Population Density Analysis of a Liver Lobule

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Abstract: We wanted to compare the population densities of hepatocytes and sinusoids in a generated liver lobule with a real image of a liver lobule. We used Matlab to generate the functions to compare the simulated image with a real image.

Introduction

The liver is comprised of a network of hexagonal liver lobules. Each lobule has a central vein from which sheets of hepatocytes radiate outward from. The hepatocytes are separated by a network of sinusoids. We wanted to study the relationship between the hepatocytes and sinusoids by analyzing their population density.
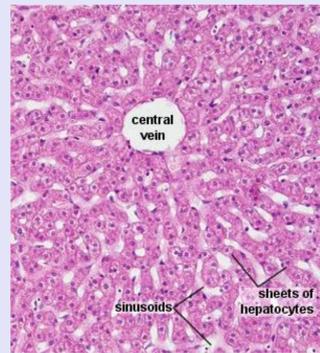

Fig 1: Labeled liver lobule (http://www.lab.anhb.uwa.edu.au/mb140/CorePages/Liver/Images/liv11he.jpg)

Methodology

We used Matlab to construct a simulated image modelling the hepatic structure and sinusoid network inside a hexagonal liver lobule. We also used Matlab to generate a comparable lobule from a real image. The following steps outline the process taken to compare the real image with the simulated image.
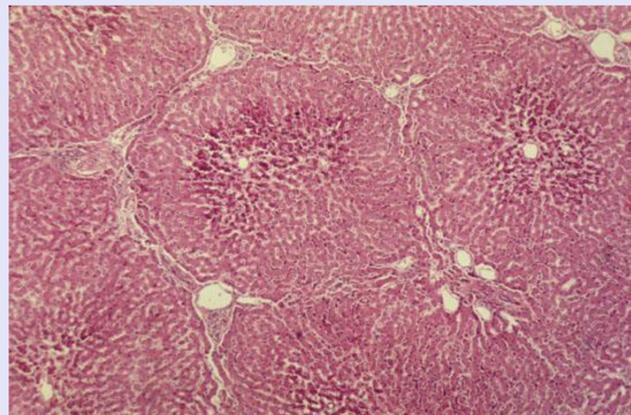

Fig. 2: Image of a real liver lobule
http://www.meddean.luc.edu/lumen/MedEd/orfpath/images/fig02x.jpg

Step 1: Taking a real image, we applied a function that separates the sinusoid network from the hepatocytes.
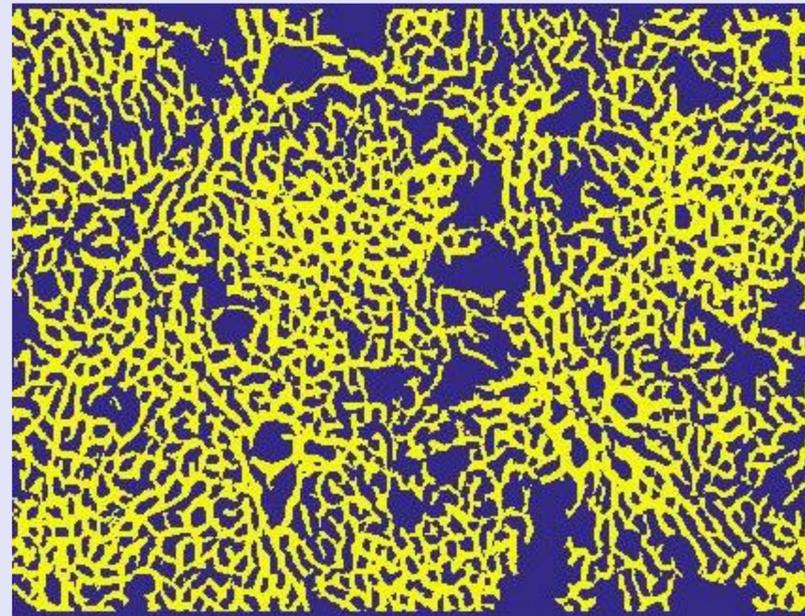

Fig. 3: Real image with isolation of hepatocytes and sinusoids.

