DERMO-CrACY – a dermatology solution

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RESEARCH CONTEXT

Skin cancer is common worldwide, with an increase in incidence over the last decade. Diagnosis is conducted using the **dermatoscope**, an instrument that allows the viewing and subsequent acquisition of an image of the skin lesion in a high-resolution and epiluminescent manner. Early diagnosis is crucial for the prognosis of affected patients and reduces the complexity of treatment and the resulting morbidity. Recently, and even more in the current pandemic context, **teledermoscopy**, in which doctors consult dermoscopic images transmitted electronically, has recently been shown to be effective in triage and in the early detection of skin cancers.

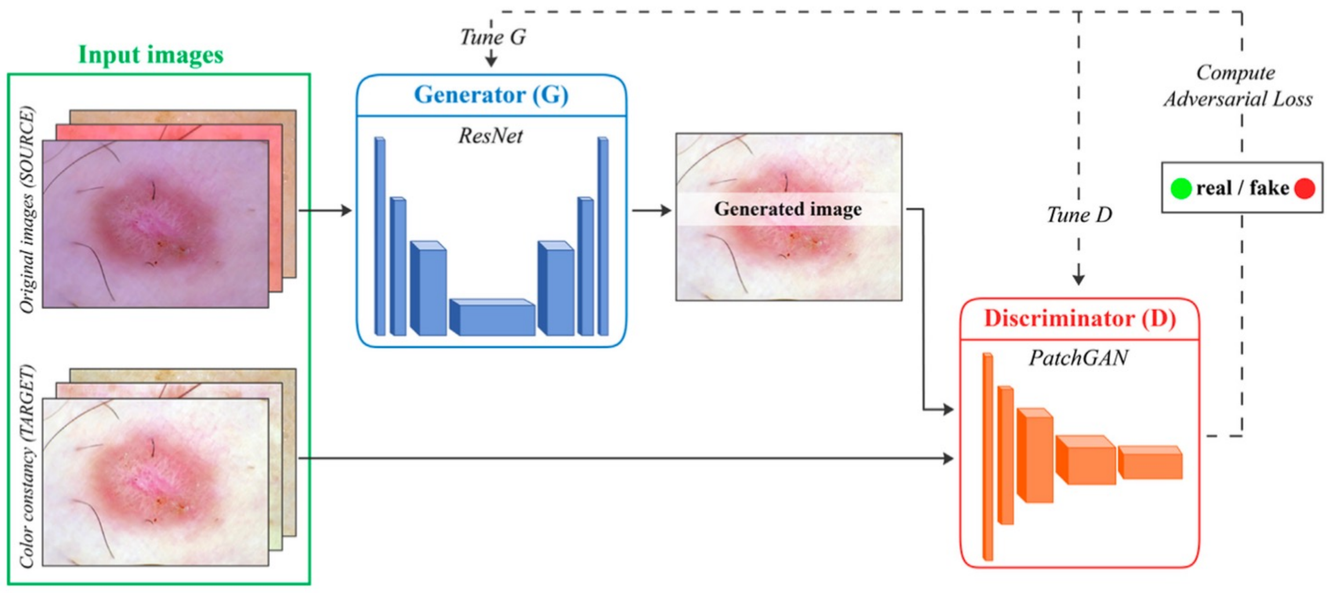
In this context, the overall topic of my PhD research program is the development of an open-source cloud-based method for both acquiring dermoscopic images using a smartphone microscope and for the subsequent normalization/segmentation/classification of the acquired images using deep learning- based techniques.

