Quantitative Analysis of Lipid Droplets using iterative image processing

GROUP 23
ANKUR ABHIJEET (1911026) ; SMS
SUMMIT BIKRAM NAYAK (2011167) ; SPS

Introduction : This paper explores the use of machine learning algorithms for efficient and accurate quantification of lipid droplets in cells, providing promising potential for disease diagnosis and treatment.

Related papers: “A novel automated image analysis method for accurate adipocyte quantification”

"Deep Learning for Quantitative Analysis of Lipid Droplets in Cells"

Baseline Algorithm: K-means clustering is used in quantitative analysis of lipid droplets using iterative image processing to segment images of cells and identify regions of interest, such as individual lipid droplets, based on their unique intensity values.

Image Preprocessing:The first step is to preprocess the image by removing any noise or artifacts that may interfere with the analysis.

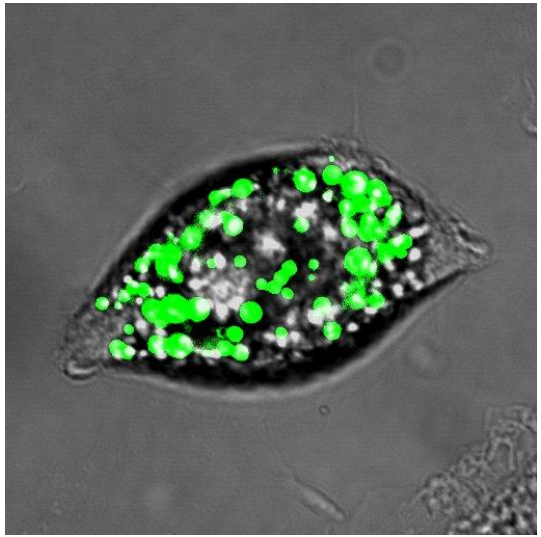
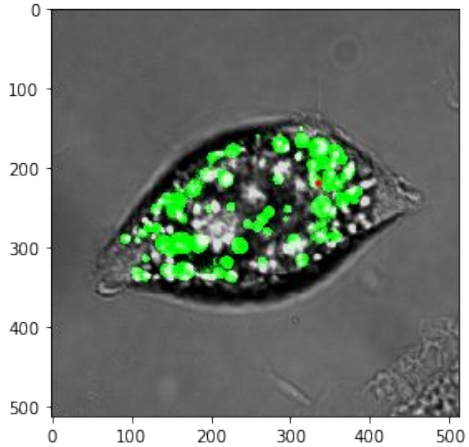
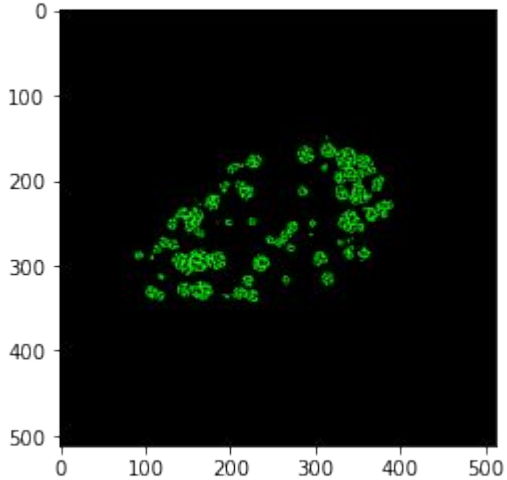


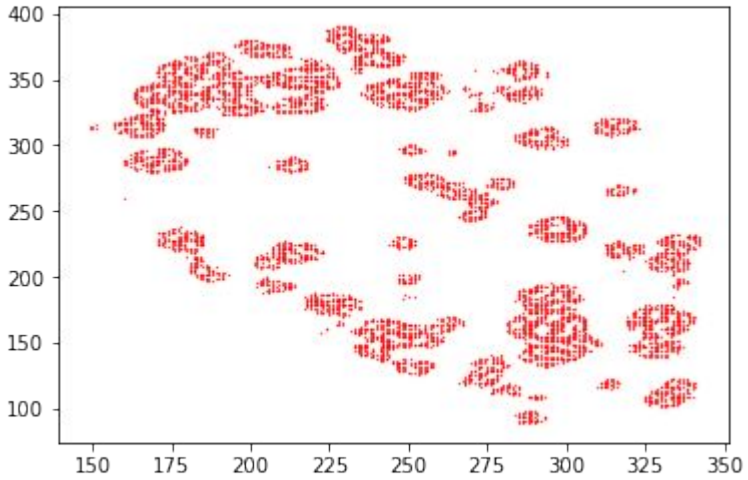
Image Segmentation:The next step is to segment the image into different regions, where each region represents a potential lipid droplet.

