Online Proceedings

Poster Session 1

MGH 241, Easel 150

11:00 AM to 1:00 PM

Comparison of MRI-CT Registration Algorithms for Evaluating Electrode Placement in Deep Brain Stimulation Experiments

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Mentor: Swati Rane, Radiology, UW Medical Center
Mentor: Kurt Weaver, Radiology
Mentor: Andrew Ko, Neurological Surgery

Deep brain stimulation or DBS is a medical treatment procedure for Parkinsons patients who have exhausted all medication-related therapy or who have debilitating motor issues. DBS involves placement of electrodes into the brain to stimulate target regions with electrical impulses. Surgeons typically use both CT and MRI scans to help them plan the placement of electrodes. While MRI provides excellent tissue contrast, it cannot be used to assess electrode placement due to the metal in the electrode. CT scans show only bone and metal but no details of the brain tissue. A combination of MRI and CT images is therefore necessary to ascertain that the electrodes are indeed in the predetermined location. There are challenges due to the use of two imaging modalities. The MRI and CT images differ in resolution and do not align with each other. The goal of our project is to apply and compare multiple inter-modal image registration methods to determine the best approach to combine the MRI and CT images. We registered the CT image (which shows the electrodes) to the MRI (which shows the brain tissue) in FSL using mutual information, correlation ratio, or normalized correlation ratio. We also use similar registration algorithms from Advanced Normalization Tools (ANTs) for this purpose. We found the method that works best for patients on a case-by- case basis, and also one that gives the best results in a wide variety of cases. Our preliminary work suggested that the mutual information based registration approach using FSL provides the best registration between images.

Poster Session 2

Commons West, Easel 11

1:00 PM to 2:30 PM

Strain-Dependent Electrical Resistance of Carbon Nanotubes–Cellulose Composite Papers

Zoie Tisler, Junior, Bioresource Science and Engineering
Mentor: Anthony Dichiara, Bioresource Science & Engineering
Mentor: Kurt Haunreiter, Bioresource Science and Engineering

For 4,000 years, paper has served the purpose of recording information and in this work, it's uses are being expanded upon. Within the advancing field of flexible electronics and wearable devices, paper has recently been investigated as an environmentally friendly alternative to the traditional petrochemical-based polymeric materials. In this work, carbon nanotubes (CNTs) were employed as fillers to produce electrically conductive papers using a universal papermaking process. Lignin, an underutilized byproduct of the pulp and paper industry typically treated as a waste and burned for energy recovery, was utilized as a renewable surfactant to prepare aqueous dispersions of CNTs and softwood fibers, which served as precursors for the manufacturing of conductive paper (60 g/m^2). CNTs were functionalized to increase the presence of hydroxyl groups and further improve the interfacial strength between CNTs and cellulose fibers through hydrogen bonding. The microstructure of the CNT–cellulose composite papers was analyzed by electron microscopy and Fourier transformed infrared spectroscopy. Both tensile strength and internal bonding of the papers greatly increased with CNT loadings as low as 2.5 wt%, and the volume resistivity was in the range of 1.5 kΩ.cm. The piezoresistive behavior of the composites revealed through examination that the relative resistance first increased linearly at low strains followed by an exponential growth at larger strains. When employed as a stress/strain sensor, the conductive papers exhibited higher sensitivity compared to conventional strain gauges. These novel CNT-cellulose composite papers have outstanding multifunctional properties that can revolutionize the way smart materials and electronic devices are manufactured and used.

Poster Session 2

Commons West, Easel 10

1:00 PM to 2:30 PM

Development of an Advanced Water Sensor Using Carbon Nanotube Enriched Cellulose Papers

Sydney Fry, Senior, Bioresource Science and Engr: Business
Mentor: Anthony Dichiara, Bioresource Science & Engineering
Mentor: Kurt Haunreiter, Bioresource Science and Engineering

Paper has been utilized for centuries by humans for writing, printing, and packaging. It has properties of being flexible, biocompatible, and biodegradable which make it a valuable low cost and environmentally friendly alternative to petrochemical-based materials for applications in robotics, electronics, and microfluidics. In particular, electrically conductive materials, which possess the merits of minimal weight and good processing ability, can be integrated into the manufacturing process of structural parts, allowing the implementation of a sensor function. By mixing multi-walled carbon nanotubes (MWCNTs), sheets of hexagonally packed carbon atoms rolled into concentric seamless cylinders, with insulating cellulose fibers, we were able to produce a conductive paper that retains its strength and exhibits sensitive resistive changes when exposed to water and humidity. The fabrication process was based on traditional papermaking methods and included the refining of unbleached softwood Kraft fibers, the suspension of cellulosic fibers in MWCNT–cationic polymer mixtures, and the filtration, pressing, and drying of the resulting pulp to prepare handsheets with grammage of 60 g/m$_2$$.Theas - preparedMWCNT -$
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