Signals Measurement and Estimation Techniques Issues in the Micro/Nano-World

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Some characteristics of the « micro-nano world »

Techniques and Issues in the Micro/Nano-World

Assembled systems

- Carbon nanotube: Diameter: 100 nm
- Bacterium: 2-6 µm
- Lymphocyte: 6-15 µm
- Pollen: 20-40 µm
- Oocyte: 200 µm
- Gear wheel: 800 µm
- Hearing prosthesis: 1 mm

Surface effects are predominant

Microfabrication

Electronic scanning

Optical microscopy

• **Consequences of scaling down:**
  – needs of microsystems or systems acting at the microscale
  – requirements of measurements (Force & position) for control issues or to understand physical phenomena

• **Micro-nano scale specificities:**
  – Signal of very small amplitude, small signal to noise ratio
  – Influence of surface forces
  – Small free space
  – Resolution in the submicron and micro-Newton range
  – Influence of environment
Problematic

- Existing sensors
  - Interferometers
  - Scanning electron microscopes
  - Cameras
  - Laser sensors
  - Strain gage
  - Piezoceramic sensors
  - Capacitive sensors
  - ...

Lack of sensors with suitable range, accuracy, bandwith, number of DOF and size

- Pushing back of the limits of automation
- Development of new sensors
Main consequences for control

Noisy signals:
- low magnitude of useful signals
- ratio Signal/Noise is unfavourable

High environment sensibility

Non-linear, variant and stochastics models

- difficulty to integrate the sensors
- sensibility to the environment
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<th>Time</th>
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| 9:00 am | Observer techniques applied to the control of piezoelectric microactuators  
* Micky Rakotondrabe, Cédric Clévy, Ioan Alexandru Ivan and Nicolas Chaillet, from FEMTO-ST (Besançon, France) |
| 10:00 am | Measurement and control for high-speed sub-atomic positioning in scanning probe microscopes  
* Andrew J. Fleming and Kam K. Leang, from University of Newcastle (Callaghan, Australia) and University of Nevada (Reno, USA) |
| 11:00 am | Microrobotic tools for the measurement of small forces  
* S. Muntwyler, F. Beyeler and B. J. Nelson, from ETH (Zurich, Switzerland) |
| 1:30 pm | In-situ mechanical characterization of mouse oocytes using a cell holding device  
* Roxanne Fernandes, Andrea Juriscova, Robert F. Casper and Yu Sun, from University of Toronto (Toronto, Canada) and Samuel Lunenfeld Research Institute, Toronto Mount Sinai Hospital (Toronto, Canada) |
| 2:30 pm | In situ characterization of thin-film nanostructures with large-range direct force sensing  
* Gilgueng Hwang and Stéphane Regnier, from University Pierre et Marie Curie (Paris, France) |
| 3:30 pm | A mechanism approach for enhancing the dynamic range and linearity of MEMS optical force sensing  
* Gloria J. Wiens, from University of Florida (Gainesville, USA) |
| 4:30 pm | Observer-based estimation of weak forces in a nanosystem measurement device  
* Alina Volda, from GIPSA-Lab (Grenoble, France) |