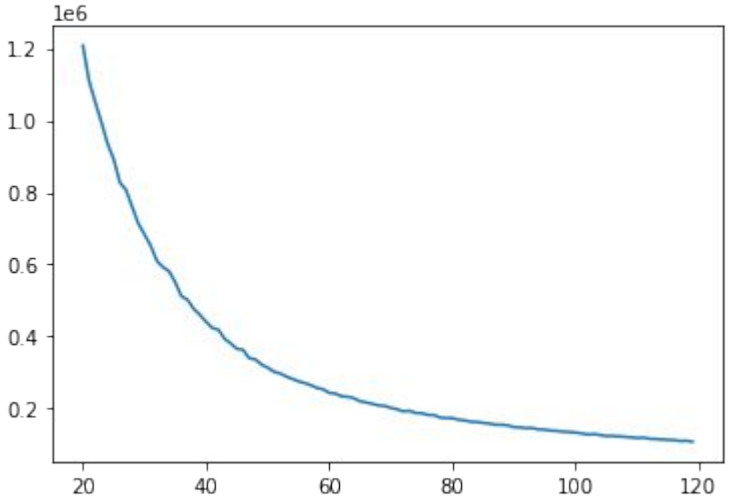
Feature Extraction: The third step involves extracting features from each segmented region such as differentiating on the basis of color.
The stained part in the picture provided was found to be having a 255 in green pixels for the lipid portions.



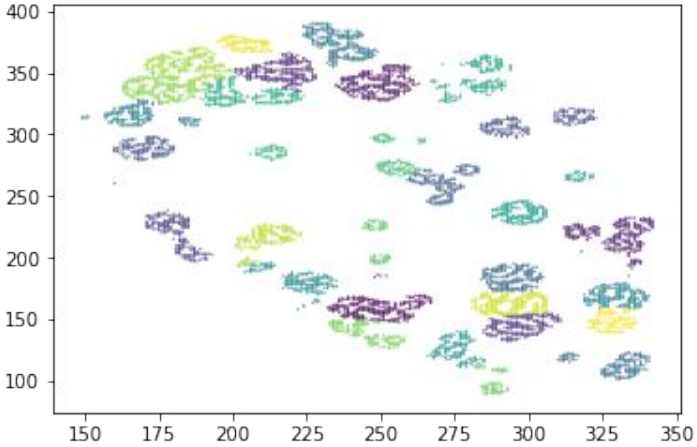


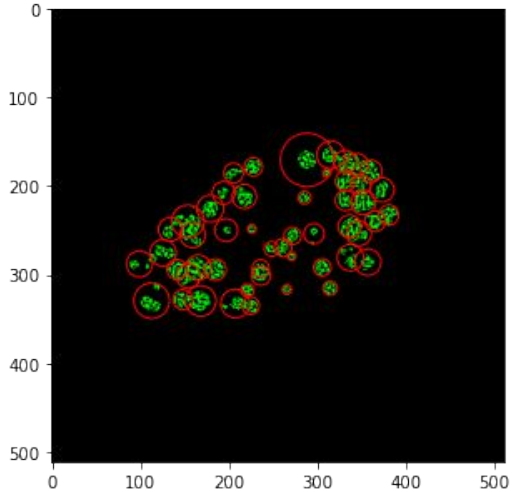
K-means Model: Using K Means model with manual input of k and then using elbow method to get a optimum k value. The photo was converted, stored and processed as a numpy array for using k means.





