CAREER: Optically Transparent Gripper for Microassembly

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ABSTRACT: The University of Arizona is currently developing new ways to handle micro-components and manufacture miniature devices for use in various fields. By establishing an active research exchange program with the Budapest University of Technology and Economics a student from the University of Arizona has been able to interact with Budapest University of Technology and Economics faculty and graduate students and learn about analytical methods for modeling vibrating micro-component systems. These interactions have also helped to establish a working relationship with Budapest University of Technology and Economics which will help foster future research opportunities. The study abroad program has also afforded the University of Arizona student with the opportunity to learn about other cultures in ways which are unique to the study abroad program.

INTRODUCTION (LIMIT: 1 PAGE)

The University of Arizona is currently developing new ways to handle micro-components and manufacture miniature devices for use in various fields. In order to manufacture and assemble complex miniature devices, components with dimensions from several microns to a few hundred microns must have a way of being manipulated such that they are oriented in the correct position, compliant with automatic vision feedback systems, and handled with the appropriate amount of force. Because conventional assembly techniques often result in uncontrolled gripping and release or visual obstruction of the micro-component, the development of a micro-gripping technology with integrated optical alignment capabilities based on a transparent electrostatic micro-gripper is being investigated. By means of applying a function generator to a piezo-electric crystal, the gripper will undergo high frequency vibration and cause the micro-component attached to its surface to vibrate. This vibration will allow the component to align itself with the shape of the

electrostatic field and orient itself in the correct position without interfering with any optical sensors.

By establishing an active research exchange program with the Budapest University of Technology and Economics it is the hope that analytical methods and ideas about complex vibrating systems will be taught to visiting University of Arizona students through interactions with Budapest University of Technology faculty and graduate students. It is the aim of the University of Arizona students to develop new methods for modeling dynamic systems on the micro-component level while exposing the members of the Budapest University of Technology and Economics faculty and students to the practical applications of micro-technology along with methods for developing micro-technology.

In order to accomplish these goals, an undergraduate from the University of Arizona, Jesse Bertin, has traveled to the Budapest University of Technology and Economics in Hungary. He arrived in Budapest on August 21st, 2007 and will complete his research and return to the University of Arizona on January 8th, 2008.

RESEARCH ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATION (LIMIT: 1-1/2 PAGES)

While at the Budapest University of Technology and Economics Mr. Bertin has been developing a computer program to model the vibration of a micro-component on the surface of an electrostatic gripper. During experiments performed at the University of Arizona, micro-components vibrating on the surface of the electrostatic gripper have exhibited both stable and unstable behavior. Because of this a method is needed to determine what characteristics will force the gripper system to become unstable. While in Hungary Mr. Bertin has created a two-dimensional computer model in MatLab which takes into account the dynamics of rigid body motion, force conditions acting on the micro-component, and material properties of the vibrating system. He is currently in the process of verifying the model by performing simulations and comparing it to data collected at the University of Arizona. Once the accuracy of the computer model has been established the identification of critical characteristics will be made possible by running the simulation for different initial conditions. Figures 1 and 2 are examples of the types of results gained by inputting different initial conditions into the current two dimensional model.

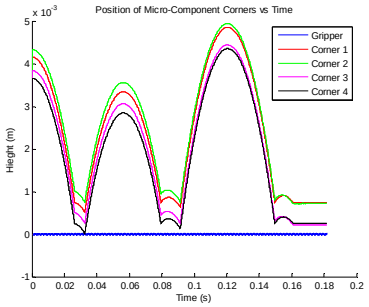

Figure 1

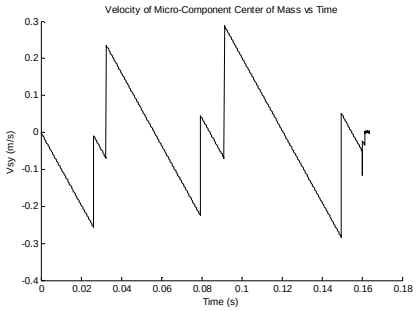

Figure 2

While performing his research Mr. Bertin has had the opportunity to work with members of the Budapest University of Technology and economics faculty and a few graduate students. He has received one on one instruction on rigid body dynamics and collisions, had access to technical papers authored by Budapest University of Technology and Economics faculty on the subject impact physics, attended special lectures on vibration dynamics given by Budapest University of Technology faculty, and learned about potential research projects for future exchange students by learning about the research being performed by Budapest University of Technology and Economics graduate students. Before leaving the Budapest University of Technology and Economics Mr. Bertin will also be working to expand this program into a three dimensional model and eventually to a model allowing the full six degrees of motion.

BROADER IMPACTS OF THE INTERNATIONAL TRAVEL (LIMIT: 1-1/2 PAGES)

While studying at the Budapest University of Technology and Economics I have been given opportunities to interact with and learn about other cultures in ways which would not have been possible in the United States. I have had the privilege of becoming friends with students from countries such as Estonia, France, Cyprus, Finland, Spain and Hungary to name a few. I have traveled to different parts of Hungary, the Czech Republic, and Poland. And I have been able to visit cultural and historical sites in Budapest. Including; The Budapest Museum of Fine Art, the Roman village of Aquincium and the Budapest Museum of History. These experiences have exposed me to different views about life, politics, religion, education. Living in a foreign country and not speaking the local language has forced me to become more self-reliant and taught me how to work around language barriers and cultural differences.

Academically speaking, by going to the Budapest University of Technology and Economics, as opposed to simply communicating through emails or conferences, University of Arizona has been able to establish a personal relationship with members of the Budapest University of Technology and Economics. It has created a

better understanding of each other's research while fostering intellectual inspiration which can only be achieved by day to day interaction. While at the Budapest University of Technology and Economics I have had the opportunity to speak with graduate students about their research and I am currently exploring ways in which those programs might be brought back to the University of Arizona. Because I share the same office as those graduate students I get to see on a daily basis what it is that they do, not just read a technical paper about what they have already accomplished.

DISCUSSION AND SUMMARY (LIMIT: 1 PAGE)

In conclusion my international research experience has helped me become a better individual both intellectually and socially. I have found both the faculty and student population of the Budapest University of Technology and Economics to be both accommodating and insightful. The knowledge imparted to me by my professors has helped greatly in the pursuit of the overall goals of the NSF grant and the interactions with Hungarian graduate students may well be the inspiration for future research opportunities.

ACKNOWLEDGEMENTS

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BRIEF BIOGRAPHIES OF RESEARCHERS

Jesse Bertin is an undergraduate student pursuing degrees in Mechanical and Aerospace Engineering at the University of Arizona. He will be graduating in May of 2008 and is planning on pursuing a Master's Degree in Mechanical Engineering after graduation. He has performed research in the Advanced Heat Transfer Laboratory at the University of Arizona and worked as an Aerospace Engineering Intern at Sargent Controls and Aerospace. He has been working in the Advanced Microsystems Laboratory at the University of Arizona since May of 2007.

Eniko T. Enikov received his M.S. degree from Technical University of Budapest in 1993 and Ph.D. degree from University of Illinois at Chicago in 1998. As a Postdoctoral Associate at University of Minnesota, Dr. Enikov has Associate Professor at the Aerospace and Mechanical Engineering Department at the University of Arizona. His current research is focused on the design and fabrication of micro-electromechanical systems (MEMS), the development of theoretical models of active actuator materials used in MEMS and developmentof relevant applications of these. Dr. Enikov's group at the University of Arizona has an ongoing research and development program on tactile

displays, electrostatic micro-grippers for assembly of MEMS, and nano-assembly of macro-molecules using electrostatics.