Image Display, Histograms, Brightness and Contrast

Image Processing & Analysis for Life Scientist

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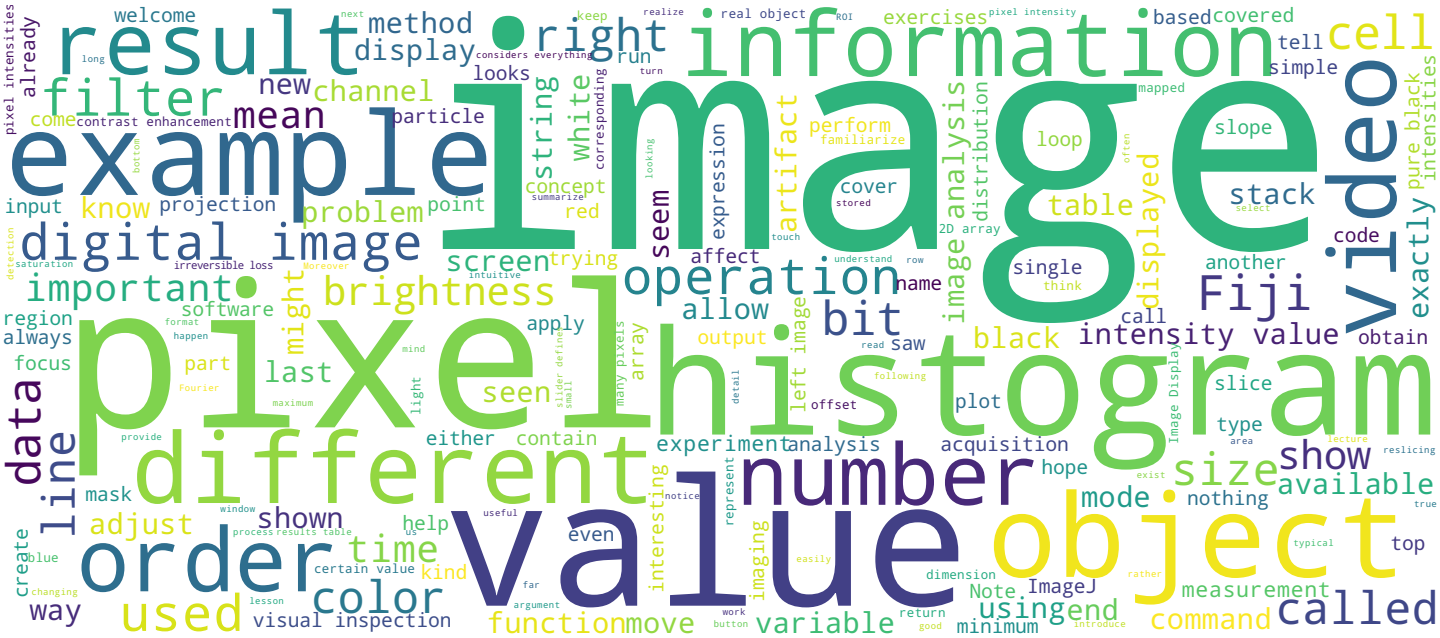

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Summary

- Representing Image Data
  - 2D Images
  - Histograms
- Basic Image Display Adjustment
  - Adjusting Brightness and Contrast

