Design of Mechatronic Systems and Benefit of Open Source Software Tools

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Mechatronic Design

Mechatronic design
is already described …

… in VDI guideline 2206

V Model

FOSS

Free and

Open

Source

Software

(Bruce Perens, Eric Raymond 1998)

e. g. Linux, Firefox, Thunderbird, OpenOffice, …

MATLAB/Simulink

Company The MathWorks, Inc.

Web http://www.mathworks.com/

Price on request, students version ~70,00 €

MATrix LABoratory – MATLAB

M scripts to be executed as *.m file

Also symbolic calculation (CAS) possible

SIMULINK

Graphical input of block diagrams, stored as *.mdl file

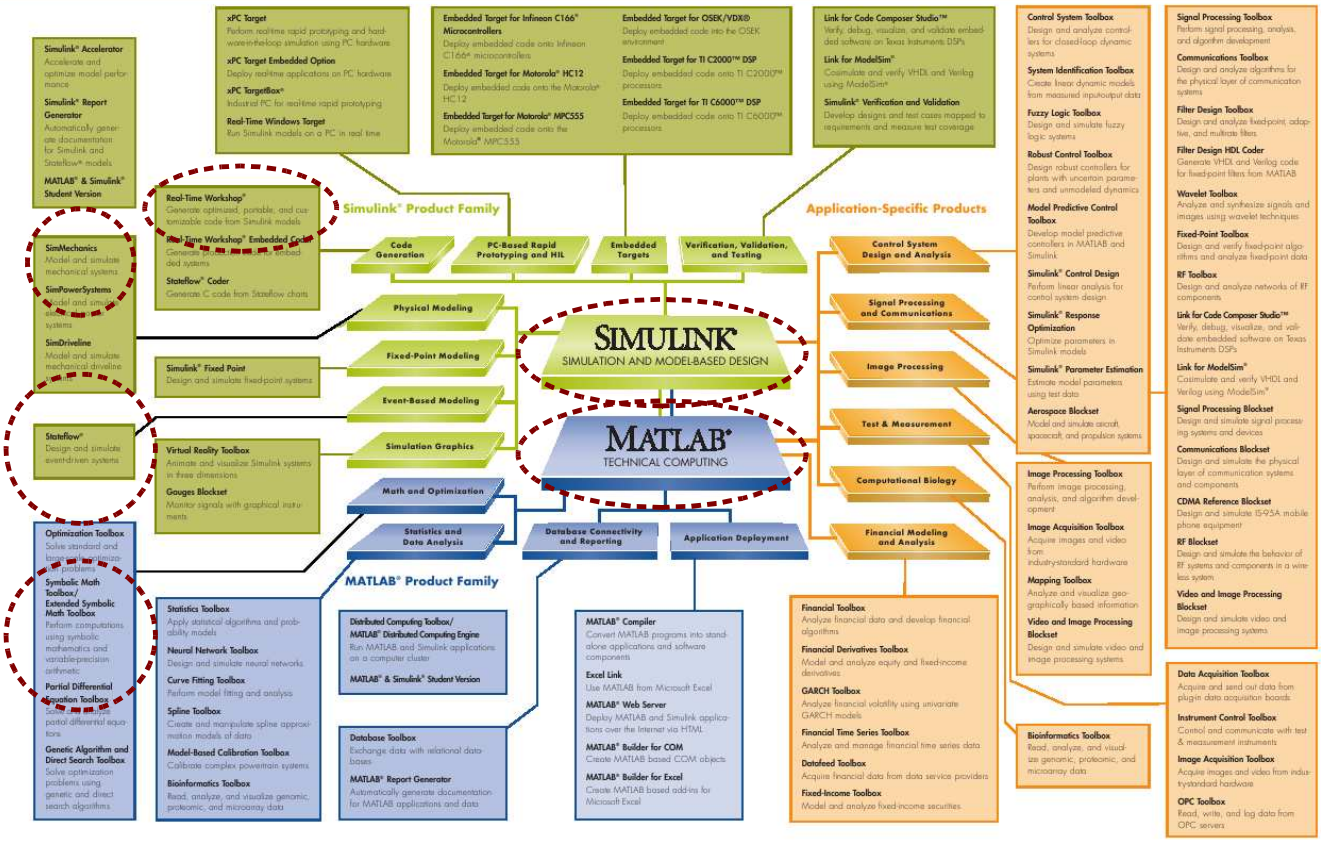
mdl-file can be called in M script

RTW Real Time Workshop

Compilation to real-time models for different processors/ microcontrollers and for different operating systems or run-time systems

“The MathWorks delivers a complete set of tools for modelbased design of control systems – from the development of concepts to the application of software in embedded systems.”

