Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

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Inventors

Jianming Liang
Zongwei Zhou
Md Mahfuzur Rahman Siddiquee
Nima Tajbakhsh

Contact

Jovan Heusser
jovan.heusser@skysonginnovations.com

Convolutional Neural Networks for Medical Image Segmentation

Convolutional neural networks (CNN) are useful in a variety of applications ranging from computer vision to signal processing. Segmenting organs and lesions in medical images for computer aided diagnoses (CAD) is an area in which CNNs are becoming the state-of-the-art. In particular, U-Net and other U-Net-like CNN architectures have shown great promise in increasing the accuracy of medical image segmentation models. U-Nets are characterized by skip connections between the layers in the down-sampling contracting path and the up-sampling expanding path, which help to not only migrate context spatial information from layers in contracting path to layers in expanding path but also overcome the vanishing gradient problem. Nevertheless, information gaps have been observed in the gradient through the skip connections.

Researchers at Arizona State University have developed a new architecture to bridge the information gaps that are observed in skip connections in U-Net and other CNN architectures used in medical image segmentation. This architecture forms new paths with different depths, some of which focus on localization and coarse segmentation, while others focus on fine-detailed segmentation. This novel architecture was tested on multiple different segmentation tasks with results demonstrating significantly increased performance over the original U-Nets and their variants.

This novel architecture outperforms U-Nets and their variants in several applications across diseases and modalities and has great clinical utility in medical image segmentation CAD applications.

Potential Applications

- Medical image segmentation

o Computer-aided diagnosis (cancers, nodules, anatomical defects, other diseases)

o Automatic measurement of organs

o Cell counting

o Simulations based on determined boundaries

- Contouring during treatment planning

Benefits and Advantages

- More precise output based on multi-scale information of input image
- Strengthens multiple resolution features propagation
- Encourages feature map reuse
- Utilizes implicit multi-scale deep supervision
- Accelerates convergence speed
- Better pixel intersection-over-union compared to U-Net like architectures

For more information about this opportunity, please see

Zhou et al - DLMIA Workshop - 2018

For more information about the inventor(s) and their research, please see

Dr. Liang's laboratory webpage