



# Proposing a novel Cascade Ensemble Super Resolution Generative Adversarial Network (CESR-GAN) method for the reconstruction of super-resolution skin lesion images

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## ABSTRACT

**Background:** Skin cancer is one of the most malignant cancers worldwide. Its early detection plays a prominent role in the patients' treatment. The quality of skin lesion images to ease the diagnosis of skin cancer is highly regarded. One of the most common technologies to take the skin lesion images is through a dermoscopy device. However, it is not accessible to all people. Capturing the images via other technologies such as mobile devices, is available everywhere, although they suffer from poor quality.

**Materials and methods:** In this paper, a novel Cascade Ensemble Super Resolution Generative Adversarial Network (CESR-GAN) method is proposed to reconstruct super-resolution skin lesion images using low-resolution counterparts. Specifically, a novel feature-based measurement loss function is designed to obtain more details as much as possible and generate higher quality images.

**Results:** Experimental results from quantitative and qualitative comparisons between our CESR-GAN model and other state-of-the-art methods show that our proposed method outperforms the compared methods on ISIC, and PH<sup>2</sup> datasets, respectively.

**Conclusion:** The CESR-GANs method can be used to generate super resolution skin images of skin lesions with highly notable performances.

## 1. Introduction

Skin cancer is one of the most common diseases, and it includes approximately one-half of the annually diagnosed cancer types [1]. The most aggressive form of skin cancer is Melanoma with a considerable death rate, about 1% of casualties in the United States with skin cancer is because of this type [2]. Early detection plays a prominent role in patients' treatment processes and can increase their survival rate. The estimated survival rate for diagnosed patients in 5 years rises from 15% to more than 97% if identified at the earliest stage [2].

An automated diagnosis system is a great tool to assist physicians in making clinical decisions. This is incredibly considerable for skin cancer detection since it is challenging for physicians to diagnose Melanoma. Even in specialized centers with unaided eyes, they achieve almost a little more than 60% accuracy [3].

Details of skin cancer images are essential in the lesions' diagnosis; therefore, it is important to have quality images. A dermoscopy device takes high-quality skin lesion images, but it is not ubiquitous for all

patients worldwide. Also, it is still challenging for the experts to identify skin cancer based on images taken with a dermoscopy device.

Nowadays, one of the most cost-effective and accessible technologies for patients to take a skin lesion image is using mobile devices. Unlike the dermoscopy images that can show the below surface of the skin with high-resolution and high-magnification, the images taken from a smartphone have various challenges, including poor lighting conditions and blurred motion out-of-focused or shaking images. To use these poor quality images for automatic skin cancer diagnosis, the main prerequisite is to enhance their quality.

Therefore, the main aim of this study is proposing a novel method for the reconstruction of super-resolution skin lesion images from the low quality ones. Since there is a lack of publicly published skin lesion mobile images, we converted the International Skin Imaging Collaboration (ISIC) images into low resolution (LR) ones and assess our proposed method by evaluating its performance for generating super resolution (SR) images from LR ones.

ISIC dataset is a broad, publicly available dataset of images captured

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