The MathWorks Product Family Overview



National Instruments: LabVIEW

Company National Instruments Corp.

Web http://www.ni.com/labview/

Price from 1.249,00 €, student version from 24,95 €

LabVIEW, Real-Time, PDA, FPGA, Embedded

- Graphical input of block diagrams, stored as *.vi file
- Data acquisition, controlling devices online
- Easy design of graphical user interfaces GUI
- Compilation of real-time models for different processors or microcontrollers and for different operating systems or runtime systems, embedded systems

Questionnaire

Questionnaire made 2005 – 2007 by
VDI/VDE GMA, Technical Committee Mechatronics

Most used tools	Manufacturer	Type
MATLAB/Simulink	The MathWorks	Multidomain simulation
Dymola	Dynasim	Multi-domain simulation
dSPACE	dSPACE	RP/HiL hardware target
EAGLE	CadSoft	PCB design
ANSYS Multiphysics	ANSYS	Finite element method
AMESim	LMS International	Multidomain simulation
OrCAD	Cadence	PCB design
Adams	MSC Software	Multi body simulation
ASCET-MD, -RP	ETAS	Code generation, modelling, design, code generation
CarSim	Mechanical Simulation	Car simulator
Catia V.5	Dassault Systèmes	Product design
CarMaker	IPG Automotive	Testing and developing
SimulationX	ITI	integral interpretation of mechatronic systems

Commercial and Open Source

- All called software tool are commercial programs with the benefits:
  - (Very) Good professional support
  - Broad use in industry
  - Further development will be done
  - Libraries available
  - Warrantee is understood
- Open source software can give us some advantages:
  - No runtime license costs
  - inexpensive development tools
  - Open source code allows to be verified from anyone
  - Open source code can readily be used in future projects
  - Further development with other suppliers easily possible, no dependence on a certain supplier

Open Source Automation Development Lab

The goal of the Open Source Automation Development Lab (OSADL) is to promote and support the usage of open-source software in the context of machine and plant control systems. In principle, it aims to support these industries in a similar manner the Linux Foundation supports industries that provide carrier grade, data center, desktop and mobile systems.

http://www.osadl.org/

Among others, OSADL is acting as a “purchase community”: The membership fees are used to delegate the development of Open Source software projects the majority of members is requesting or at least agreeing to. Current projects center on Realtime and Safety Critical Linux, on Board Support Packages, on an RTDM compatibility layer and many other topics relevant for the automation industry.

Octave

Author John W. Eaton

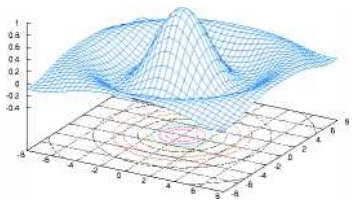
Web http://www.octave.org

Price free

GNU-Octave

Scripts can be executed as *.oct or *.m file (compatible to MATLAB *.m file)

No graphical input



Characteristics

“GNU Octave is a high-level language, primarily intended for numerical computations. It provides a convenient command line interface for solving linear and nonlinear problems numerically, and for performing other numerical experiments using a language that is mostly compatible with Matlab. It may also be used as a batch-oriented language.”

Scilab/Scicos

Organization INRIA, The French National Institute for Research in Computer Science and Control

Web http://www.scilab.org

Price free

Scilab

Scripts can be executed as *.sci file (not compatible to MATLAB)

Scicos

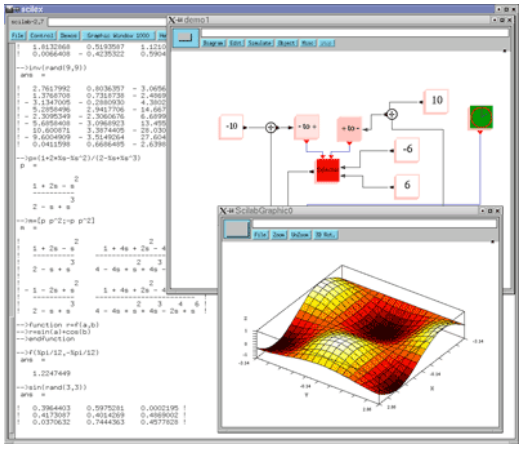
Graphical input of block diagrams, stored as *.cos file (not compatible to Simulink's *.mdl file)

COS file can be called in SCI Script

Multi domain simulation is under development

Scilab and C compiler system

“Like Visual Studio, Scilab version 3.0 gives a pre-configured environment to use the lcc-win32 C compiler system (free for non-commercial use).”



