By Marsha Shoemaker

WORLD CLASS

CONNECTIONS

Yi Zheng's research collaborations with Mayo, Medtronic bring excellence to the classroom

SCSU engineering professor Yi Zheng's office offers a glimpse into his complex story. Scientific charts with incomprehensible formulas mingle with family photos – a boy in a hockey jersey and a baby girl in a pink hat. Textbooks and electronic models of student projects lie next to colorful memorabilia from homeland China.

Zheng is a seasoned biomedical engineering researcher who's helped develop ultrasound technology with Minnesota's Mayo Clinic and Medtronic and China's Sichuan University – discoveries that soon m be commonplace instruments in the detection and treatment of breast cancer, heart disease and other life-threatening conditions.

He's also in his sixth year as chair of the SCSU Department of Electrical and Computer Engineering, which has added bachelor of computer engineering and m[illegible]of electrical engineering degrees and doubled enrollment under his watch.

Most evenings, his primary role becomes that of husband of Dr. Wei Ning Hu, a pediatrician with CentraCare Clinic, and dad to 12-year-old Eugene and 3-year-old Montessori pupil Anna. He takes turns preparing meals and being a hockey dad, reading to his little girl and listening to his son practice the piano.

Frequently it's back to the books and charts by 9 p.m. for four more hours of research before his day ends and he gets a few hours of sleep.

"I'm really proud of my work, and I enjoy very much working with renowned research partners," Zheng said. Teaching comes first, however.

"Students are number one here," he said. "Our philosophy is we care about students, about teaching them to learn and succeed. The research experience they get in our department makes them ready for industry when they graduate." Involving his s[illegible]nts in groundbreaking research exposes them to opportunities rare in undergraduate settings.

His undergraduate students have won five first-place and two second-place awards in Institute of Electrical & Electronics Engineers (IEEE) paper competitions in the past 14 years, when they competed with top-ranked universities in the Twin Cities and nine Middle Western states. In 1994 Kolman Johnson placed first for developing a portable heart monitor. Nick Zilmer took first place for a 1991 paper and was offered a job on the spot by a visiting manufacturer. In 1989, Michael Surmar became the first SCSU winner of the competition. Since the early 90s Surmar has extended his school project at Life-Touch Studio with computerized photo taking and instantaneous photo reviewing.

"Dr. Zheng is keeping a very high standard in our undergraduate and graduate programs, and the success of his students has proven he is right," said Shukui Zhao, [illegible] currently is working toward his Ph.D. a[illegible]e University of California, Davis. "His lectures are so interesting, his mind runs so quick, and his questions are inspiring. You will never fall asleep in his class."

At SCSU, Zhao participated in the collaborations with Mayo Clinic, and Medtronic. "I really thank Dr. Zheng for his efforts to give me these opportunities. The experience is very important and beneficial for a student like me. We conducted research with the Mayo Clinic and we reported some of our research at the IEEE international symposium last year in Hawaii. I learned a lot, especially from Dr. Greenleaf at Mayo, who has been a pioneer in his field for many years."

Dr. Greenleaf is James Greenleaf, a world-renowned scientist who has been a leading researcher at the Mayo Clinic since the 1960s and is a pioneer in the development of three-dimensional ultrasound technology. Zheng's relationship with Greenleaf goes back to 1991, when his wife Wei Ning was a research fellow at Mayo. During a visit to her lab, the two men struck up a conversation, and their collaboration began soon afterwards on development of a method to study breast cancer using ultrasound.

"We highly value our interactions with Dr. Zheng," Greenleaf said. "He is an outstanding researcher and is very creative. Over the years we have developed several novel solutions to medical ultrasound problems."

Most recently Zheng and Greenleaf have been working on vibroacoustography, a new ultrasound method that simulates vibration of body tissue to provide diagnostic information for detection of breast cancer and arterial problems.

"Images from vibroacoustography are much better than current medical ultrasound images and are comparable to CT imaging – you see the breast or prostate or other tissue as it is," Zheng said. "It's a revolutionary image modality. And, it doesn't add the safety risk that radiation does."

Practical applications of the ultrasound developments can be used to detect dysfunctional tissue in any soft tissue organs. "The technique has great potential for noninvasive biopsy applications," Zheng said.

Zheng's relationship with Medtronic also has resulted in valuable research that has involved students and led to discoveries that are likely to have practical application in the near future.

It began with his National Science Foundation of China-supported study of electrical and mechanical relationships in the human body – especially cardio-electrical syndrome. Zheng and his co-workers at Sichuan University and Sichuan Hospital developed Doppler tissue imaging to quantitatively analyze the sinoatrial node and cardio-electrical conduct pathway, what he calls the powerhouse generator and distribution network for the entire body. "A dysfunctional sinoatrial node or a blocked conduct pathway can cause heart disease."

With researchers from Sichuan University and Sichuan Hospital in China, Zheng successfully used ultrasound to observe the activities of a sinoatrial node and developed a method to use ultrasound to study the relationship between electrical passageways and mechanical movements of the heart. Medtronic, a leading producer of pacemakers, which artificially generate electrical pulses to control heart movement, became interested in using ultrasound to guide the pacemaker implant process and provided two grants to support further study.

"The ultimate goal is to develop a cardiac electrical and mechanical model using ultrasound," Zheng said. "We can observe with ultrasound and associate the local mechanical movements with electrical pulses from a sinoatrial node or from a Medtronic pacemaker."

In addition to discovering ways to improve the diagnostic process and health care, Zheng is involved in research projects in wireless communications and light propagation. He is passionate about science and engineering – and he wants to see more young people become just as excited.

"Our graduates are doing fantastic research," Zheng said. "They're eager to learn, and in four years they learn so much. That gives me great satisfaction."

"Besides their technical study, It's very important for my students to understand the social and global impact of what they're doing," Zheng said. "We emphasize ethics issues in engineering, and global understanding is part of that."