Functional Design-Prototyping using OpenModelica

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Outline

1. Introduction
2. Functional Design-Prototyping
3. Road Map for Functional Prototyping
4. Summary and Outlook
Product-Design in Engineering Education

- interdisciplinary student project to develop excavator control devices
- combine product design, machine simulation, media design and rapid prototyping facilities
- very inspiring and instructive for all parties involved

... even for OpenModelica
FUNCTIONAL DESIGN-PROTOTYPING
Designing an Interactive Product

**Functionality**
- requirements
- variants
- validation

**Appearance**
- shape
- visual and haptic

**Experience**
- comfort
- familiarization
Comprehending Design

**Functionality**
- simulation
- physical prototypes

**Appearance**
- sketches, drawings
- models, mockups

**Experience**
- interactive simulator

Design-Prototyping has to be **fast**, **easy**, **cheap** and **meaningful**!

... interactive simulators are complex, costly and extensive.
How can the development of interactive (driving)-simulators for rapid prototyping be accelerated, cheapened, and simplified?
ROAD MAP FOR
FUNCTIONAL PROTOTYPING
Rapid Simulator Prototyping - Ingredients

- Design Prototype
- \( \mu \text{C, Sensors} \)
- Input Signals
- Modelica_DeviceDrivers
- Functional Model
- OMC Visualization
- Visualisation
- the user
Physical Device Prototyping

- Rapid Prototyping is cheap, fast and widely-used
  - 3d-printing, laser-cutting, CNC-milling

- Makerspaces offer public access to machinery

- Free CAD software
  - educational licenses at your institute
  - FreeCAD  [http://www.freecadweb.org](http://www.freecadweb.org)
Sensor Concept

- electronics
  - basic sensors
  - control elements

- low-budget μC-boards
  - Arduino, Raspberry Pi

- Communication
  - USB, Bluetooth
Sensor Signals as Model Inputs

https://github.com/modelica/Modelica_DeviceDrivers

Road Map for Functional Prototyping

read serial port
store byte message as external object
deserialize message
type casting
scaling
synchronize realtime (optional)
Modelica_DeviceDrivers and OMC

- Efforts to get serialPort and packager running:
  - ExternalObject alias-detection and substitution
  - Linking external libraries under windows
  - String parameters for external constructors for FMUs
  - Avoid multiple evaluation due to flattened equations
  - Fixes in M_DD
Visualisation

- OMEdit visualization feature based on scene description file *visual.xml*
- Visualization of MSL – multibody shapes (basic shapes, dxf, stl)
- Result Files (mat, csv) and realtime synchronized FMUs(me 1.0/2.0)
Road Map for Functional Prototyping

Visualisation

![Graphical representation of functional prototyping roadmap]
Proper Visualisation

... needs a tool that is designed for graphic application.

www.unity3d.com
Proper Visualisation
Recap the Ingredients

- **Design Prototype**
- **Input Signals**
- **Visualisation**
- **Functional Model**

**Flowchart Diagram**:
- The user connects to **Design Prototype**
- **μC, Sensors** feeds into **Input Signals**
- **OMC Visualization** connects to **Functional Model**
- **Modelica_DeviceDrivers** feeds into **Input Signals**

**Road Map for Functional Prototyping**

- **Linköping 06/02/2017**
- **Functional Design-Prototyping**

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**Technical UNIVERSITY DRESDEN**

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Recap the Ingredients
SUMMARY AND OUTLOOK
Summary

- successful, interdisciplinary student project at TU Dresden
- enhancements for visualization and partial M_DD support in OpenModelica
- FMU-based toolchain for rapid simulator setup
Outlook

- support M_DD in OMC
- work on realtime features
- enhance FMU-based visualization
- interactive simulations for teaching
- nice visualization
... or old-fashioned arcade games:

https://github.com/vwaurich/ModeliPong
Thank you for your attention.

Thank you OM-developers for your support.

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