Functional Sample: Parallel Kinematic Machine Robot and Its Real-Time Control from Linux OS

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The participation at the exhibition was realized by the Department of Control Engineering, FEE, CTU in Prague as an academic member of Open Source Automation Development Lab (OSADL, http://www.osadl.org/). The OSADL group invited academic members to be its co-exhibitors and promoted all activities connected with the preparation and the final exhibition realization.

Hall 5, OSADL Booth No. 276
Linux ERT target for MathWorks' Simulink Embedded Coder® allows to compile a model of designed control system to the C-code and to combine it with target specific support functions.

The resulting executable/controller can be run in real-time on the target Linux system. The running dynamic system can be augmented via tunable block parameters in the Simulink model and data can be acquired and visualized with Simulink scopes.

Linux ERT target heavily uses real-time capabilities of real-time variant of the Linux kernel. The resulting control system supports sampling frequencies up to 20 kHz.

With carefully selected x86 or embedded hardware, such system can run for months without missing a single deadline (see OSADL Quality Assurance Farm:

http://www.osadl.org/QA-Farm-Realtime.qa-farm-about.0.html).

The target includes Simulink blockset for communication with CANopen protocol and for accessing multifunction data acquisition I/O cards.

Further information:

- Lintarget project at Source Forge: http://lintarget.sourceforge.net/
  project download area contains Linux ERT target and a CANopen blockset.

- Linux ERT target source code: http://rtime.felk.cvut.cz/gitweb/ert_linux.git
  version updated for real-time and native GNU/Linux host/target system setup.

- Humusoft MF624 I/O card blockset: http://rtime.felk.cvut.cz/gitweb/mf624-simulink.git
  initial version of blockset supporting analog and digital input/output, IRC, PWM and PWM measurement for MF624 cards.
Example of ERT Linux Target

Realization of the control for parallel kinematic machine robot (Moving Slide) developed at the Department of Adaptive Systems Institute of Information Theory and Automation Academy of Sciences of the Czech Republic

More information about ERT Linux target is available at project page: http://lintarget.sourceforge.net/

Top Milling Machine Tools and Their Advanced Control

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Perspectives in machine tools
Aim is to push forward kinematical and dynamical limits with efficient utilization of input energy. Possible ways to achieve this aim may be the following:
- design of new machines (new parallel constructions)
- application of new drives (backlash-free gearboxes, linear motors employ a direct electromag. principle)
- advanced control for drive units or whole machines.
All is valid for top milling machine tools used widely in industrial production due to their universality.

Start-up operations: homing & calibration
New machine configurations call for new procedures: homing, due to possible structural collisions in parallel constructions, requires to operate all drives together up to predefined home position; calibration, initializing local sensors, should run individually, limited to small vicinity of definite e.g. home position, otherwise undefined structure motion may occur.

Control operation: conventional x advanced control
Control may be realized either as a local independent drive control or as a global complete machine control. The former, conventional control, needs to compensate for mutual unproductive actions of parallel coupling, opposite to this approach, the latter, advanced control, generates efficient control actions without undesirable effects. The diagram below shows appropriate control circuits used for top milling parallel machine.
Adaptive Systems

The Department of Adaptive Systems focuses predominantly on the design of decision-making systems. The essential ability – adaptivity – enhances their efficiency. Decades of research have brought a number of conceptual, theoretical, algorithmic, software and application results.

The departmental “know-how” serves to resolve national as well as international research projects in collaboration with industry and government agencies: http://www.utia.cz/AS/partners

The topics of interest include control of technological systems, drive control, industrial robotics, mechatronic and automobile applications with focus on system modelling, data analysis and estimation.

The applicability of adaptive systems is currently being extended towards complex scenarios by improving the classical adaptive systems and by developing their new versions.

The increasing complexity of the problems addressed directs the main stream of the research towards decentralized control of large-scale systems and normative decision-making. The interplay between theory and limited computing power is the common issue linking various domains.

Key Relevant Research Fields and Competence Areas

- Control & Decision Making Theory - adaptive control, model-based control, Bayesian estimation, prediction with link to various industrial applications, robotics, mechatronics.
- Signal Processing - digital signal processing algorithms, parallel algorithms and architectures, field-programmable gate arrays, embedded systems.
- Image Processing - image fusion, image registration, distorted object recognition, content-based image retrieval.
- Pattern Recognition - statistical model-based pattern recognition, modelling of random fields for scene interpretation, statistical feature selection.

Mission

The Institute is involved in fundamental as well as applied research in computer science, artificial intelligence, stochastic informatics, systems and control theory, signal and image processing, pattern recognition, and econometrics. It contributes to increasing the level of knowledge and education and to applications of research results in practice. The Institute publishes the journal Kybernetika.

Institute Highlights

- Wide international cooperation activities, participation in EU-funded projects, and bilateral agreements & contracts: http://www.utia.cz/grants
- Long-term R&D in concepts, theory, algorithms, software and applications: http://www.utia.cz/research

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Advanced Model-based Generalized Predictive Control for PMSM Drives