

PRESS RELEASE – June 2010

Work seminar entitled: “Robots for micro-nano technological operations” 2010
held in Bakadzhitsite, Bulgaria.

In the frame of the national conference with international participants
“Mechanisms, mechanics of the machines, Machine building and energetic technologies”
MMMMET 2010
Hotel Jambolen, 25 – 27 June 2010

The purpose of the Hydromel Work seminar on Robots for micro-nano technological operations was to provide opportunities for scientists and engineers working in the field of Mechatronics, Robotics and Biomechanics in the framework of the FP6 Hydromel Project to present the results obtained and discuss current research, as well as to exchange new ideas, and establish a basis for future collaboration. Another goal of the seminar was to present the Hydromel project results to more broad society of specialists in the field of mechatronics and robotics, mechanisms, mechanics of the machines, machine building and new technologies.

The FP6 Hydromel **Work seminar “Robots for micro-nano technological operations”** was held on 26th June 2010 in the frame of the national conference with international participants “Mechanisms, mechanics of the machines, Machinebuilding and energetic technologies”, 25-27 June 2010 in Bakadzhitsite, Bulgaria with total number of participants more than 100.

Bakadzhitsite is a chain of low hills which belongs to the geological Srednogorie as it stretches east of the river Tundzha, about 15 kilometers from the city of Yambol. The conferences took place in the hotel “Jambolen”. The papers were addressed through 4 main groups of specialists: theoreticians and experimentalists, designers, technologists and industrial users.



Hotel Jambolen - Bakadzhitsite, hosted Hydromel work seminar on Robots for micro-nano technological operations

The Conference chairman Prof. Veselin Pavlov opened the work seminar and gave the floor to Assoc. Prof. Ilia Roussev. Prof. Roussev introduced the project Hydromel and Bulgarian participation in this project to the conference participants.

After that Dr. **I. Ivanov** made a presentation “*Milestones in robotic injection of cell cultures*”. Some cell cultures like suspension, adherent and other cell cultures were presented. The stages of robotized injection of cell cultures were determined and structured.

In the next presentation “*Visual servoing of a robotic cell injection system*” by assoc. prof. **I. Rousev** an experimental study of two techniques in the field of visual servoing was presented. An approach for facilitating the injection micropipette point detection, focalizing and tracking is developed. A deliberate investigation is performed to resolve the problem with automatic pipette integrity detection. Blue laser light is used in both techniques.



Assoc. Prof. I. Rousev presented his paper at the work seminar

In the investigation “*Force sensor for biological and industrial micro/nano applications*” also presented by Assoc. prof. **I. Rousev**, $\mu\text{N}/\text{nN}$ force sensors are considered appropriate for many scientific and industrial tasks and biological applications in the domain of micro- and nano-technology. A force sensor being integrated into modular robotic system having large working range, high precision and integrated piezo-resistive sensor was presented. The robot performs a working space of the glass-pipette with dimensions up to $50 \times 50 \times 50 \text{ mm}^3$ and realizes rough positioning to the cell membrane with accuracy of $1 \mu\text{m}$. The integrated force sensor provides the robot control system with sub μN resolution feedback.

The next paper “*Teleoperation controlling and sensors in micro and nano scale*” presented by Ph.D. student **D. Penchev** was about the main principles and approaches for teleoperation controlling of robots for micro – nano- technological operations. Appropriate types of sensors for micro and nano scale and their basic circuits are analysed for possible applications in the NSF project SpeSy-MINT.

In the paper “*Structural synthesis and kinematics of hybrid macro – micro robots*”, presented by Dr. **VI. Kotev**, some problems of synthesis and kinematics of hybrid macro – micro robots with close kinematic chain were discussed. Also macro and micro accessible area, transfer ratios of five links manipulating system were determined. It was shown that structures of the manipulation mechanisms changed according to the

Prof. **P. Genova** gave talk about “*Synthesis of hybrid macro- micro – robots by the methods of kinematic geometry*”. A methodology for synthesis of planar linkage manipulation mechanisms with linear part of its trajectory was suggested. With the mechanisms with two degrees of freedom two principally different problems were solved with implementation of the methods of kinematic geometry. First one is a direct problem of kinematics - for a given mechanism configuration and a given transfer ratio of the velocities at the two inputs in order to find the point of Boll. And second one is the inverse problem – with a given Boll point and the normal to its trajectory – the kinematic parameters of the mechanism are sought.



The slide content is as follows:

IMA Institute of Mechanics – Bulgarian Academy of Sciences
IAS Institute of Applied Sciences – Bulgarian Academy of Sciences

3D and 4D based FE Analysis for the modelling and investigation of a 3D and 4D based system

- The stiffness matrix is evaluated according to the techniques from several structural experiments, each of which produces the angular deformations (8) corresponding to the nodal supports (N). The regular stiffness matrix is a three dimensional, symmetric (N³) matrix. It is assumed that the stiffness matrix is a diagonal one since the investigation of joint motion sample geometry is a circular one and thus each FEA experiment returns just one component of the matrix.
- The joint geometry and the FEA model are performed using the computer code SOLIDWORKS CAD system. The selected material of elastic joint is the brass (Br) (E=100 GPa) with Young's modulus of $E=100$ GPa, and Poisson's ratio of $\nu=0.33$.
- The diagonal component of the stiffness matrix is calculated at each experiment. The experiments are carried out for various widths of the most bending head area. The results are presented in Table 1.

	λ_1 (Hz)	λ_2 (Hz)	λ_3 (Hz)	λ_4 (Hz)
λ_1 (Hz)	58.748	68.748	529	529
λ_2 (Hz)	58.807	68.807	454	454
λ_3 (Hz)	126.00	126.00	475	475
λ_4 (Hz)	172.28	172.28	533	533
λ_5 (Hz)	225.90	225.90	585	585
λ_6 (Hz)	281.60	281.60	640	640

Table 1

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The final paper “*Two ways of the modeling and analysis of a serial – parallel micro manipulator with elastic joints*” was presented by assoc. Prof. **D. Chakarov**. A piezo actuated micro robot with a serial – parallel structure including elastic joints was considered. A CAD and kinematics models and calculations with finite elements were presented in order to estimate the values of mechanical parameters. The stiffness of principal components of the robot structure was evaluated using pseudo rigid body approach where elastic joints were modeled as revolute joints.

After the presentations there was a discussion. The various theses connected with synthesis, design, kinematics, dynamics, modeling, control and manufacturing of the hybrid macro and micro robots for micro and nano technological operations were pointed out. The applications of these robots in different productions like microelectronics, micro biology and chemistry, etc. were discussed. Attention was paid to accuracy of position of robots, displacement, hysteresis, sensors, and control.

All 8 presented papers were accepted for publishing in a special volume of the journal “Mechanics of the Machines”, issued by the Publishing house of the Technical University of Varna, ISSN 0861 – 9727.

Contacts and information:

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