees, robustness, disturbance rejection and competence in control required for system administrators to use them. Therefore, each of these methods will be compared and evaluated based on this criteria. Finally, we present our contribution of a feedfoward approach in addition to the feedback loop for a better disturbance rejection, performance and use of the computing power.

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