

review

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Saving Soldiers' Sight



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Soldiers in combat zones spend day in, and day out, in harm's way. While body armor often protects soldiers from fatal injuries, many are victims of severe eye injuries. This is especially true in the warfare arena of using improvised explosive devices (IEDs) against U.S. soldiers.

The number of combat eye injuries has increased significantly. Eye injuries are common in the military and are particularly high in noncombat situations involving explosive devices, accounting for almost 90 percent of all military eye trauma. Eye trauma—particularly in such situations—must be treated immediately to prevent severe damage to the eye and potential loss of vision.

The key to upping the odds is preparing military ophthalmologists with the unique training needed for primary repair of ocular injuries.

For a team of professors, surgeons, computer science students and alumni, their mission is to ensure the soldiers who do suffer eye trauma have a better chance of keeping their sight.

Millersville University and Pennsylvania State University's Milton S. Hershey Medical School are working on innovative solutions to bring military

ophthalmologists up to speed on trauma surgery to the eye.

Funded by a grant from the U.S. Department of Defense, the goal of the two-year project is to develop both the hardware and software for an Ocular Trauma Microsurgery Simulator (OTMS), which can be used for a variety of training simulations by both veteran and new ophthalmologists to injuries specific to war situations.

Heading Millersville's team is Dr. Roger Webster, professor of computer science, Mike Fiorill '03, hardware engineer and owner of Digital Indigo Technologies, and two Millersville computer science whiz kids who just graduated in May.

Millersville's group works closely with Dr. Joseph Sassani, a respected ophthalmologist and professor of ophthalmology and pathology at Pennsylvania State University's Milton S. Hershey Medical School.

This project is a reunion of sorts for Webster and Sassani who teamed up several years to collaborate on a successful project for cataract surgery simulation.

Simulating surgery

Webster has performed hundreds of surgeries—from laparoscopic gall bladder to cataracts—not literally, but virtually. Interpreting surgical practices into 3-D modeling and software is serious business. Yet, it is based on a game—video gaming software.

Like many of today's simulators, the OTMS was modeled after video game applications with a joystick as the main control device and a video screen for monitoring.

The team spent the past year developing the hardware for the simulator. Several types of surgical instruments needed to be developed with each tool requiring its own independent position and orientation tracking. Sensors indicate the range of motion and degree of freedom (how far they are opened or closed).

As a seasoned and respected ophthalmologist with more than 30 years of performing eye surgery, Sassani played a key role throughout the development stages of this process, testing all prototypes and providing expertise and feedback on its strengths and weaknesses.

He confers regularly with the team to advise if the instruments "feel right," if the equipment being developed is acceptable for training purposes and guides the team on the overall approach a surgeon takes with traumatic eye surgery.

Simulation concentrates on closely mimicking the movements of the surgeon. This includes the ability to zoom and adjust angles and degrees from the cameras through adjusting the joy stick, surgical instructions and the foot pedal controls. Modeling the sensations experienced by the surgeon is another objective.

Skills needed

Proficiency of any skill requires practice, and this is especially true in surgery.

The benefits of using virtual reality for training provides a realistic learning environment where multiple repetitions are possible. It is a situation that is usually more conducive to learning than the stressful and high-stakes atmosphere of an operating room. The device also simulates emergencies and then documents proficiency before they are



Motherboards—286 of them from other projects, and space for future ones—decorate the walls of the Intelligent Machines Laboratory in Millersville's computer science department.

encountered clinically, documenting the mastery of skills before progressing to more challenging skills.

Acquiring or refreshing the needed surgical skills, prior to deployment at a medical center near a combat zone, can be a challenge. An ophthalmology residency program dictates a surgi-

cal component for certification. Although some ocular trauma microsurgery is part of the residency training, it may not be recent. Eye traumas most frequently encountered in a military situation are unique and require intervention prior to a soldier being shipped to a specialized medical facility to treat the eye injury.

Additionally, the techniques have changed. Microsurgical suturing used to be standard procedure for cataract surgery. But, the trend has evolved in sutureless, clear attachment. This is better for the patient, but has had the result of ophthalmologists not having the experience in microsurgical suturing techniques, which are needed to repair traumatic wounds of the cornea or sclera (the white of the eye).

Suturing and knot-tying techniques—and keeping tracking of the placement of the sutures—requires practice. Virtual simulation is ideal for honing these skills.

