Database for Image-Based Motion Estimation

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Most organ function is categorized by tissue deformation. For example the motion of the heart is responsible for pumping blood throughout the body. For this reason many motion estimation algorithms have been developed to quantify cardiac motion. Tagged MRI is a non-invasive technique utilized to quantify tissue motion and has inspired the development of many other motion estimation algorithms of the heart. The problem lies in extending these motion estimation algorithms from the heart to other organs such as the brain for analysis of traumatic brain injury and the tongue for speech analysis. For this reason our research worked to develop a data set to calibrate motion estimation algorithms for the brain and tongue.

Tagged magnetic resonance imaging (MRI) is currently used in clinical and research settings to monitor tissue deformation. However, computerized methods have been created to simulate this technique known as motion estimation algorithms. The two organs that were evaluated in this research were the brain, whose deformation under acceleration is though to contribute to traumatic brain injury; and the tongue which deforms during speech. In order to validate brain and tongue motion estimation algorithms we have developed a dataset of known rigid and non-rigid deformations.

In order to develop the data set for the brain and tongue an appropriate motion had to be developed to categorize the deformation of the two organs. For the brain, an apparatus was developed by collaborators to analyze the deformation of the brain under rotational acceleration; and for the tongue, a finite element model was developed in the lab for the analysis of the contraction of different tongue muscles. In the brain simulation the analysis of rigid motion was conducted by quantifying 25 z-axis rotations. These rotational angles were analyzed and modeled using a tagged brain atlas image. After deformation high and low resolution images were acquired that reflected the prescribed deformation.

For the tongue the finite element model described a series of intrinsic and extrinsic muscles that contribute the speech production. The manipulation of these different muscles was used to construct the phrase “ageese” by modeling three different speech sounds /a/, /gi/ and /s/. The model deformation was reflected on a tongue atlas image by monitoring the displacements of the nodes on the model and mimicking the same displacements on the image therefore producing the same deformation. Slices of the tongue volume were taken and used to compose the non-rigid portion of the data base. The final database is composed of rigid brain deformations and non-rigid tongue deformations. In this set the deformations are known and quantified and can therefore be used to calibrate motion estimation algorithms for both the brain and tongue.