Robotic challenges in non-invasive sampling of biomarkers
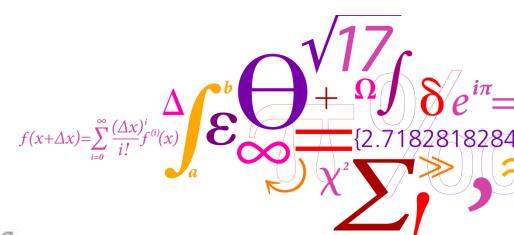
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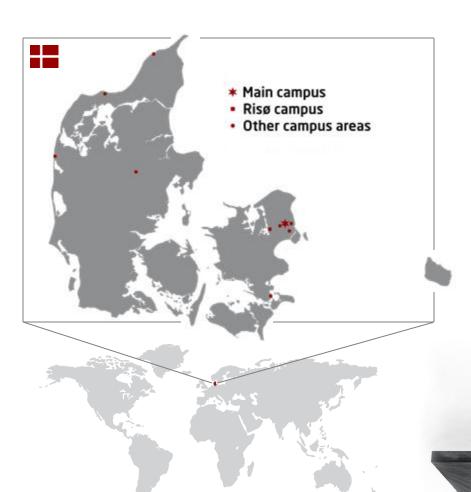
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Automation and Control
Department of Electrical Engineering

Technical University of Denmark

(founded 1829; first rector H.C. Ørsted)

* Main campus
* Risø campus
* Other campus areas

Key figures

Total students	~9.300
including Ph.D.	1.150
and Int. M.Sc.	1.000
Research publications	4.000

Ranking

Leiden Ranking 2013:
no. 1 in Scandinavia
no. 7 in Europe

Current state of industrial robotics
Pick and place / assembly

- Fast and precise movements
- The robot is encaged
- Working with same type of objects
- Working with rigid objects
- Very simple recovery
- Substantial cost of reconfiguration

Research topics
- Sensor based control
- Real-time control
- Easy reconfiguration
- Coworker
- Learning

Biomarker sampling: Saliva

- The sampling of saliva is an on-demand sampling that could be done as often as at every milking if needed.

- To obtain a saliva sample the robot might be programmed to dust a sponge with feed powder and then offer the sponge to the cow, withdrawing it after it had been in the mouth briefly

- The triggering of the sampling could be done by an indication in the milking station control system.

Biomarker sampling: Sweat

- The sampling of sweat is to be performed on a scheduled basis maybe once a month for every cow in the heard.

- To obtain a sweat sample the robot would apply an absorbent heated sweat-collection patch and then recover the patch at the next milking

- The sweat sampling is performed using a heat patch and is a dry sampling making it easier to handle

Biomarker sampling: Hair

- The sampling of hair is to be performed on a scheduled basis maybe once a month for every cow in the heard.

- To obtain a hair sample the robot would operate a set of clippers together with a vacuum line.

- The hair sampling is performed using a standard cutter and is also a dry sampling making it easier to handle

Robotic requirements

- Coworker (no cage)
- Variaty in size, color and shape
- Sensor based
- Real-time control
- Reliability

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Compliant robot motion

- Using force and/or torque measurements
- Avoid damage to object
- Well researched but still not widely used in industry
- Passive or active

Reliability and learning

- **Varying** object size, shape, surface …
- **Deformable** object
- Force signature: not only for failure detection, but also for **failure prediction**
- Adjust strategy or abort execution in the event of predicted failure
- Situation awareness

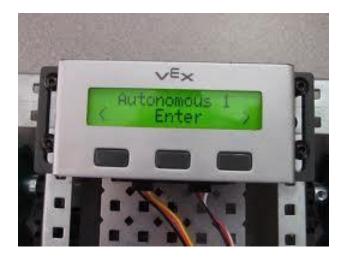**DTU Electrical Engineering, Technical University of Denmark**

User interface

- Industry standard
- Programming

Conclude

- Sensor based feedback
- Real-time operation
- Handle variaty
- User interface
- Scheduling and interface to supervisory systems

- Very interesting real world task