Image Registration with Applications to Medical Imaging

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Abstract

Image registration is ubiquitous in Computer Vision, Medical Imaging and other fields of Science and Engineering. Image registration maybe defined as, given a pair of images possibly acquired from different view points under varying image acquisition parameters or from two different sensors, to estimate the unknown coordinate transformation that would align the images. The coordinate transformation may be linear (e.g., rigid, affine etc.) or nonlinear (e.g., polynomial etc.). Several well known approaches (e.g., the SSD method, the Mutual Information method etc.) to solve this problem will first be reviewed and following this, I will present a relatively new method that involves a novel measure of information in a random variable based on its cumulative distribution and dubbed the cumulative residual entropy (CRE). This measure parallels the well known Shannon entropy but has the following advantages: (1) it is more general than the Shannon Entropy as its definition is valid in the discrete and continuous domains, (2) it possess more general mathematical properties and (3) it can be easily computed from sample data and these computations asymptotically converge to the true values. Based on CRE, I will define the cross-CRE (CCRE) between two random variables, and apply it to solve the image alignment problem for parameterized (3D rigid and affine) transformations. The key strengths of the CCRE over using the mutual information (based on Shannon's entropy) are that the former has significantly larger tolerance to noise and a much larger convergence range over the field of parameterized transformations. We demonstrate these strengths via experiments on synthesized and real image data.