METHODOLOGY

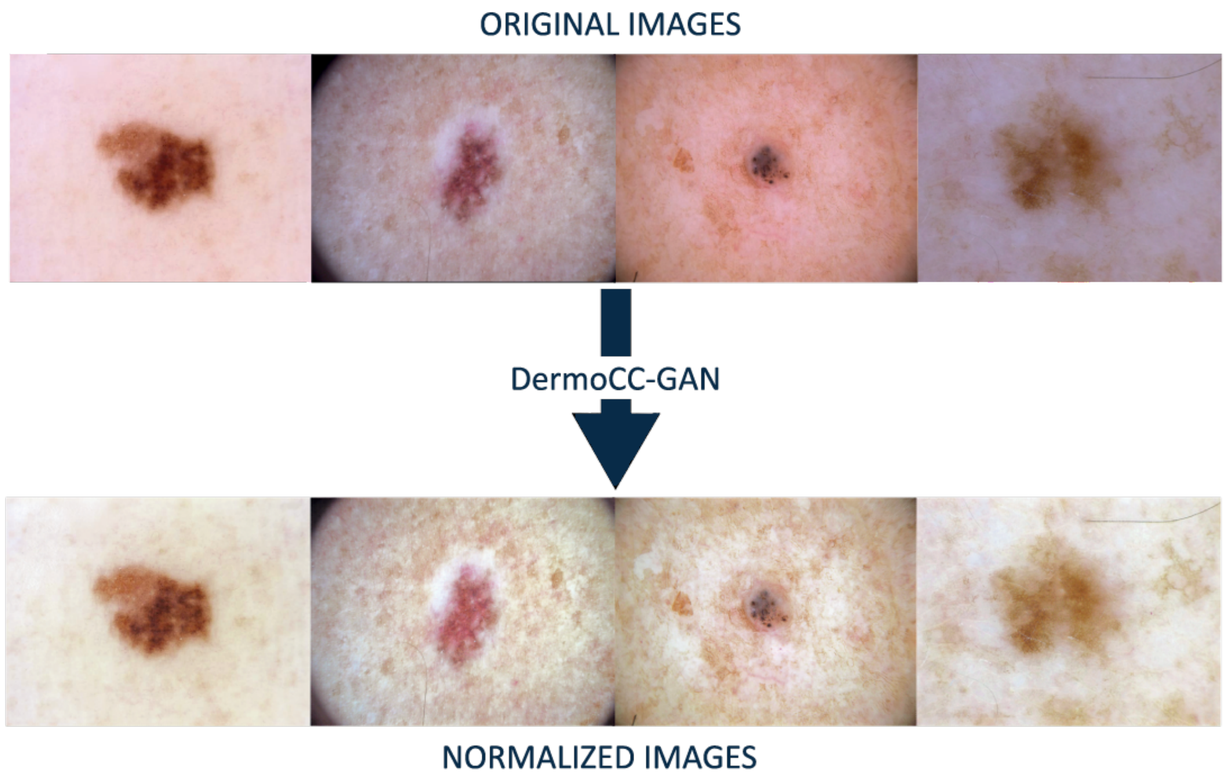
Some of the main factors that most influence image quality, and consequently the accuracy of the clinical visual diagnosis is the **illumination** and the **high chromatic variability** of the images. State of the art color costancy algorithms partially succeed in lowering this variability, given their **heuristic** and **parameter-dependent** nature. From the need for a robust yet versatile instrument comes ***DermoCC-GAN***, a GAN (Generative Adversarial Network) based color constancy tool that allows to obtain images that seems to be acquired with the same acquisition preset.

The **main novelty** of ***DermoCC-GAN*** is the formulation of the color constancy task as an **image-to-image translation problem**.
A pix2pix model was trained with 1300 pairs of 512x512 images (original image and image standardized with a custom heuristic algorithm that performs optimal color-costancy on the training set).
The model was trained for 200 epochs and updated every 64 images (batch size).
The model hence learns the **domain transfer task** (from original to color standardized image) and is then able to accurately apply the color constancy on test images characterized by different illumination conditions.

The proposed framework was tested using a test-set of 8715 images.



RESULTS



DermoCC-GAN was compared with the leading state-of-the-art color-costancy algorithms: GW (Gray World), SOG (Shades of Gray), Max-RGB.

The quality of normalization was assessed in terms of **NMI** (Normalized Median Intensity)-SD and NMI-CV.
Lower values indicate that the method is more able to transform an entire image dataset into a common color space.
Our DermoCC-GAN outperforms the other algorithms by obtaining the lowest values (0.0461 NMI SD and 0.0527 NMI CV).
To assess the impact of the color constancy provided by DermoCC-GAN within a deep learning framework, both classification and segmentation tasks have been implemented:

- ***Classification task*** = DenseNet121 trained on DermoCC-GAN normalized images obtained the highest average accuracy of 79.2% vs. an average accuracy of 76.6% obtained with original images.
- ***Segmentation task*** = UNET trained on DermoCC-GAN normalized images obtained the highest average dice of 90.9 vs. an average dice of 81.1% obtained with original images.

FUTURE WORKS

- The development of a framework capable of generating synthetic dermatoscopic images via GAN, with the aim of making the already implemented CNN-based classification systems more robust.
- The development of a GAN-based enhanced method for dermoscopic images.

PUBLISHED WORKS

It is possible to view all published papers by framing the QR-Code.

ATTENDED CLASSES

HARD SKILLS

- **01UJBRV** Adversarial training of neural networks (15 Hours)
- **01QTEIU** Data mining concepts and algorithms (20 Hours)
- **01UJUIU** Human-Ai Interaction (25 Hours)

SOFT SKILLS

- **02LWHRR** Communication (5 Hours)
- **01SHMRR** Entrepreneurial Finance (5 Hours)
- **08IXTRR** Project management (5 Hours)
- **01RISRR** Public speaking (5 Hours)
- **01SYBRR** Research integrity (5 Hours)

Tutors: Filippo Molinari, Kristen M. Meiburger, Massimo Salvi

PhD Day 2022
25th October 2022, Dental School, Torino