STATEMENT OF RESEARCH INTERESTS

Yanbao Ma

My broad research interests revolve around the area of micro total analysis systems (μTAS) for biological and biomedical applications fueled, in part, by my current research which focuses on the design and development of automatic microfluidic systems for point-of-care diagnosis and treatment for urinary tract infection by using genotypic detection. There are three subsystems, sample collection, sample preparation, and sensing for the final detection system. I am in charge of modeling and designing the first two subsystems.

Centrifugation has been commonly used to separate and concentrate biochemical or biological species including uropathogens for more than fifty years. The challenge was to design a bio-filter in portable automatic micro-fluidic systems as a substitute to centrifugation. Two different types of designs were used. The first design of the bio-filters was realized by using dielectrophoretic (DEP) forces, which excels in the concentration in sample media with low conductivity. Numerical prototyping was applied in the design to dramatically reduce the time required to transform our concept into a chip. Meanwhile, membrane separations were used as the second approach for the design of the bio-filter. However, the clinical urine sample is indeed very prone to fouling. We have successfully designed a bio-filter to separate uropathogens from clinical urine samples by applying hydrodynamics in the design of the bio-filter to generate a vortex during filtration in order to attenuate the fouling process.

For our detection systems, the detection time is mainly determined by the sample preparation subsystems, including several mixing processes. One goal of this project is to design micro mixers that achieve chaotic mixing to significantly decrease incubation and detection processing times. The optimal design of micro mixer and integration with the automatic micro fluidic detection system is currently underway.

My long term research goal in the field of micro total analysis systems (μTAS) is to develop a dynamic, interdisciplinary, research program which can enable chemical and biological discovery, drug discovery, medical diagnostics, and therapeutics. In micro TAS, proper design of fluidics is a major task. My Ph.D. work was on numerical simulation of fluid flows. Six papers based on the dissertation have been published or submitted in the prestigious Journal of Fluid Mechanics. With my extensive numerical skills and experimental experiences in the postdoctoral training period, I will focus my future research to pursue an understanding of micro-/nano- fluidic phenomena and to achieve optimal design of micro-/nano- fluidic systems for facilitating biological laboratory research and biomedical diagnostics and therapeutics.

As part of my start-up research, I would like to extend my current research in three specific areas: 1) microfluidic systems for biomedical diagnosis and treatment, 2) microfluidic systems for cell handling and tissue engineering, and 3) development of numerical tools for modeling and designing complex microfluidic systems. I will collaborate with people working in closely related areas and apply for joint funding. I am enjoying the teamwork of my current interdisciplinary projects and I look forward for extensive collaboration in the future.

Statement of Teaching Interests

Yanbao Ma

The scientific word is changing so fast. I firmly believe a carefully-designed interdisciplinary curriculum can provide students the breath and well-designed fundamental scientific curriculums can provide them the skills to adapt to these changes. I view teaching as an important part of a faculty member's professional life. It is a different kind of challenge from scientific research. Moreover, teaching can be an equally rewarding experience and can often lead to insights that contribute to research. I enjoyed teaching and was fortunate to have several different teaching assistantships that have been very beneficial.

Since 1999, I have acted as a teaching assistant at the University of California at Los Angeles for an undergraduate course, *Introduction to Aerodynamics,* for three quarters. As a TA, I lead discussion sections, counseled student, designed and supervised course project. After serving as a teaching assistant for three quarters, I was promoted to teaching associate. I lead discussion and review section for undergraduate course, *Mathematics of Engineering.* I was able to interact with students and get them motivated. I helped students to develop problem-solving techniques and to deepen their understanding of course contents. In 2003, I was promoted to teaching fellow and lead laboratory section for *Electronic Circuits.* I really enjoyed giving lectures and working with students. This has been a very encouraging and rewarding experience to me.

My basic philosophy in teaching consists of two essential components: to *motivate* students and to guide them to *learn*. Students will study hard only if they are highly motivated such that they become interested in the materials and enjoy pursuing novel knowledge of the subject. Therefore, I plan to emphasize engineering applications in my teaching and encourage students to actively participate all possible laboratories and real hands-on projects.

In the future, I will be interested in teaching classes at both undergraduate and graduate levels, such as Elementary Fluid Mechanics, Fluid Dynamics, Aerodynamics, Numerical Methods for Engineering Applications, Engineering Thermodynamics and Applied Mathematics for undergraduate students, Compressible Viscous Flow, Turbulence, Advanced Computational Fluid Dynamics, Stability of Fluid Motion, and Micro Fluidic Flow for graduate students. While most of the fluid mechanics courses are classical, I will try to add new materials relating to modern technologies. At certain circumstances, new classes may be developed to address special topics of emerging technologies.