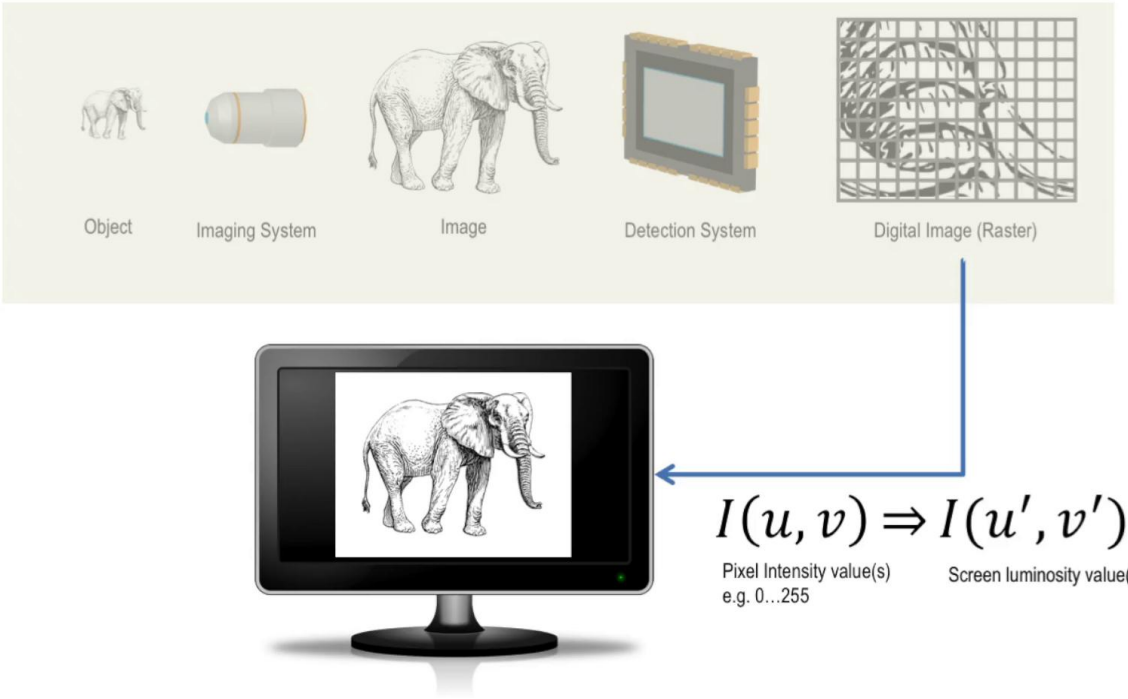
Hi! And welcome to this lesson on Image Display, Histograms, and brightness & contrast adjustment. In this video, we'll be approaching how digital images are displayed on a computer, and discuss ways in which image data can be represented. Finally, we'll see how image display can be adjusted for improved visual inspection. In detail, we'll see how digital images, which I will abbreviate as images for simplicity sake, can be represented. The typical forms are 2D intensity maps and histograms At the end of the video, we will go through the most simple way to adjust the display of an image: through contrast enhancement. And to touch on the problem of image saturation.

Notes

Summary

0m 05s

How A Digital Image Reaches Your Eyes

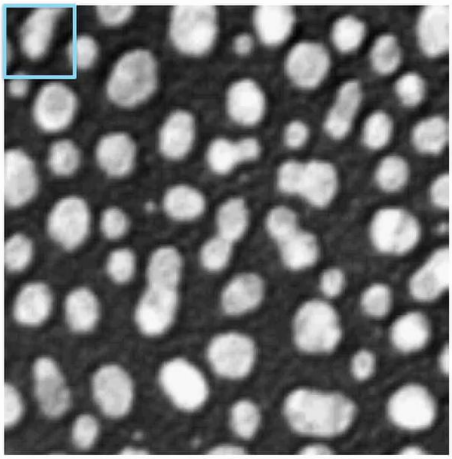


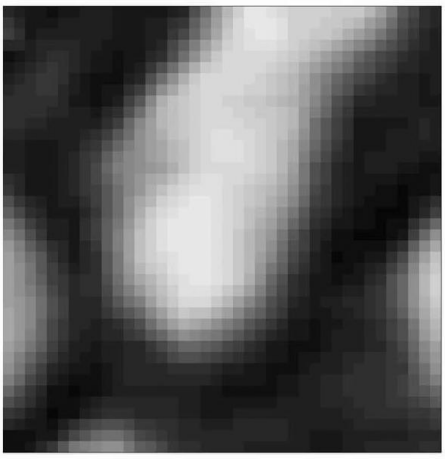
After the video, you'll have a few exercises to familiarize yourself with the ImageJ commands. And we will address what qualifies as acceptable contrast enhancement, and how to report it. Now, let's refresh on how we go from a real object to a digital image. What we have when looking at the monitor is the image of our object. However, to get there we have to go through an imaging system and a detection system that does the rasterization which means the discretization of the real object into the digital image. This classically gives rise to an array of value at different coordinates, which can then be displayed on our screen.

