**BACKGROUND**

Medical images especially throat and endoscopy images are normally hazy, lack of focus, or uneven illumination → difficult the diagnosis process for doctors.

A method to improve the quality of medical image to support the diagnosis is essential → Deep learning-based image dehazing technique is promising to address this problem.

However, paired ground-truth training images for supervision are almost unavailable to obtain in reality.

We propose an unsupervised medical image improvement framework (MIINet) for supporting doctors in making medical diagnostic decisions.

**PROPOSED METHOD**

MIINet has two modules:
- Image Dehazing Module (IDM): To transform bad quality image to clean image.
- Image Super-resolution Module (ISR) (optional): To enlarge image size when doctors need to inspect more details.

- IDM is improved version of CycleGAN. ISR is adapted from ESRGAN.
- We propose the perceptual loss ($L_{perceptual}$) to preserve important attributes from original input such as structure, color, texture.

**EXPERIMENTAL RESULTS**

**Dataset**
- We collected 200 low-quality (LQ) throat images and 1,400 high-quality (HQ) throat images.
- Training IDM: 100 LQ and 100 HQ (randomly selected from 1,400 HQ images). Training ISR: 1,400 HQ images. Testing: 100 LQ images.

**Evaluation metric**
- Mean doctor opinion score (MDOS) based on the mean opinion score is used to evaluate the quality of throat images.
- Three experienced doctors were asked to give scores (from 1-5) for LQ, CycleGAN/MIINet generated throat images (higher is better).
- Mean doctor opinion score (MDOS) for supporting doctors in making medical diagnosis.

**DISCUSSION**

- CycleGAN improved a much better visual quality from LQ images but still has much lower scores in comparison with our MIINet
  - CycleGAN either changes the color or generates different structure or texture from input images.
  - CycleGAN learns to generate images that look close to the target domain (similar color) and has no mechanisms to preserve the original attributes.
  - Generated images from CycleGAN are not favorable for making medical decisions.

- MIINet are recommended to support throat diagnosis based on doctor’s feedback
  - The introduction of the perceptual loss helps the MIINet to generate compelling quality images and preserve the originality from inputs.
  - Significantly improved the MDOS from original LQ images.

- There is a trade-off of adding perceptual loss
  - In a very few cases, CycleGAN generates slightly better visual focus images than our MIINet since it has more freedom to generate close outputs to the HQ target images.

**CONCLUSION & FUTURE WORKS**

Conclusion
- We proposed the medical image improvement framework (MIINet) for supporting making medical diagnosis.
- We confirm the effectiveness of our MIINet for supporting doctors in image-based throat diagnosis by using the MDOS testing.
- The introduction of simple yet effective perceptual loss largely improved the quality of LQ images and achieved a promising result on the real-world throat dataset.
- Generated images from MIINet are more favorable for doctors to make their decisions.
- Our MIINet could have a potential impact on different types of medical images.

Future works
- Evaluation of MIINet is still based on subjective metric (MDOS), adding more objective metrics is important to confirm the effectiveness of our method.
- Further development on different types of medical images is needed.