Distributed and Redundant Electromechanical Nose Wheel Steering System (DRESS)

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- DRESS: Distributed and Redundant Electromechanical Nose Wheel Steering System
- Plans to EU7
BUTE, Faculty of Transportation, Department of Transport Automation

- Head of the Department:
  prof. József BOKOR (member of the Hungarian Academy of Sciences)
- Staff: 22
  - 2 professors
  - 3 associate professors
  - 12 assistant professors
  - 2 engineers, lecturers
  - 2 techniciens
  - 1 administrator
- 10 PhD students
- Several external lecturer
BUTE, Faculty of Transportation, Department of Transport Automation

**Education**
- Computing, Electronics
- Electrical engineering
- Control Engineering
- Transport Automation
- Rail Automation
- Road Traffic Automation
- Control of Safety Related Transport Systems (sub-modul)
- Modern Control Theory II.

**Formation**
- PhD formation
- Special courses for industrial partners
Mission Statement in R & D General Aspects

• Control Theory
  • Modern
  • Postmodern
  • Nonlinear

• Identification

• Safety Analysis
  • Failsafe
  • Fault tolerant control
Aircraft Modelling & Control

Increasing dynamic stability of aircrafts

Model and Simulation

Stability

5-8 Juin, 2006 Warsawa
Transport in 7th FP
Aircraft Modelling & Control
Implementing comfort factors through control

Performance and Robustness

Performance parameters

5-8 Juin, 2006 Warsawa
Transport in 7th FP
Aircraft Modelling & Control

Improvement in manoeuvrability

Fault detection, reconfiguration and adaptive control

Cooperative Control

5-8 June, 2006 Warsawa
Transport in 7th FP
Aircraft Modelling & Control

UAV testbed generation

Cooperative Control

Simulator tests, cooperation with other departments

5-8 Juin, 2006 Warsawa

Transport in 7th FP
Traffic Automation

Parameter Estimation and Optimal Control

Microscopic and macroscopic models

5-8 Juin, 2006 Warsawa

Transport in 7th FP
Traffic Automation

Adaptive Simulation

Real System

On-line measurements -- Database -- Control

Simulation

AI system, and Reference model

5-8 Juin, 2006 Warsawa

Transport in 7th FP
Traffic Automation

Traffic Simulation

Automatic model generation

On-line state measurement, control

5-8 Juin, 2006 Warsawa

Transport in 7th FP
Traffic Automation

GPS/INS navigation System architecture

Vehicle coordinates

Inercial Navigation

GPS receiver

5-8 June, 2006 Warsawa

Transport in 7th FP
Railway Signaling

- Rail signaling systems
  - Complex functionality
  - Safety critical system
  - The FM can be effectively applied

- Application efforts
  - Formal Methods Europe, FMERail project
  - FORMS workshop-series

- The wide-area usage of FM is not yet reached
  - Reason: The efforts don’t count the special requirements of the railway signaling
Railway Signaling

- The disadvantages of Classic Specification Techniques:
  - inadequate, mistakable, contradiction, incomplete
- Improving functionality ➔ complex systems
  - The error removal is not sufficient
    ➔ Fault avoidance (formal methods) and fault tolerance
- Significance at the area of safety critical systems
Structural dependability analysis of safety related systems

- Dependability analysis can be carried out for the general architecture
- Global system architecture studies
- Dependability analysis can support fault tolerant control development providing the combination of component failures which lead to system malfunction (in some terminology, these combinations are called as minimal cut sets).
- Fault-tree analysis (FTA) is selected as the main tool. The FTA supports the investigation of parameter sensitivity, thus it can be examined how the system safety can be improved by means of changing the reliability of individual components.
- Beside this, the system safety can be analyzed in different operational situations including degraded states also, and the solution can be validated in quantitative way.
- When available, it can help the selection of different reaction to degradation based on the desired safety level.
- Domain of application: Railway, heavy vehicle control systems, NPP
DRESS

Distributed and Redundant Electro-mechanical nose wheel Steering System
State of the art of nose wheel steering systems:

- Use of hydraulic actuators (multiple configurations)

- Command by the automatic pilot and flight controls computer during automatic braking (to maintain a straight direction)

- No existing automatic ground guidance. Current systems do not provide the required safety level to support such a function. Automatic landings are limited to CATIIIb (some minimum visibility is required).
DRESS objectives:

- Study & Validate a redundant electromechanical actuator
- Study & Validate the control system based on a distributed architecture
- Particular attention to be paid to shimmy phenomenon (new system stiffness and damping of oscillations with an electromechanical system)
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</table>
Plans for EU7

National and international projects

- Permanent collaboration with the System and Control Laboratory of the Computer and Automation Research Institute of the Hungarian Academy of Sciences on the mentioned research projects.
- US-Hungarian Science and Technology Program joint project. (MIT)
- Permanent cooperation with UMN Dep. of Aerospace Engineering and Mechanics, prof. Gary J. Balas mainly in aircraft modelling (LPV systems) and in FDI
- Reliability Analysis of Protection Systems in NPPs Using Fault-Tree Analysis Method, Paks, Hungary
- Railway signaling related works, permanent collaboration with MÁV
- Hungarian National Office for Research and Technology through the project "Advanced Vehicles and Vehicle Control Knowledge Center"
- Hungarian National Science Foundation supports for research and development
Plans for EU7

- G. BALAS, prof. Dept. of Aerospace Eng. and Mechanics, Univ. of Minnesota, MN. Theme: Identification and control of flexible structures.
- M. ATHANS, Prof. MIT LaS, Cambridge, MA. Theme: System identification and robust multivariable control.
- R. PATTON, Prof. Univ. of Hull, England. Theme: Integration of quantitative and qualitative fault diagnosis methods, within the framework of industrial application.
- Prof. A. CHARETTE and Prof. RT. BUI (UQAC-CANADA). Theme: Mathematical modeling and optimizing technical dynamic systems by MAPLE computer programming.
- Prof. Gérard L. GISSINGER ESSAIM/MIAM, Université de Haute Alsace Modélisation et Identification en Automatique et Mécanique, Tempus JEP-14191-99
- Prof. Luc DUGARD, Laboratoire d'Automatique de Grenoble, Tempus JEP-14191-99
- Prof. Gianfranco RIZZO, Department of Mechanical Engineering UNIVERSITY OF SALERNO, Tempus JEP-14191-99
- Prof. Reinhart VERSCHOORE, University of Ghent, Tempus JEP-14191-99
Plans for EU7

- Aircraft modelling and flight control systems
- Testbed generation for Unmanned Air Vehicle (UAV)
- Detection filter design algorithm, and its application in safety critical vehicle systems (trains, aircrafts, road vehicle, NPP)
- Road traffic system modelling and control
- Heavy vehicles rollover stabilization
- GPS/INS navigation
- Battery fed and hybrid electric cars
- Application of safety-PLC in Transport Automation (Railway)
- Railway automation (Formal Methods)