Clustering :now the model can be used to cluster the segmented regions into different groups, where each group represents a lipid droplet. The model clusters the lipid droplets in form of drops to identify the specific segments as drops of liquid.

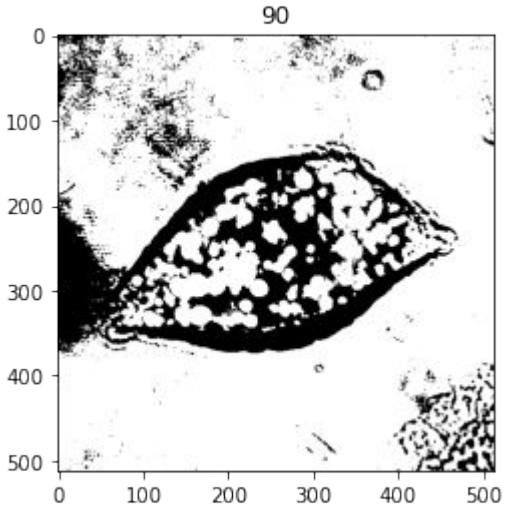


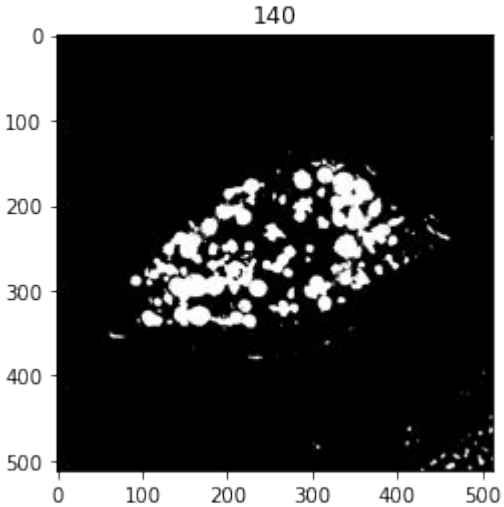


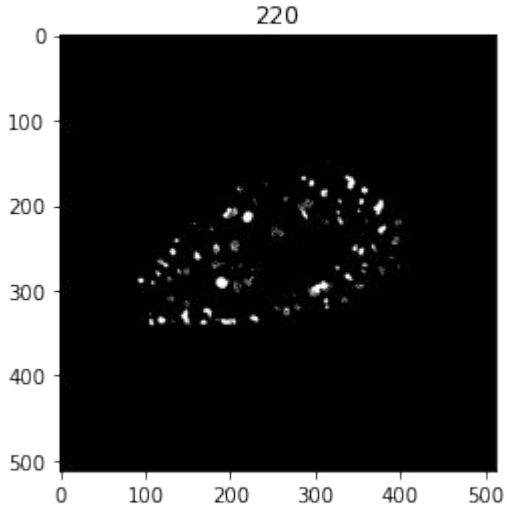
Post-Processing: The quantification of lipid area can be done by calculating the area of each cluster centroid. The final step involves post-processing the results to obtain the final lipid droplet quantification.

Limitations faced

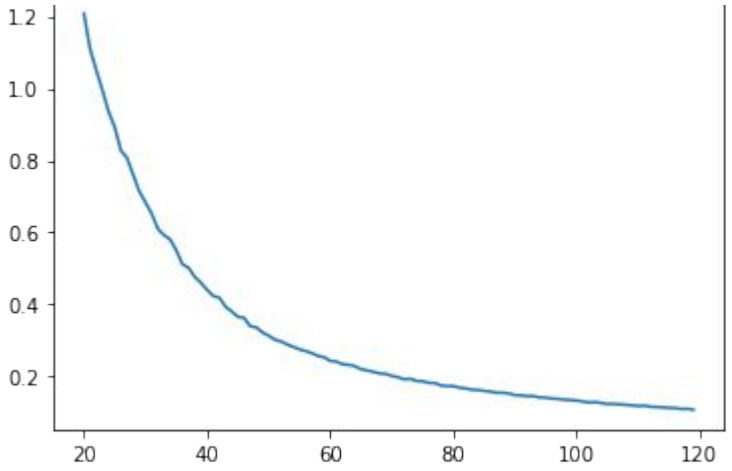
At first we tried to differentiate on the basis of pixel value after converting the image to greyscale, then we faced problems in selecting the optimum pixel and the shifted to green scaling in the RGB segment, helping us to identify the segments with stained lipids.

