INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The human brain is made of soft tissues that floats on cerebrospinal fluid (CSF), and it frequently shifts during a surgical process. The brain-shift prevents a neuro-navigation (NN) system from locating the diseased region. A brain ultrasound (BUS) imaging system is utilized to monitor the surgical procedure. Brain-shift can be corrected by registering the pre-operative brain ultrasound (pBUS) and the corresponding intra-operative brain ultrasound (iBUS) images. The similarity between the pBUS and the corresponding iBUS image is affected for a variety of reasons, which makes the registration difficult. This thesis developed three methods to extract similar regions in pBUS and iBUS images and register using these regions. The first method finds the common edge-rich regions from the registering image pair and is followed by the registration of those edge-rich regions through the minimization of the mean-squared registration error. The second method proposes a fast and fully automatic method for extracting the hyper-echoic(HE) regions from the registering image pairs. The patch-based approach makes the segmentation faster and robust to noise. The segmented HE regions are registered by minimizing the registration error. The third approach adopts a patch-based level-set strategy for segmenting three prominent HE regions namely, the longitudinal fissure, choroid plexus, tumor, and two anechoic regions namely, the ventricles and the resection cavity. A registration method is followed on the segmented image sections. Various gradient-based and heuristic optimizations are used for minimizing the mean-squared registration error during registration. Experiments were conducted on selected image pairs from the RESECT and the BITE datasets. For performance evaluation, the segmented ground truth images are prepared by annotating the boundaries of different regions in coordination with an expert radiologist. For comparing registration performance, common tag-points are selected from the registering image pairs, and the improvement of mean target registration error (mTRE) after registration is analyzed. Experimental results demonstrate the superiority of the proposed segmentation-based approaches to the state-of-the-art methods.