Abstract

Today, many embedded or cyber-physical systems, e.g., in the automotive domain, comprise several control applications, sharing the same platform. It is well known that such resource sharing leads to complex temporal behaviors that degrades the quality of control, and more importantly, may even jeopardize stability in the worst case, if not properly taken into account.

In this thesis, we consider embedded control or cyber-physical systems, where several control applications share the same processing unit. The focus is on the control-scheduling co-design problem, where the controller and scheduling parameters are jointly optimized. The fundamental difference between control applications and traditional embedded applications motivates the need for novel methodologies for the design and optimization of embedded control systems. This thesis is one more step towards correct design and optimization of embedded control systems.

Offline and online methodologies for embedded control systems are covered in this thesis. The importance of considering both the expected control performance and stability is discussed and a control-scheduling co-design methodology is proposed to optimize control performance while guaranteeing stability. Orthogonal to this, bandwidth-efficient stabilizing control servers are proposed, which support compositionality, isolation, and resource-efficiency in design and co-design.

Finally, we extend the scope of the proposed approach to non-periodic control schemes and address the challenges in sharing the platform with self-triggered controllers. In addition to offline methodologies, a novel online scheduling policy to stabilize control applications is proposed.