

ABSTRACT

In recent years, medical image fusion has attracted a lot of research publications from researchers. It involves the combination of multi-modal medical images (e.g. MRI, CT, PET, etc.) into a composite image with more detailed diagnostic information than each individual image. Popular medical image types include X-rays, computed tomography (CT), positron emission tomography (PET), magnetic resonance imaging (MRI), and single photon emission computed tomography (SPECT). For example, MRI images provide detailed structural information of the organs inside of the body, while PET images contain functional information of the body's metabolism. Hence, medical image fusion can allow the informative complementation of the two image modalities and supports doctors and radiologists in making more accurate diagnosis and treatment.

Current research methods expose several limitations in medical image fusion. The first disadvantage is related to the synthesis of the base components, in which the max or average methods are often applied to create the fused base component due to its simple computation. However, max or average methods usually produce a reduction of information, contrast and brightness of the fused component. The second limitation is related to the synthesis of the detail components where similarly to the base component, the max or average methods are applied to produce the fused detail component. With the max methods, it tends to select the detail information from MRI image rather than the PET image. As a consequence, the fused image loses information from the PET image modality.

In this thesis, we study the state-of-art methods and techniques to overcome the mentioned limitations of the medical image fusion problem so as to enhance the efficiency of the medical image fusion problem. Our works focus on the fusion of MRI and PET images of the brain as a case study. The main contribution of our thesis is at two folds: The proposal of a new algorithm to fuse the base components based on the Equilibrium optimization algorithm; and the proposal of a new algorithm to fuse the detail components based on deep learning and transfer learning. The experimental results show that the proposed method greatly

enhance the contrast of the fused medical MRI and PET images compared to the state-of-the-art works.

Keywords: Medical Image Fusion, MRI, PET, Deep Learning, Transfer Learning, Optimization.