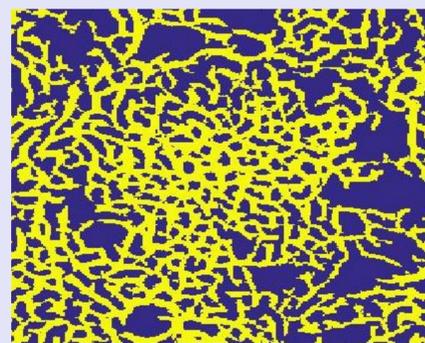**Step 2:** Isolate and center a rectangular region around the lobule we want to analyze.

Fig. 4: Isolated lobule of the real image.

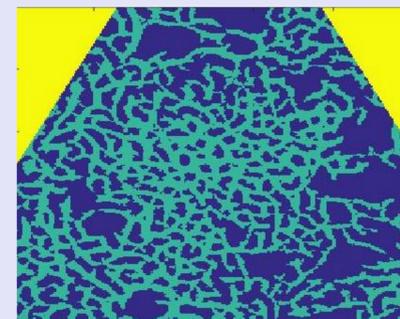**Step 3:** Apply a cutting algorithm to isolate a hexagonal shape.

Fig. 5: Isolated lobule with the top corners cut off.

Step 4: Compare the real image with the simulated image, making sure they are the same size. The simulated image was generated via a modified diffusion limited aggregation (DLA) algorithm within Matlab, in a separate project.
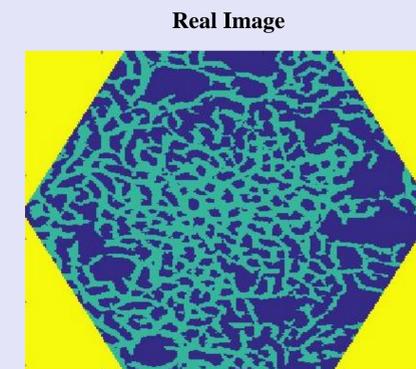
Real Image

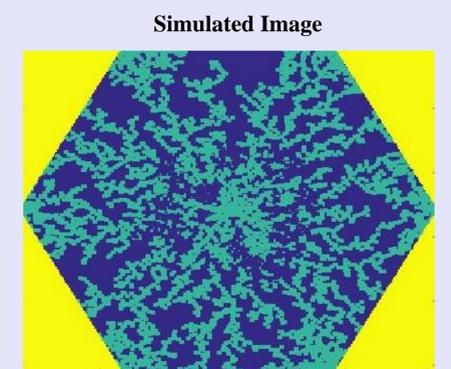**Fig. 6:** The generated sinusoid and hepatic distribution from the real image

Simulated Image

Fig. 7: The simulated image generated

Step 5: Use a histogram to compare the population density of the real image with the simulated image. Make the appropriate changes to the simulated image.
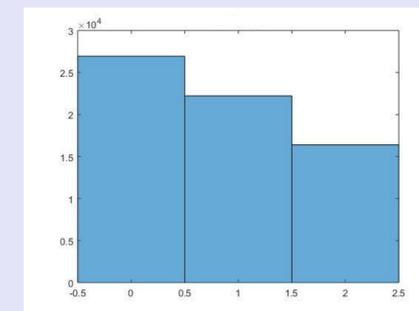

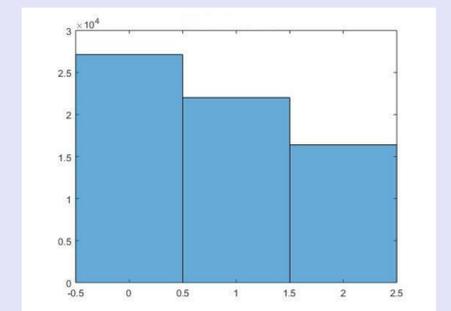**Fig. 8:** Hepatocyte and Sinusoid histogram of a real image

Fig. 9: Hepatocyte and Sinusoid histogram of the simulated image

Results

We were able to determine the appropriate ratio of hepatocytes to sinusoids in our generated image by comparing the histogram graphs. The first bar of the histogram is the hepatocyte population, and the second bar is the population of sinusoids. These results have helped us to make the simulated image as accurate as possible and will be used for investigating the diffusion of blood throughout the liver.