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Attention Res-UNet:
Attention Residual UNet With Focal Tversky Loss for Skin Lesion Segmentation

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ABSTRACT

During a dermoscopy examination, accurate and automatic skin lesion detection and segmentation can assist medical experts in resecting problematic areas and decrease the risk of deaths due to skin cancer. In order to develop fully automated deep learning model for skin lesion segmentation, the authors design a model Attention Res-UNet by incorporating residual connections, squeeze and excite units, atrous spatial pyramid pooling, and attention gates in basic UNet architecture. This model uses focal tversky loss function to achieve better trade off among recall and precision when training on smaller size lesions while improving the overall outcome of the proposed model. The results of experiments have demonstrated that this design, when evaluated on publicly available ISIC 2018 skin lesion segmentation dataset, outperforms the existing standard methods with a Dice score of 89.14% and IoU of 81.16%; and achieves better trade off among precision and recall. The authors have also performed statistical test of this model with other standard methods and evaluated that this model is statistically significant.

KEYWORDS

Attention gates, Dermoscopy, Lesion Segmentation, Medical Images, Residual connections, Squeeze and Excitation

1. INTRODUCTION

Automated medical image segmentation has been extensively studied in the medical image analysis field since radiologists usually have to manually look for malignancy in a pool of images and match cancer-related features to candidate tumors (Hesamian et al., 2019b). In this process of diagnosis, some features may get easily missed in many cases and there also exist some important features that cannot be extracted visually but can be with an automated system. The disagreement among different radiologists in the segmentation of images is reported to be between 2% to 49% (Hesamian et al., 2019b). All these facts are the primary motivation for designing a computer aided segmentation

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model for segmenting medical images accurately. As per 2022 statistics related to cancer article (Siegel et al., 2022), approximately 1,918.030 cancer cases will be detected of which 99,780 will be of melanoma skin cancer. A report by (Siegel et al., 2021), the death rate of cancer has dropped from its peak in 1991 to 2018 because of a reduction in smoking and the development of models that lead to early detection and medication of cancer. If detected in the early stages the survival rate for melanoma skin cancer is 93% according to 2021 statistics (Siegel et al., 2021). The unconstrained development of abnormal cells leads to skin cancer which can further spread to the rest of the organs of the body. Cancer of the skin is often defined as fatal melanoma or benignant (Wei et al., 2019). Among various kinds of skin cancers, melanoma cancer is of utmost deadly, accounting for a large percentage of skin cancer deaths(Siegel & Miller, 2019). Because of the fatal nature of melanoma, it has attracted ample research and clinical attention.

Photography, dermoscopy, confocal scanning laser microscopy (CSLM), optical coherence tomography (OCT), ultrasonography, magnetic resonance imaging (MRI), and spectroscopic imaging are presently utilized to help dermatologists in skin lesion identification (Hasan et al., 2020) . Dermatologists commonly visually scrutinize the produced photos using the specified procedures to detect cancerous skin, which is typically thought to be a laborious and time consuming task. Dermoscopy, which has been in use for over 20 years, has increased the diagnostic rate when compared to viewable surveillance solely (Mayer, 1997). The ABCD benchmark assists non-professionals in distinguishing benignant melanocytic naevi from melanoma while screening skin lesions (Abbasi et al., 2004). End-to-end computerized technologies that can precisely segment skin lesions of all sorts are very appropriate to emulate the clinical ABCD benchmark. Computer aided diagnostic programs have been designed to support medical experts and enhance accuracy. In many diagnostic centers, computer aided diagnosis has become the habitual clinical practice for diagnosing abnormal growth of lesions in medical images. Computer aided technologies for dermoscopic medical images are typically most of the time made of more than one unit including image acquisition, image pretreatment, segmenting images, feature mining, and classification units (Fan et al., 2017)(Jalalian et al., 2017). The precise segmentation of lesions in Dermoscopy images from the normal skin serves a significant role in gaining unique and exemplary characteristics of melanoma areas of interest in Dermoscopy images(Wei et al., 2019). Several skin lesion segmentation models (Yuan, 2017)(Ebenezer & Rajapakse, 2018)(Berseth, 2017)(Bi et al., 2017) that utilize deeper neural networks with convolutional layers have been developed and have substantially improved the outcome of segmentation. Though, automatically segmenting skin lesions from their background is still considered an open research problem or a challenging problem because of the following reasons:

- Deep CNNs can't be effectively trained due to a lack of data in the medical imaging field. Deep learning methods have greatly enhanced the performance of medical image segmentation however these networks usually require a huge amount of labelled input samples to execute the training. Gathering such huge quantity of labelled dataset in medical image analyses is oftentimes a vigorous task and annotating new images will also be tedious and costly.
- There is an imbalance in labeling Dermoscopy images as some of the lesions occupy a small portion of the images and cannot be discriminated from the background so the recall rate of models must be improved. A low recall means small size skin lesions are missed.
- Skin tumors generally occur in different colors, shapes, and locations, have uneven and vague boundaries, and have a low distinctive feature with the neighboring skin. Also the existence of several artifacts like body hair, frames, air bubbles, blood vessels, shadows, haphazard lighting, markers, and ink. (Hasan et al., 2020) can escalate the complexity of segmentation models.

To the best of our understanding, these issues have yet to be fully resolved. In this research paper, the authors focus on how to deal with data imbalance and boost the performance of computerized segmentation of skin lesions. The authors propose an ensemble Attention Res-UNet model by

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