Design of Cyber-Physical Systems

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Overview

Until the late 1980s, information processing was associated with large mainframe computers. Later, office applications started to be dominating. More recently, miniaturization also enabled the integration of information processing and the physical environment using computers. This is reflected in the introduction of the term ``Cyber-Physical Systems'' (CPS). They can be defined as **integration of computation and physical processes**. The same term has also been used to denote connecting information about physical objects to the internet, a combination also called the ``Internet of Things'' (IoT). It is expected that most future applications of information technology will be CPS/IoT-related. In contrast to classical office applications, CPS/IoT-applications cannot be designed by considering only software issues. Rather, there will be a complex interaction between the physical environment, the hardware platform and the software running on it. Mechanical, energy, thermal, security and safety issues have to be considered. Understanding these interactions requires knowledge beyond classical software design.

This course aims at providing knowledge on such interactions, in this way tearing down walls between departments. The course includes an overview of modeling techniques for CPS/IoT systems, the mapping of applications to execution platforms, the evaluation of (partial) designs and some outstanding characteristics of CPS/IoT hardware and software execution platforms. A few advanced systems will be presented toward the end of the course.

Course participants will learn these topics through lectures as well as case studies. Some assignments will be shared to stimulate research motivation of participants.

Modules	A. Introduction: Scope, opportunities & challenges of cyber-physical systems (CPS) B. Modeling: requirements, models of computation, early phases, hybrid systems, timed automata, C/E nets, Petri nets and data flow, Discrete event systems, imperative styles, communication libraries, Ptolemy, UML, other modeling paradigms, Special requirements for CPS hardware: battery models, security issues. C. System software: embedded operating systems, resource access protocols D. Design evaluation: Pareto-optimality, quality of results, real-time calculus, worst case execution time estimation, energy modeling, thermal modeling, dependability, other objectives E. Mapping to platforms: scheduling algorithms for single cores, independent jobs on multiple cores, jobs with precedence constraints (list scheduling, HEFT, integer linear programming, genetic algorithms)

	F. Optimizations: Scratchpad allocation strategies, Worst-case execution time aware optimization G. Full systems: research results on fault tolerance in real-time systems, research results of the cooperative research center SFB 876 on resource constrained machine learning (bio virus detection, model based optimization for cancer medication prediction) **Number of participants for the course will be limited to fifty.**
You Should Attend If…	you are a graduate and havecleared first level courses in Data structures & Algorithms, Computer architecture and Operating systems
Fees	The participation fees for taking the course is as follows: **Participants from abroad : USD 500** **Industry/ Research Organizations: Rs 15000/-** **Academic Institutions: Rs 5000/-** The above fee includes all instructional material and free internet facility. The participants will be provided with accommodation on payment basis if available.

Prof. Peter Marwedel is a Professor at the University of Dortmund. He is one of the early researchers in high level synthesis, working on MIMOLA system for a number of years. He has taught and published extensively in Embedded Systems Design.

Prof. M. Balakrishnan is the Deputy Director and Professor of Indian Institute of Technology Delhi. His research interests are in Assistive Technologies, Embedded System Design, EDA and System Level Design and FPGA based Accelerators.

Dates:
12th Feb. (Monday) to
20th Feb. (Tuesday), 2018
Time:
3:30 PM to 5:00 PM
Venue: IIT Delhi
(Room to be announced)

Course Co-ordinator
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