Temporal Bone Dissection Simulation

A. Specific Aims

This proposal is in response to the program announcement, Bioengineering Research Grants, PA-02-011 and has specific relevance to the National Institute on Deafness and Communication Disorders. The program announcement seeks the promotion of multi-disciplinary research that applies an integrative approach to develop knowledge and/or methods to treat disease. The focus of this design-directed research is the development, evaluation, and dissemination of a computer-synthesized environment **that emulates temporal bone dissection** for training residents in otological surgical techniques and procedures. Congruent to the programs announcement's request for the assessment of technical capabilities, we will evaluate the efficacy of the simulation in the resident curriculum both locally and through a multi-institutional validation study. The development of this surgical simulation environment will include the definition of minimum performance levels and help to quantify standards of practice, training, and education for otologic residencies.

Otologic disease accounts for over $8 billion in health care costs annually in the United States (NIDCD 2002). Training the health professional charged with treatment of this significant disease process requires 5 to 7 years at an annual cost of over $76,000. The single largest cost of surgical treatment of disease is incurred in the operating room at a rate of up to $1,500/hr. Extra time required to train surgeons in the operating room “becomes an intolerable uncompensated charge” (Dawson and Kaufman, 1998). The expected application of this research is to provide an adjuvant environment for learning the surgical treatment of otologic disease. As a novel approach, if the healthcare provider is better at treating a disease process, a more direct and rapid impact on human health can be achieved. Our refined hypothesis is that a virtual environment for temporal bone dissection is equivalent to training with cadaveric temporal bone dissection in the anatomy laboratory Our long-term premise is that simulation technologies can **serve to** increase efficiency in training and raise proficiency of the practitioner in a safe and cost effective manner.

Through previous funding under the R21 mechanism (1-R21 DC04515-01), we developed a virtual simulation to be used as an auxillary method for teaching temporal bone dissection in the residency curriculum. Using volumetric visualization techniques with integrated stereoscopic display, haptic (force) feedback, and aural simulation, we have achieved a straightforward, comprehensive learning environment. The multimodal interface provides a seamless simulation for non-deterministic drilling and cutting of bone as well as an intelligent tutor for learning regional anatomy in the surgical context.

We seek further funding to extend and refine this virtual environment and by freely disseminating the system, to validate its efficacy through a multi-institutional study. We have designed an iterative approach to continually improve the system and evaluate its effectiveness in facilitating training. Through multi-institutional collaborations and evaluations, we will establish common goals and standards to improve quality and functionality, and evolve a system that provides a high level of utility for resident training. Through its effective application, **we seek to mitigate** the daunting learning curve and provide quantitative assessment of performance and progress. The system will be scaled to integrate multimodal and multiresolution data and provide robust utility for current needs in: resident training and assessment. **Although not the focus of this effort, long-term extensions include;** preoperative patient assessment/presurgical planning; professional development and evaluation, **and will be the focus of future proposals.**

The first year goals of this proposal are to:

- ?? Acquire and integrate new multimodal and multiscale data to support advanced otological techniques
- ?? Integrate new enabling technologies and develop algorithms to increase the systems realism
- ?? Disseminate the software environment to early adopters at various multi-institutional contacts
- ?? Validate the efficacy of the simulator through local trials, and establish techniques to reflect these studies remotely

The long-term objectives (years 3 and on) are to:

- ?? Facilitate the acquisition, development, and validation of federal surgical pathologic data repositories for use in otological simulators

- Develop and integrate new algorithms to increase the level of realism in the system, thus supporting the required complexity required for otological simulation
- Disseminate best-practice information regarding these technologies to facilitate the adoption and adaptation of emerging simulation technologies into surgical training programs
- Validate the efficacy of the work by scaling and conducting a multi-institutional study to determine the efficacy of the simulator in the otology curriculum