Smart and small robots for the micro-world

*Europe has stimulated the R&D in **micro- and nanosystems technologies** in the past since these technologies form the basis of a new generation of products, techniques and market opportunities. A key problem area is the non-availability of flexible, high-precise nanohandling machinery, especially for the **assembly of microsystems**.*

*The project aims to develop a nanohandling station operating in a scanning electron microscope (SEM). **Microassembly, nanotesting** and **functional and pharmaco genomics** are the main application fields.*

Benefits are expected for microsystem technology (MST), microassembly, nanotribology, material nano-characterization, microbiology, medicine, pharmaceutics, microelectronics (probing of IC's), mechanical engineering and high-precision positioning.

Within the project, two robot platforms for coarse positioning (semiautonomous and a fixed) will be developed. A modular design of the robots should allow an easy conversion of the desktop station for different applications. Beside the SEM, micro video cameras and tactile-/force microsensors have to be developed and integrated.

Two operation modes are to be implemented: telemanipulation using a haptic interface ("virtual reality") or automatic control.

The Market

The project addresses a market of rapidly increasing importance. It will develop techniques that will serve the increasing demand for (semi-) automated micro-assembly and nano-handling. Industries such as pharmaceutical companies, chemical industry, companies producing optical equipment and scanning electron microscopes, mechanical / electrical engineering companies, IC manufacturers, producers of micro- and nano-drives, and the telecommunications industry are discovering the necessity of nano-handling machinery. In this context, the project is important to improve competitiveness with Japanese and North-American companies on future markets.

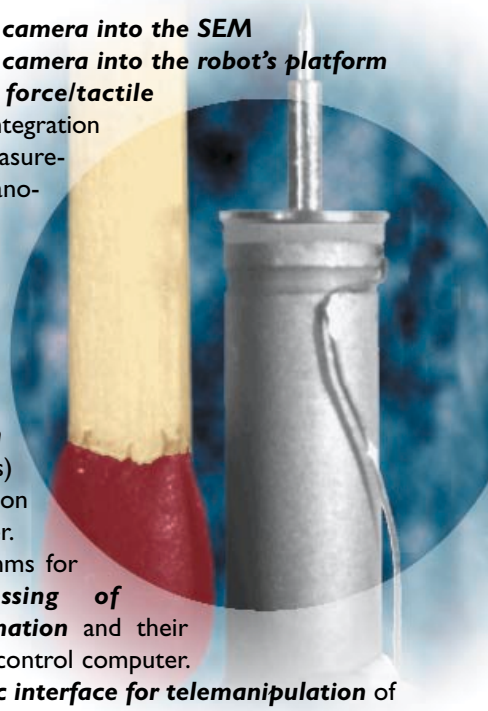
Innovations

NANOROBOTS

- ***SEM-oriented development of a versatile nanorobot.***
  Semiautonomous mobile platform, non-autonomous fixed platform (five degrees of freedom, motion resolution of the platforms and manipulators: up to 5 nano-metre (nm); operation speed of the platforms: up to several cm/s, operation speed of the manipulators: up to several cm/s or 45°/s.
- ***Actuators for the nanorobot.***
  Manipulators employing piezoelectric actuators combining long displacements with an accuracy of a few nm.
- ***Microgrippers and end-effectors.***
  One of the industrial project partners has developed a series of different nano-motor driven grippers operating with one nanometer resolution. The design and production technology of the micro-grippers has to be improved.
- ***Integration** of the robot into an SEM.*
  Three mechanical interfaces have to be implemented in a SEM: an interface for data exchange between robots and user, an interface for energy supply and an interface for a video camera..

