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A Gated Transformer-Based U-Net Model for Cardiac MRI Segmentation

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ABSTRACT

Abstract - Cardiac Magnetic Resonance Imaging (CMRI) is recognized as the most reliable technique for evaluating cardiac function and morphology. However, manual or semi-automatic segmentation of heart chambers and vessels can be labor-intensive, inconsistent, and prone to errors. In this study, we explore the potential of employing attention mechanism-based medical image segmentation models, focusing on gated transformer architectures, to address these challenges.

In the first stage of our research, we identified the limitations of traditional convolutional neural networks (CNNs) in capturing long-range spatial dependencies and global contextual information, which are essential for the accurate segmentation of cardiac MRI images. To overcome these limitations, we developed a gated transformer-based U-Net architecture that incorporates attention mechanisms. This novel architecture enables more effective feature extraction and better handling of complex structures, leading to improved segmentation performance.

We tested our gated transformer-based U-Net model using the MnMs-2 dataset and compared its performance against traditional CNN-based models. Our experiments discovered that using a cosine annealing rate scheduler is more effective than ReduceLROnPlateau for the convergence of transformer-based architectures. Furthermore, we found that implementing the gating mechanism into attention layers enhances the performance of the transformer-based U-Net architecture on average by at least 2%. These results demonstrate the potential of attention mechanisms and gated transformer architectures in improving cardiac MRI segmentation accuracy and consistency.

Keywords: MMs-2, Transformer U-Net, U-Net, Learning Rate Scheduling Algorithms, CMRI Segmentation

Subject Descriptors:

- Medical Imaging → Deep Learning → Medical Image Segmentation
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