Hardware development included the head model and workstation casting. A 3-D relief model designed and programmed for both the instruments and the anatomy was required including that the eyes be removable, allowing for additional flexibility when working around the eye globe.

The need for immediate care is absolutely critical in order to increase the possibility of a patient's sight being saved or restored. When a person suffers such eye trauma, there is a short window of time to treat and stabilize the injury before infection or other complications can manifest.

Filling a Need

Although all ophthalmologists have at least some experience with ocular trauma microsurgery during their residency training, the need for retaining is necessary when providing aid to military forces. Ophthalmologists, who are assigned the task of primary repair of ocular injuries, could reap enormous





Top left: The team: Mike Fiorill '03, Dr. Rogert Webster, Boba Fett, Will Killham '11, Matt Maize '11 and Dr. Joseph Sassini. volupta tectores.

Bottom left: Dr. Joseph Sassani demonstrates how a surgeon holds the instruments

Next page: The testing one of the surgical instruments on the 3-D simulator.

benefits from simulation of microsurgical repair of ocular trauma—especially if such training opportunities occurred soon before their assignment to medical centers near combat areas.

Beginning ophthalmologists would also benefit from simulation training, considering the challenges they face acquiring “real world” training during their residency years.

“The goal is to provide a prototype for instruction,” says Webster.

Intelligent Machines Laboratory

Tucked into Millersville’s Roddy Hall is the Intelligent Machines Laboratory, where motherboards hang from the walls like futuristic Picasso’s and a life-size cutout of Star Wars’ Boba Fett stands guard. It is here that the gang of five have spent the past year designing the hardware for the OTMS.

“I want students to feel like they are inside a computer,” says Webster, referring to those motherboards. “I strive to make this lab as comfortable as possible to encourage creativity and innovation.”

The focus of research projects in the Intelligent Machines Laboratory has varied over the years from robotics to artificial intelligence to surgical simulation. Regardless of the project, the emphasis has always been on state-of-the-art, internally and externally funded computer science research featuring undergraduate student involvement with faculty and other experts.

Cozy yard sale couches and recliners are scattered among the high tech equipment. The place also feels comfortable as students and recent graduates collaborate with seasoned professors without any hesitation or hints of intimidation.

“There is a mutual respect for ideas and problem solving,” notes Webster. “It’s also about having fun while you’re working.”

Webster is committed to involving his students in cutting-edge research and credits the students for having the passion and motivation to take on whatever challenge he throws their way.

The lab’s creature comforts also plays a role when students often work on ideas and problem-solving into the wee hours of the night.



Building a better simulator

While there is another commercial OTMS currently on the market, it falls short in several areas where the team sees room for improvement. One of these areas is in the flexibility of the device to simulate a variety of ocular procedures and even non-ocular procedures. Another is to reduce the costs of the device and thus, make the simulator available for training many more ophthalmologists in ocular trauma microsurgery.

"It's amazing what we've been able to accomplish already on this project," notes Webster.

What's next for year two of the project? Mathematical algorithms to detect the interaction between the instruments and the anatomy is on the to do list. Developing the simulator's software programming will include a variety of ocular surgical procedures.

Team collaboration

Mike Fiorill, who serves as lead consultant for the hardware project, has more than 15 years of electronic engineering experience.

He was inspired to form his own business in 1998 while still a Millersville student. The idea struck while he was dining on

a plain pizza at Millersville's historic hangout, affectionately known as The House of Pie. On the 10th anniversary of his successful business—Digital Indigo Technologies—Fiorill celebrated at the spot, with the very same order.

"With the simulator, a mistake does not harm a patient," says Fiorill. "You just hit the reset button and have another go at it."

For recent graduates Matt Maize '11 and Will Killham '11 this project has served as a stepping stone in their path to a bright future. Maize, who completed an internship with Dell Computers in Austin, Texas, last summer had a job as a software engineer. In June, he moved to Texas to begin his career with Dell.

Killian has moved on to graduate school at the University of Delaware where he received a full scholarship to pursue his doctorate. In fact, this year, all computer science graduates landed successful jobs or are entering prestigious graduate programs this fall.

As for Webster, he will continue bringing bright minds to the Intelligent Machine Laboratory and give them the inspiration they need to succeed.