UNIVERSITI TEKNOLOGI MARA

OBJECT-ORIENTED DEEP NEURAL NETWORK SEGMENTATION FOR MEDICAL IMAGES

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PhD

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Medical images are important towards diagnosing various medical condition in human bodies. Medical image data contains valuable information that can be utilized by medical expert. The information inside the images however requires the process of segmentation where the portion of the image is segmented for further investigations. This process however proves to be a very challenging task due to large variations of pixel features in medical images. Therefore, developing a segmentation model that can provide automatic yet efficient segmentation towards the images is essential. Deep Neural Network (DNN) particularly the Convolutional Neural Network (CNN) has demonstrated to be able to produce efficient segmentation towards medical imaging. This approach however is very demanding in terms of the training time and processing resource required to train the model due to the employment of CNN structures that requires the spatial relations between individual pixels to be exhaustively processed. In addition, CNN also requires large datasets to train and test its neural network. The CNN structures depend on the input of images via the conventional image representation such as bitmap of 3x3 dimensions. Therefore, this research proposes the employment of Object-oriented Programming (OOP) paradigm of describing the image dataset via Object-oriented Pixel Descriptor (OOPD). This is done to amplify the amount of information contain within an image to provide more depth towards the pixel data in medical images. This approach is then complemented with deep neural network to train the Object-oriented Deep Neural Network (OODNN) segmentation model. To evaluate the proposed approach, three different medical image datasets are employed; brain Magnetic Resonance Image (MRI), retinal fundus, and cells histopathology. These datasets are trained using only 10 images from each dataset to investigate the performance of the proposed approach under low dataset count. The proposed approach is evaluated in terms of training performance (training time and accuracy and loss) and segmentation performance via Receiver Operating Characteristic (ROC) confusion matrix using 20 data from each dataset. To generate an in-depth performance analysis, three recent state-of-the-art CNN-based segmentation model using different variations of backbone/encoder model is also trained and evaluated using the same parameter as the proposed approach. For all three datasets, OODNN shows that it can provide efficient segmentation with the overall figure of 0.771 balanced accuracy comparable to recent state-of-the-art CNN-based segmentation model but with significantly less amount of training time and computing resource under low training dataset count.

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