SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

REAL-TIME TEMPERATURE IMAGING USING ULTRASONIC CHANGE IN BACKSCATTERED ENERGY

MS Dissertation Defense

By
Weiyuan Zhao
MS Candidate

Preston M. Green Department of Electrical and Systems Engineering
Washington University in St. Louis

Abstract: Thermal therapy from low-temperature cryosurgery to high-temperature ablation of tumors and unwanted electrical pathways has gained increased attention. Temperature imaging (TI) from magnetic resonance studies is the de facto standard for volumetric estimation of temperature. Ultrasound has the advantages of being cheap, portable, non-invasive and non-ionizing. Our group showed in predictions for single scatterers, simulations of scatterer populations and measurements in 1D, 2D and 3D, that CBE changed monotonically with temperature with 1^{o}C accuracy. An obstacle to clinical application of CBE TI is estimation of temperature in real time, which is limited by time for motion compensation (MC).

To achieve real-time TI, we implemented a two-computer architecture. Our Terason 3000 ultrasonic imaging system collected and sent raw images over a jtcp connection to a TI computer with a GeForce GTX 770 GPU card. The TI computer performed motion compensation and extracted temperature images. Turkey specimens were imaged during heating with hot water (75^{o}C) in 1 cm tube. Total heating time was 1200 sec, with a 30 sec interval between image acquisitions; tissue temperature was monitored with thermocouples.

Over six experiments at 3 thermocouple sites, the accuracy of CBE TI was 0.8±0.7^{o}C. Using its CPU, the TI computer updated temperature images using rigid MC in 4 sec, and using more nearly accurate nonrigid MC in 7 sec. Nonrigid MC time was reduced to 0.2 sec using the GPU processor along with optimization of the MC algorithm. Calculation of CBE in MC images and conversion of CBE to TI takes less than an additional 0.1 sec.

With TI time reduced to < 0.3 sec, the limit to real-time CBE TI now lies with the Terason 3000 system. It takes about 5 sec to transform an ultrasonic image in its native format to Matlab before sending it to the TI computer. Therefore, we believe CBE TI can be done at a 1 Hz frame rate with < 1^{o}C error if conversion to Matlab in the Terason 3000 can be reduced to less than 0.7 sec.

DATE: Friday, November 21, 2014
TIME: 1:30 p.m.
PLACE: Green Hall. Room 0120

Research Advisor:
Dr. R. Martin Arthur

This seminar is in partial fulfillment
of the Masters Degree

Washington University in St. Louis
SCHOOL OF ENGINEERING & APPLIED SCIENCE