Ptolemy II

Organization University of California at Berkeley

Web
http://ptolemy.berkeley.edu/ptolemyII/

Price free

Characteristics

“The focus of Ptolemy is on component-based design. The philosophy of this project is centered on using different models of computation and developing an environment that allows the mixing of these models of computation to create a heterogeneous application.

Ptolemy is a polymorphous modeling tool used for the simulation of embedded applications.”

Implemented domains

- CT: continuous-time modeling
- DDF: dynamic dataflow
- DE: discrete-event modeling
- FSM: finite state machines and modal model
- PN: process networks with asynchronous message passing
- Rendezvous: process networks with synchronous message passing
- SDF: synchronous dataflow
- SR: synchronous reactive
- Wireless: wireless

JVisu

Organization Community, Pengutronix e.K.

Web
http://sourceforge.net/projects/jvisu
http://www.pengutronix.de/software/jvisu/

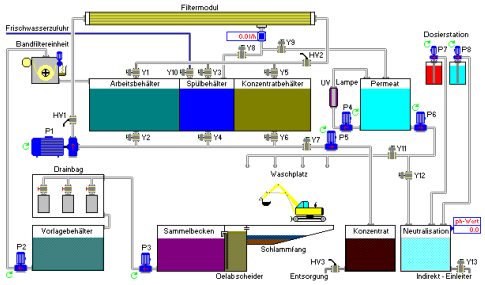
Price free

Characteristics

"One of the "building blocks" of Open Source automation technology is the Human Machine Interface. JVisu was written with the needs of field control technicians in mind – you don't need programmer's skills to write your own machine visualisation frontend."

JVisu Highlights

- Graphical Interface Builder for easy construction of interfaces
- Clear Separation between HMI frontend and PLC backend
- Java applet runs in every JDK-1.4.x enabled web browser
- High performance due to optimized communication channels
- Easily adaptable to field devices with well known protocols



Maxima

Author MIT, William Schelter 1982 – 2001
Community

Web http://maxima.sourceforge.net/
http://wxmaxima.sourceforge.net/

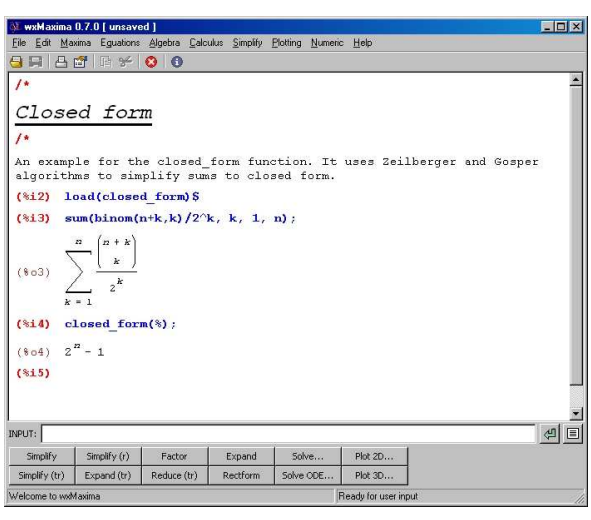
Price free

- available for Windows, Linux, MacOS X
- GUI and integration in other programs:
  http://maxima.sourceforge.net/relatedprojects.shtml

"**Maxima** is a system for the manipulation of symbolic and numerical expressions, including differentiation, integration, Taylor series, Laplace transforms, ordinary differential equations, systems of linear equations, polynomials, and sets, lists, vectors, matrices, and tensors. …"

"**wxMaxima** is a cross platform GUI for the computer algebra system maxima based on wxWidgets."

Computer algebra system Maxima – wxMaxima



Conclusions

- We have a number of very useful **commercial programs** for mechatronic design, and the further development of its is going on.
- The use of **FOSS in IT**:
  - enabled a very dynamic further development regardless company limits,
  - saved license fees,
  - resulted in programs of a very high quality,
  - freed customers from particular software companies.
- In **automation** there is a very great interest in getting same effects using FOSS.
- Several manufacturers joined together in **OSADL** to work on:
  - A universal and widely scalable **real-time OS** using the mainline linux kernel with RT-patches
  - a universal **interface** for field devices
- We should extend the work of groups like OSADL to FOSS tools for the design of **mechatronic systems**!

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Thank you for your attention