Chest X-Ray Images Classification and Deconvolution

BME 590 Project Proposal

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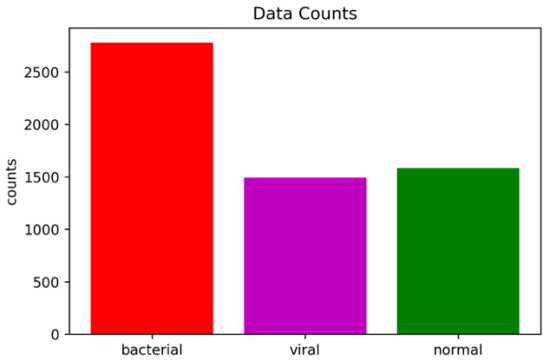
• General Aim

Nowadays, the diagnosis of pediatric pneumonia is a stressful task all over the world. According to WHO, pneumonia kills about 2 million children every year and is thought as the leading cause of childhood mortality.[1] To better protect our next generation, accurate and timely diagnosis is necessary. Thus, we may want our X-Ray images to be classified automatically to detect the presence of lung infection and whether the infection is viral or bacterial. However, the X-Ray images are often blurred due to physical systems (***focal spot blur***) and make classification much harder. This project will simulate this blurring effect and discuss the impact of it (how it may affect the classification accuracy) and try to reconstruct the images by using CNN.

• Discussion

(a) Data Sources

The X-Ray images used in this project are derived from pediatric patients of one to five years old from Guangzhou Women and Children's Medical Center, Guangzhou, China.[2] It contains 5856 X-Ray JPG images and 3 categories (normal, bacterial and viral) in total. Nevertheless, this dataset is imbalanced, as it has 2780 bacterial cases, 1493 viral cases, and 1583 normal cases.



(b) Expected Simulations

The X-Ray images are often affected by ***focal spot blur***, which can be modeled by the convolution of the ideal image and a gaussian blur kernel.[3] To figure out how this effect may affect our classification system, the chest X-Ray pictures will be smeared by using convolution and hence generate a blurred set. The classification accuracy will be compared between using the original set and the blurred one.

Since the blurring effect reduces image quality, the deconvolution process is important as well. In this project, we are going to compare a conventional method called the Richard-Lucy algorithm and CNN to find out whether CNN can help to deblur or not.

(c) Expected CNN

For classification, a simple CNN will be enough. It will take each image as an input and output a one-hot code to represent its category.

For deconvolution, I am going to use U-Net.[4] It will take a blurred image as input and generate a deblurred image having the same size.

(d) Quantitative Analysis

On the whole, this project is going to discuss the impact of X-Ray images blurring and try to reconstruct unblurred images. The main quantitative analysis in this project will be:

1. The classification accuracy comparison among using original, blurred and deblurred images.
2. The deconvolution effect comparison between using Richard-Lucy and U-Net. The tentative criteria used in this project will be the Frobenius norm between the original picture and the deblurred one. Besides, the visual effect of the reconstructed images should be a primary reference as well.

$$|D|_{Frobenius} = \sqrt{\sum_i \sum_j |d_{ij}|^2}$$

$$D = I_{original} - I_{deblurred}\ (elementwise\ subtraction)$$

• References

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[3]. Nagesh, S.S., Rana, R., Russ, M., Ionita, C.N., Bednarek, D.R. and Rudin, S., 2016, March. Focal spot deblurring for high resolution direct conversion x-ray detectors. In Medical Imaging 2016: Physics of Medical Imaging (Vol. 9783, p. 97833R). International Society for Optics and Photonics.

[4]. Kuntz, J., Maier, J., Kachelrieß, M. and Sawall, S., 2019, March. Focal spot deconvolution using convolutional neural networks. In Medical Imaging 2019: Physics of Medical Imaging (Vol. 10948, p. 109480Q). International Society for Optics and Photonics.