ABSTRACT

Image registration is a preprocessing technique used to compare any two digital images of the same object obtained from different sensors or by a same sensor at different interval of time. Various registration algorithms are proposed in the literature to register medical images like CT, MRI, PET and SPECT images of brain, lungs, heart, etc., One of the most important applications of medical image registration is image guided therapy in neurosurgery. Apart from other organs, accurate registration of retinal images helps the physician to diagnose several retinal diseases like glaucoma, diabetes, and age related macular degeneration. This is due to the fact that the retinal image represents the local and temporal information of the retina which can be viewed at any given instance.

Registration of retinal images helps in the detection of vascular trees to deal with occlusion effects. Retinal vein occlusion is an eye condition due to the blockage of blood circulation in the retinal vein. It seconds to diabetic retinopathy as a cause of visual loss due to retinal vascular disease. There are two forms of Retinal Vein Occlusion (RVO): Branch Retinal Vein Occlusion (BRVO), Central Retinal Vein Occlusion (CRVO). If the central vein is affected, it is known as central retinal vein occlusion or if the occlusion occurs in any one of the retinal branches it is called as branch retinal vein occlusion.

This research aims at overcoming the challenges in diagnosing retinal occlusion by developing optimal algorithms for sequential registration of retinal images affected with CRVO and BRVO. An attempt has been made to differentiate the registration procedures for retinal images affected with CRVO and BRVO. The number of matching coordinates is reduced and significant coordinates that have maximum similarity between the reference and input retinal images are selected. This decreases the computational time and complexity of registration that helps the ophthalmologists in diagnosing the retinal occlusion at the earlier stages.

A new algorithm, Mutual Information based Registration after Extracting the Bifurcations (MIREB) is developed by combining the advantages of area based and feature based methods to register RVO images. This involves the segmentation of the bifurcations from the affected retina by region growing and edge extraction and then, calculating the mutual information between the input image (RVO affected retina) and the reference image (Healthy Retina). The mutual information of two images will give maximum image intensity values of the corresponding pixel pairs if the images are geometrically aligned. Registration efficiency is increased when the two images are effectively aligned. The registration results are tested on the retinal images affected with vein occlusion available in DRIVE and STARE database and optimized using Genetic Algorithm and Simulated Annealing Algorithm. The results are promising with increased accuracy, but when tested with real time images

obtained from ophthalmologists, the accuracy is decreased because of the nonuniform illumination and poor quality of image due to the impact of the disease. The ophthalmologists suggested separate registration process for CRVO and BRVO images, as they differ in their anatomy and pathology.

To overcome such difficulty and to provide robustness against the non uniform intensity illuminated retinal image, Random Sample Consensus (RANSAC) based registration is applied. RANSAC matching reduces the number of control points from the retinal image with numerous flame shaped haemorrhage. The registration results are optimized using Gradient Iterative Closest Point Algorithm. It is observed that this algorithm is more effective for retinal images affected with CRVO than that with BRVO. The pathological effects of BRVO illustrate that only a portion of retina is affected and a suitable algorithm has to be developed to register this type of images.

A novel Binary Particle Swarm Optimization based registration is proposed to evaluate the optimal registration problems in BRVO images. The registration is attempted after extracting the edges in the affected retina by using Modified Local Entropy Thresholding and Directional Filtering Algorithm. This algorithm is competent in identifying the specific retinal branch affected with RVO and the number of control points between the reference and the input image is optimized using BPSO. This algorithm proves to be effective in registering BRVO images. The developed registration algorithms are tested on the retinal images from the STARE and DRIVE database besides real time retinal images affected with BRVO and CRVO from ophthalmologists.

The experimental results of all algorithms are analyzed and suitability of the algorithm for CRVO and BRVO images is arrived at.