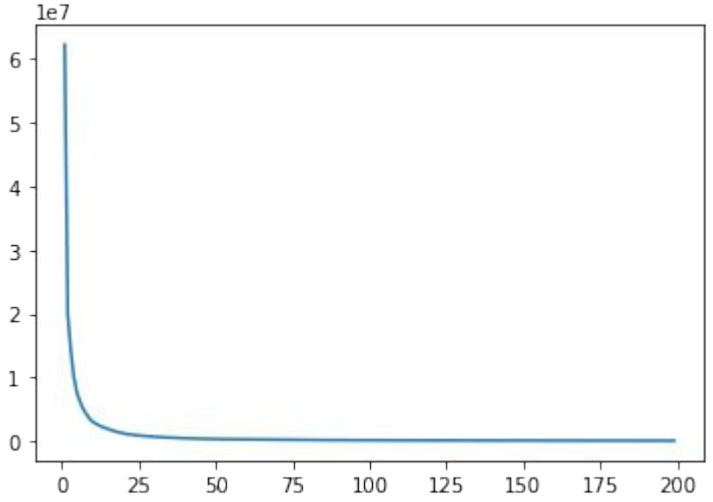




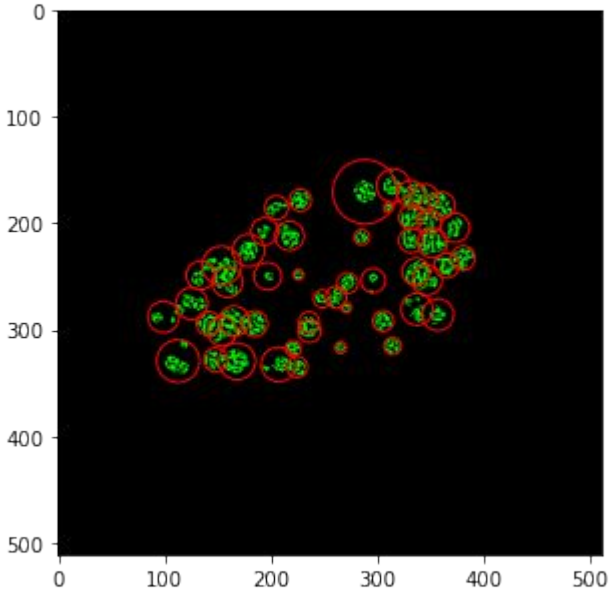


The next hurdle faced was to get the optimum k value. The elbow method comparing the total area along with number of centroids provides us with a suitable k value. But in this case we were not able to obtain a sharp drop in area for an optimum k value. Thus, we chose it at a point that seems feet manually.





The most important problem faced is determining the radius of individual centroids as some small green fragments are considered to be part of the circle increasing the expected area.



Plans:

1.Finding out a way to workout the problem with elbow method or find a way to work around it.

2.In cases such as in the figure shown , we can try to work with dividing the big empty circles multiple

smaller ones.

3.Working out a solution to find the cell boundary in the same picture

References:

[1] Osman, Omnia Selway, Joanne Kepczynska, Malgorzata Stocker, Claire O'Dowd, Jacqueline Cawthorne, Michael Arch, Jonathan Jassim, Sabah Langlands, Kenneth. (2013). A novel automated image analysis method for accurate adipocyte quantification. Adipocyte. 2. 160-4. 10.4161/adip.24652.

[2] Digital image analysis approach for lipid droplet size quantitation of Oil Red O-stained cultured cells Author links open overlay panel Manuel J. Deutsch, Sonja C. Schriever, Adelbert A. Roscher, Regina Ensenauer Research Center, Dr. von Hauner Children's Hospital, Ludwig-Maximilians-Universität München, 80337 Munich, Germany