The George Washington University
Institute for Biomedical Engineering

Colloquium
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2007 IBE Undergraduate Research Fellowship Winners Presentations

Scoring Mechanism for Medical Language Extraction

Timothy Kim, Graduate student, GW Dept. of Computer Science

Biomedical information is growing explosively, and new and useful results are appearing daily in research publications and many of these publications are available online—for example, in the PubMed MedLine database. However, automatic extraction of useful information from these online sources remains a challenge because these documents are unstructured and expressed in a natural language form. To enable data mining and knowledge discovery from such documents, this data must be made available in a structured format. During our research contained following two objectives. First objective was to study the medical terms in UMLS, and using regular expression, recognize and extract common recurring patterns that can help identify unknown medical terms from research publications. Second, to implement a scoring mechanism that will score the phrases based on how many regular expressions they fit and the significance of the regular expressions.

Simulations of High Intensity Focused Ultrasound (HIFU) Application in Tumor Treatment: Impact of Air or Bone Interfaces

Pavan Luckoor, BME junior, GW Dept. of Electrical and Computer Engineering

Background: Our objective was to investigate treatment effects of bone or air interfaces located in the post-focal HIFU region. **Methods:** Simulations were conducted using WavePro 2500 program, with ultrasound (flat and HIFU transducers, 1 and 3MHz) applied (continuously) to soft tissue (liver) with different boundaries in the post-focal region (bone, air, and a non-reflective boundary). **Results:** Using a flat transducer, the reflection from soft tissue–air interface resulted in up to 90% increase (at 1 and 3MHz) in the pressure amplitude as compared to pressures in the soft tissues before reflection. Also, the amplitude increase of up to 50% (at 1MHz) and 60% (at 3MHz) was observed due to the reflection from soft tissue–bone interface. For HIFU application, the reflection from soft tissue–air interface resulted in the amplitude increase (in the soft tissue) of up to 80% (at 1MHz) and up to 86% (at 3MHz). The reflection from soft tissue–bone interface in the post-focal HIFU region resulted in up to 15% of the amplitude increase (at 1 and 3MHz). **Conclusion:** Our simulations indicate increase in the intensities (and potential temperature rise) in soft tissues outside of the treatment area due to post-focal presence of bone or air.

Optimization of Lesion Formation using High Intensity Focused Ultrasound at Large Tissue Depths

Joshua Samuels, BME junior, GW Dept. of Electrical and Computer Engineering

HIFU is the use of ultrasound waves in the range of one to ten MHz in frequency to ablate tissue by being focused at a specific focal point. In this technology, high-power ultrasound waves are focused to a small, nearly cylindrical focal point with a volume roughly 1 mm x 10 mm, resulting in a high intensity acoustic field (1,000–10,000 W/cm^2) at the focus. This acoustic field provides both thermal and mechanical effects. The thermal effects, due to ultrasound absorption, can lead to temperature increases in excess of 70°C in less than 1 second. The mechanical effects involve cavitation and the formation of microbubbles, which can enhance the heat deposition and result in faster treatment.

The further understanding of lesion creation using (HIFU) was a main goal of the experiments undertaken last summer. Realizing the potential rewards of precise, safe, and sizeable lesions deep within the tissue for tumor ablation and cauterization, our goal was to perform various experiments each with separate smaller goals to build towards unlocking these benefits. Using different transducers at set frequencies, varied amplitudes, duty cycles, and treatment times in congruence with different positions to aid in deep lesion formation, we aimed to determine the optimal setup for deep lesion creation without unwanted tissue ablation in the pre-focal region.

At 5.2 cm, in-situ HIFU intensities dropped to 170-260 W/cm^2 (vs. 40,000-60,000W/cm^2 free field). Reflections off fat, fascia, and bubbles formed at the HIFU focus (at higher intensities) often appeared to result in pre-focal lesion formation (avg. total depth of 3.8cm). Lower intensities over longer treatment times (up to 120 s) yielded desirable lesion depth (avg. depth of 4.5 cm, highest depth of 6.8 cm), showing longer treatments at lower intensity could be the key to precise deep lesions. Lesions volumes ranged from 0.1 to 26.5 cc. Inconsistent lesion formation in our experiments showed that deep lesions in a non-uniform medium are not easily created.

A pizza lunch will be provided.