# 4 -Week-Report

# Comparative analysis of different color models for color Normalization

## Introduction

Hematoxylin and Eosin (H&E) stains are one of the primary tissue stains for histology. This is because H stain makes nuclei easily visible in blue against a pink background of cytoplasm (and other issue regions). This enables a pathologist to easily identify and evaluate the tissue.

One of the foremost and challenging tasks in H&E stained histological image analysis is to reduce the color variation present among images, which may remarkably affect the performance of the digital histological image analysis. For automated image analysis, these H&E stained images need to be normalized. This is because of the significant variation in image colors arising from both sample preparation and imaging conditions.

Stain normalization is an important processing task for computer-aided diagnosis (CAD) systems in modern digital pathology. This task reduces the color and intensity variations present in stained images from different laboratories. Consequently, stain normalization typically increases the prediction accuracy of CAD systems.

## Literature Review

- **'Digital Image Processing'** by Rafael C. Gonzales and Eugene Woods,

  The book very well explained the fundamentals of image processing and different color models like the RGB, HSI, CMY, CMYK, and Lαß and their interconversion techniques through which I was able to write down my own functional code in python to convert one image format to another. It has also very well explained different image processing methods such as histogram processing, smoothing and sharpening, and color Image segmentation, which has enhanced my understanding and interest in image analysis.

- **A method for normalizing histology slides for quantitative analysis** in Proc. IEEE Int. Symp. Biomed. Imag., Nano Macro, Jun./Jul. 2009, pp. 1107–1110 by Marc Macenko; Marc Niethammer; J. S. Marron; David Borland; John T. Woosley; Xiaojun Guan; Charles Schmitt; Nancy E. Thomas.

This paper provided two mechanisms for overcoming many of the known inconsistencies in the staining process, thereby bringing slides that were processed or stored under very different conditions into a common, normalized space to enable improved quantitative analysis.

It also very well explained one of the color normalizations which was relatively very simpler to understand and implement. And this also contained a sample Matlab code which also explained The entire process of conversion with great simplicity.

- Circular Clustering in Fuzzy Approximation Spaces for Color Normalization of Histological Images, **IEEE Transactions on Medical Imaging,** 39(5), pp. 1735--1745, May 2020. by Prof.Pradipta Maji and Mr. Suman Mahapatra.

  This paper provided me with insights on a new rough-fuzzy circular clustering algorithm for stain color normalization as well as an NMI, and BICC index for quantitative evaluation of the correlation of different color models which would be helpful for me in the evaluation of the strained images after the normalization process and to come up with a conclusion of the color model selection.

## Methodology And Future Works

Within the past four weeks, I have been reading and understanding color Image processing and different color models and their conversion techniques such as RGB ↔ CMY, RGB ↔ HSI, and RGB ↔ Lαβ, and have successfully Implemented these operations using the python programming language with utmost accuracy as the prebuild function in python's Open CV module. ( GitHub Link ).

Currently, I am working on the normalization of color Images (H & E strained) of breast cancer data sets using 3 color models (ie RGB, HSI, Lαβ ) for which I am going through some standard research papers just for understanding the different methods for normalization of strained images. And using a quantitative index defined in one of the recent papers of my guide, I will be using it for the comparative study and hence will practically determine which color model is more fruitful for H&E strain normalization.