Teaching Model-Based Design at Politecnico di Torino

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The speaker

- Associate Professor
  Politecnico di Torino
  Dip. di Automatica e Informatica
- Electronic CAD & Reliability Group
  www.cad.polito.it
- Focus: design and validation of dependable embedded systems
- Cooperates with:
  - Magneti Marelli, GM Powertrain Europe, TRW, IVECO, ...
  - European Space Agency, Thales Alenia Space, EADS, ...
The starting point: Torino 2011

- Compelling demand of engineers with basis on:
  - Model-based design
  - ISO 26262
  - AUTOSAR

- Limited answer from university:
  - Software Engineering
    - Knowledge of processes but not ISO26262
  - Specification and Simulation
    - SystemC, VHDL, but no Simulink/Stateflow
  - Automatic Control
    - MATLAB/Simulink, no code generation
The idea

- Master course on Model-Based Design, ISO 26262, AUTOSAR
- Focus on embedded software for automotive
- Target: Master students in Computer & Electronic Engineering
- Key elements:
  - Theory + Practice
  - Link with local industries
Link with local industries

Model-Based Software Design

Training Graduates Know-how

Technical skills Thesis/Internships Research demand

Industry X
Outline

- Course organization
- Case Studies
- Results
- Conclusions
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Course organization

- II year Master program in Computer & Electronic Engineering
- Optional course
- Effort: 6 credits (60 hours)
  - 4.5 hours/week lectures
  - 1.5 hours/week labs
- Topics:
  - Model-Based Design: 25 hours
  - ISO 26262: 15 hours
  - AUTOSAR: 10 hours
  - Seminars from industry experts: 10 hours
Course organization (cont. ed)

- Model-Based Design – Theory
  - Modeling of control algorithms

- Verification and Validation
  - Simulation (model-in-the-loop, software-in-the-loop, hardware-in-the-loop)
  - Formal verification

- Floating Point to Fixed Point conversion

- Automatic code generation
Course organization (cont. ed)

- Model-Based Design – The lab
  - Modeling → Simulink/Stateflow
  - Floating point scaling → Fixed-Point Designer
  - Code generation → Embedded Coder
  - Hardware validation → Freescale/Cypress evb

- Mandatory element to complement theory
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Electronic Parking assistant

- A system has to be designed that tells the drivers the distance of obstacles following the car. A proximity sensor is used to model a radar

Distance indicator
8 LEDs, the number of lighted LEDs grows while the distance decreases
Hw used for the case study

- Cypress Semiconductor PSoC 5 FirstTouch Kit

![Diagram of the FirstTouch Kit with labels for Proximity sensor and Distance indicator.]

MATLAB Virtual Conference 2014
What students do

- Design using the standard automotive development flow: V model

**System modeling**
Simulink/Stateflow

**MATLAB/Simulink**
provide effective support for all the phases of the V model

**Code generation**
Embedded Coder+PSoC Creator

**PSoC5 FirstTouch**
Implementation

- AUTOSAR-like structure

- Application Logic
  - Basic Software
    - Scheduler
    - Proximity Sensor API
    - LED API

- Hardware

Generated automatically by Embedded Coder
Developed manually
Custom drivers generated automatically by Cypress PSoC 5 Creator
System Model

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Autonomous emergency brake

- Develop a system that automatically brake the car when an obstacle is detected. A line scan sensor is used to model a front view camera.
Hw used for the case study

- Freescale Cup electric car kit

- Chassis+servo+motor
- Line scan camera
- Freedom board + motor shield
- Propulsion ctrl
- Steering ctrl
- Road image
Implementation

- AUTOSAR-like structure

- Application Logic

- Basic Software
  - Scheduler
  - Motor control API
  - Camera API

- Hardware

- Generated automatically by Embedded Coder
- Developed manually using Freescale CodeWarrior
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Interest from industries/students

- Automotive firms
  - 4 seminars/year
  - 16 MS thesis
    - 6 in progress
    - 10 newly employed

- Students
  - Growing number of enrolled students
  - 5x times the num. of students of similar courses
Outline

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Conclusions

- The course fills a gap in the ICT engineering curricula at Politecnico di Torino:
  - Excellent impact on students
    - Lab is crucial
    - Lectures are recorded and set available via streaming
  - Very promising feedback from local industries
- Key collaborations with:
  - The MathWorks
  - Freescale University Program/Cypress University Alliance
  - Local industries