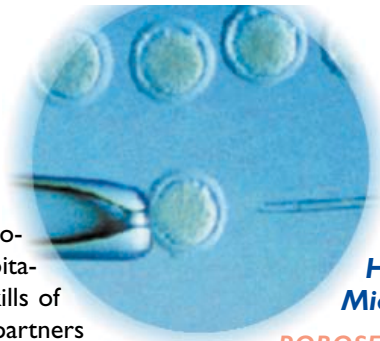
SENSORS

- ***Real-time processing of SEM images***
  Acquisition, digitisation, connection to control computer.
- ***Integration of a video camera into the SEM***
- ***Integration of a video camera into the robot's platform***
- development of a ***force/tactile microsensor*** and its integration into the gripper tip, measurement resolution 50 nano-newton (nN), range: 0-200 µN.



CONTROL SYSTEM

- development of algorithms for a ***real-time image recognition*** (SEM and video images) and their implementation on the control computer.
- development of algorithms for a ***real-time processing of acquired force information*** and their implementation on the control computer.
- development of a ***haptic interface for telemanipulation*** of the robots, with visual and force sensor feedback and connection to the robot's control.
- development of a ***"virtual reality" interface for telemanipulating*** the robot.
- development of an automatic ***PC-based control system*** with visual and force feedback.
- development of a user-friendly ***graphical user interface*** (GUI).



Development of a Smart Nanorobot for Sensor-based Handling in a Scanning Electron Microscope

ROBOSEM

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www.epfl.ch

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www.hut.fi

IET *Warschaw (PL)*
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www.iet.waw.pl

LAB-CNRS *Besançon (F)*
Centre National de la Recherche Scientifique
www.lab.ens2m.fr

Micro-Beam Sarl *Neuchatel (CH)*
www.mirobeam.ch

Nanoscale Technologies GmbH *Kassel (D)*
www.nascatec.de

Fundacion Robotiker *Bilbao (E)*
www.robotiker.es

Alicona Imaging GmbH *Graz (A)*
www.alicona.com

LEO Elektronenmikroskopie GmbH *Oberkochen (D)*
www.leo.de

Point electronic GmbH *Halle (D)*
www.pointelectronic.de

Medplant Genetics *Bilbao (E)*
www.medplantgenetics.com

Klocke Nanotechnik *Aachen (D)*
www.nanomotor.de

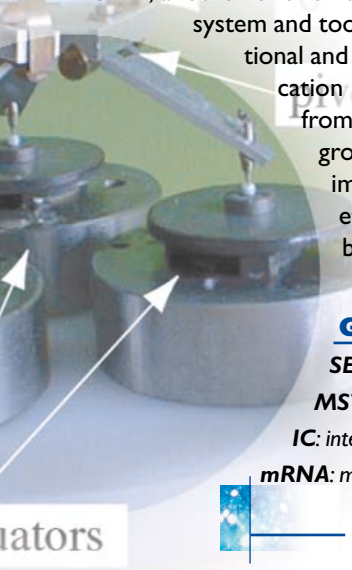
Clinica Universitada de Navarra *Pamplona (E)*
www.unav.es/cun/

The Project Team

The partners participating in the project have been chosen to provide a significant industrial potential for exploitation of the results expected and the required R&D skills of research and academic partners. The project includes partners from associated states (Poland) and third states (Switzerland) and from member states (Germany, Spain, Finland, France, Austria). The companies involved are very active on the microsystem market and play an important part in their respective fields of business. The academic and research partners are among the leading European academic and research institutes in the field of micro- and nanotechnology and advanced robot systems.

An application example

The project results will be evaluated by the implementation of **three demonstrators**, namely one for ***microassembly in an SEM***, another one for ***testing of nano-materials***, and a third system and tools for ***cell handling*** in the field of functional and pharmaco genomics. In this latter application the robot has to select specific cells from a tissue and extract mRNA from a group of cells or even from a single cell. To implement that, a robot tool has to penetrate the cell with high precision and bind specifically to the mRNA.



Glossary

SEM: *scanning electron microscope*
MST: *micro system technology*
IC: *integrated circuits*
mRNA: *messenger ribonucleic acid*

Useful links

http://www.cordis.lu/nanotechnology/home.html
http://europa.eu.int/comm/research/growth/
http://www.cordis.lu/growth

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