Ensemble UNet with Variant Encoders for Liver Segmentation

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ABSTRACT

The application of Convolutional Neural Networks (CNN) for the purpose of medical image analysis is widely recognized, with specific architectural solutions, such as the UNet, tailored for the demanding field of biomedical image analysis. Advances in deep learning models have significantly contributed to the effectiveness of medical instruments and processes, including surgeries. In Indonesia, the field of liver transplantation has seen noteworthy progress, with comprehensive enhancements across multiple dimensions, encompassing medical personnel, surgical instruments, and more [1]. These ongoing developments aim to facilitate and expand the reach of liver transplantation procedures throughout Indonesia.

Prior to a liver transplant, a crucial step involves the rigorous evaluation of both the organ donor and recipient. This pre-surgery assessment relies heavily on medical images to ascertain the optimal condition of the donor's organs, particularly the liver, for transplantation [2]. The conventional approach necessitates the involvement of numerous medical experts over extended periods, resulting in a resource-intensive process. Leveraging deep learning models for automation in this context promises to enhance its efficiency.

This study focuses on the employment of an Ensemble UNet model to automate the segmentation of the liver from CT scan images of the human abdomen. The image data undergoes a meticulous preparation process, dimension adjustment to optimize available computational resources, and the application of Contrast Limited Adaptive Histogram Equalization (CLAHE) to homogenize pixel intensity and reduce noise [3].

In the pursuit of superior segmentation results, five distinct models were tested, namely the standard UNet [4], UNet with ResNet34 [3], UNet with VGG16 [5], UNet with MobileNetV2 [6], and a hybrid ensemble model combining three encoders. Notably, the

ensemble model did not yield the highest performance. Surprisingly, the combination of UNet and VGG16 encoders emerged as the top-performing solution, achieving an Intersection over Union (IoU) score of 99.85 during the training process and 96.79 in the test phase.

Furthermore, it is worth noting that the VGG16-based model exhibited remarkable efficiency in terms of computational requirements. With a mere 73 seconds per epoch and a total of 173 epochs needed to attain the optimal result, it proved to be the most computationally lightweight option among the models tested. The findings from this research underscore the potential of the VGG16-based model as a valuable component of medical instruments designed to enhance the effectiveness of abdominal CT scan diagnoses.

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