



# Diagnosis of Precancerous Lesions with Narrow Band Imaging

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## Introduction

The treatment of tumor diseases, especially detections of precancerous tumors, is currently one of the biggest medical challenges [1]. Therefore, it is of great clinical significance to have early and automatic diagnosis on preneoplastic lesions.

**Narrowband imaging (NBI)** is one of the emerging endoscopic technologies, it filters out the broad-band spectrum of the red, blue and green light waves emitted by the endoscopic light source, leaving only the narrow-band spectrum for the diagnosis of various diseases [2]. NBI light is composed of only blue and green light as shown in figures below.

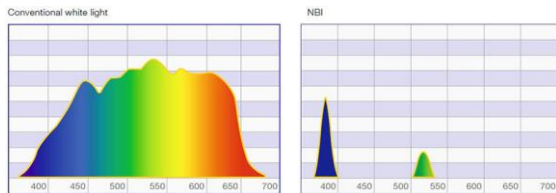
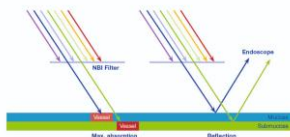


Fig1. Compared with WL, NBI is composed of only blue and green light [3]



The blue light will be absorbed and reflected by the surface of mucosal, and green light will be reflected by the vessels beneath the mucosal

Fig2. In NBI's vision, veins are shown in green because the green light will be reflected by them [3]

### Objectives of the project:

- Using deep-learning-based methods to generate "fake" NBI images from given white light images due to the high cost of NBI devices (in progress)
- Implement deep learning methods for detection of precancerous lesions using NBI images

## Image Style Translation

### Implementations:

Due to the alignment issues between white the WL image and the NBI image. The white light images have been pre-processed in Photoshop to simulate the NBI effect. The contrasts of the images have been adjusted based on R,G and B values, respectively. Some comparisons among WL images, NBI images and processed images are shown as below.

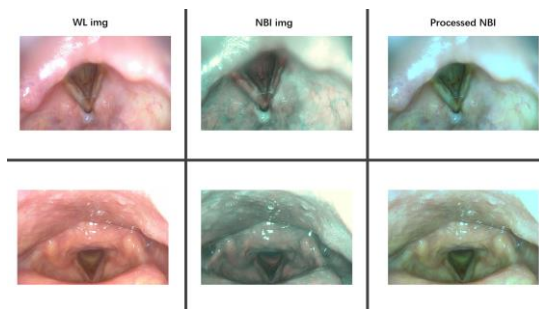


Fig3. Samples of the white light images(left), NBI images(mid column) and processed images (right)

### Known Issue and Improvement:

Vessels in NBI images are highlighted in green pattern as the green light has been reflected by vessels. Automatic image processing methods are hard to achieve this effect. Therefore, some areas may need to be colored manually.

## GAN for NBI Images Generation

**Generative Adversarial Networks (GAN)** is a classic deep learning model aiming to generate a given style of images with its Generator-Discriminator structure. In the training process, the job of the generator network **G** to generate fake images as close to the real images as possible to deceive the discriminator network **D**. The goal of **D** is to separate **G**'s images from the real image as much as possible. In this project, the input of **G** will be the white light images, the output of **G** will be the generated NBI images. Then both the generated and real NBI images will be sent to **D**, and the discriminating result from **D** will be used to update the weights of **G**. The process could be illustrated as figure below.

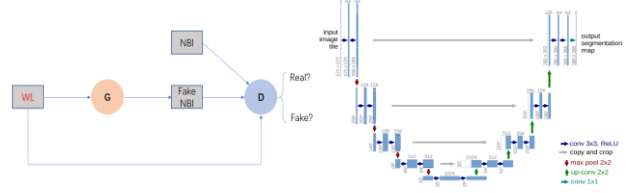


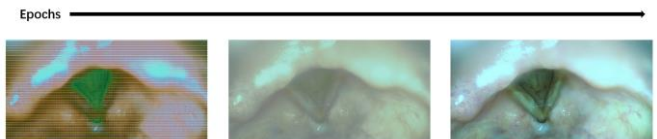
Fig4. The structure of the designed network

Fig5. Classic U-net structure

Since **G** requires WL images as input instead of random noises (in GAN's method), encoder-decoder structures like FCN and U-net have been taken into considerations. In this project U-net has been used as **G** due to the following reasons:

- The skip-connection of U-net helps maintain and share the low-level features during the encoding and decoding processes.
- U-net works well for small-scale dataset. Therefore, even with a limited number of NBI images, the light-weight structure of U-net could avoid the overfittings.

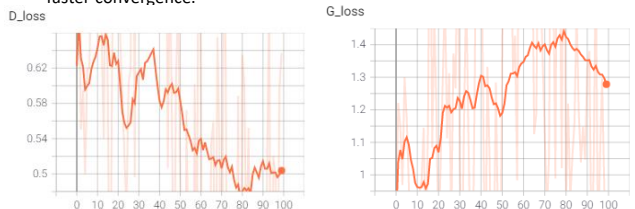
The network has been training for 100 epochs in total, and some of the training results (the fake images generated by **G** network) are visualized below:



## Discussion on Current Works

So far, the project could successfully generate fake images with decent NBI effect with helps of processed images and the GAN structures. Further works have been planned for better performance.

- In order to make the effect processed NBI images closer to the real photted images, more artiest works (like contrasts modification on some local regions) need to be done.
- The losses of **D** was fluctuating around 0.5 during the training process (figure below). According to GAN's theory, it proves the generator has enough simulate the desired effect. But generator's structure could be improved for faster convergence.



### Future Plans

- Continue modifying the GAN's structure for better performance
- Start working on lesions classification and localization on the labelled NBI images by applying related deep-learning-based methods

## References

- [1] C. Barbalata and L. S. Mattos, "Laryngeal Tumor Detection and Classification in Endoscopic Video," in IEEE Journal of Biomedical and Health Informatics, vol. 20, no. 1, pp. 322-332, Jan. 2016, doi: 10.1109/JBHI.2014.2374975.
- [2] Singh, Rajvinder et al., "Advanced endoscopic imaging in Barrett's oesophagus: a review on current practice." World journal of gastroenterology vol. 17, no. 38, 2011
- [3] OLYMPUS EUROPA SE & CO.KG, "NARROW BAND IMAGING (NBI) A New Wave of Diagnostic Possibilities.," 2015, [Online] Available: [https://www.olympus-europa.com/medical/rmt/media/en/Content/Content-MSD/Images/SCP-Pages/EndoAtlas/E0428859-NBIClinical\\_brochure\\_EN.pdf](https://www.olympus-europa.com/medical/rmt/media/en/Content/Content-MSD/Images/SCP-Pages/EndoAtlas/E0428859-NBIClinical_brochure_EN.pdf)