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Title: Towards Safe and Reliable CPS: a Learning-based Distributed Fault-Diagnosis Approach

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Abstract: Cyber-physical systems (CPS) are characterised by extensive distributed and multi-layer integration of computation and networked physical capabilities. CPS are thus ubiquitous in the current and future "distributed world" made by countless "nodes", which can be cities, computers, people, etc., and interconnected by a dense web of transportation, communication, or social ties. The term "network", describing such a collection of nodes and links, nowadays has become commonplace thanks to our extensive reliance on "connections of interdependent systems" in our everyday life, for building complex technical systems, infrastructures and so on. In an increasingly "smarter" planet, it is expected that such interconnected systems will be safe, reliable, available 24/7, and of low-cost maintenance. Therefore, health monitoring and fault diagnosis are of customary importance to ensure high levels of safety, performance, reliability, dependability, and availability. For example, in the case of industrial plants, faults and malfunctions can result in off-specification production, increased operating costs, production line shutdown, danger conditions for humans, detrimental environmental impact, and so on. Faults and malfunctions need to be detected promptly and their source and severity should be diagnosed so that corrective actions can be taken as soon as possible.

This lecture deals with an adaptive approximation-based distributed fault diagnosis approach for large-scale nonlinear systems, by exploiting a "divide et impera" approach in which the overall diagnosis problem is decomposed into smaller sub-problems, which can be solved within “local” computation and communication architectures. The distributed detection, isolation and identification task is broken down and assigned to a network of "Local Diagnostic Units", each having a "local view" of the system. These local diagnostic units are allowed to communicate with each other and to cooperate on the diagnosis of system components that may be shared or interconnected. The peculiarities of CPS and the way they present new challenges in the development of distributed fault diagnosis schemes will be discussed.