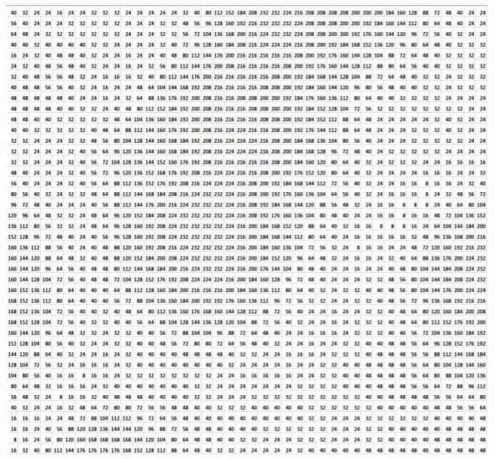
Notes

Summary

0m 44s







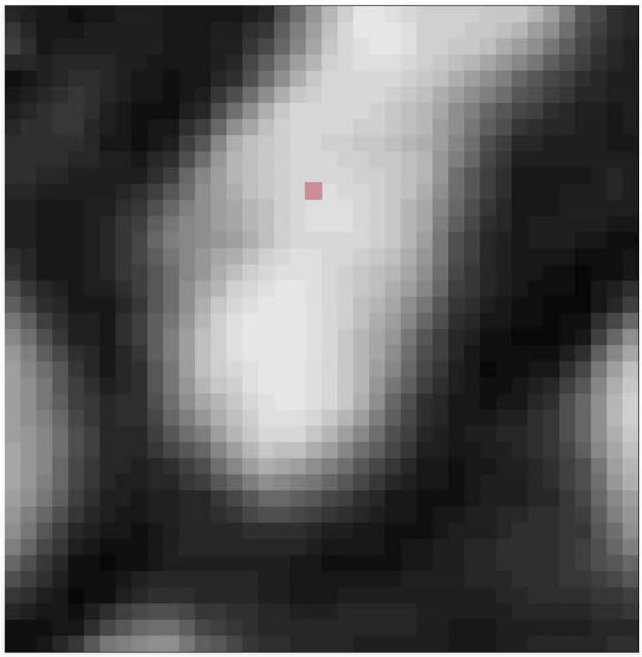
This means that if we take a look at the underlying data that represents the image, we should see nothing but numbers. If we take the blobs image from ImageJ's 'File > Open Samples' menu and focus on the upper left corner, we see that the image is made up of little squares. Inside each square or pixel a number is stored. This is the intensity value.

Notes

Summary

1m 20s

2D Data Arrays



So, really an image in this case is nothing more than a 2D array of numbers where each cell is what we call pixel. So, we have a 2D arrays of pixels and we know how to display it. Now, the interesting thing would be to be able to get some statistical information out of it. Because digital images aren't just about show and tell. They contain an enormous amount of information. At first, a typical approach would be to plot the distribution of the pixel intensities, or histogram, of the image.

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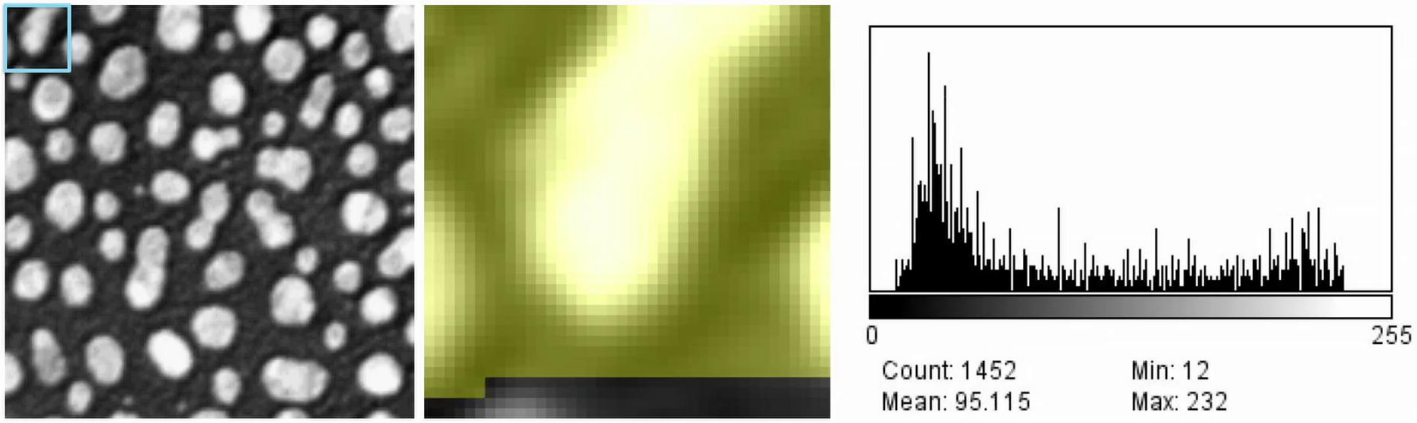
1m 44s

Image Histogram



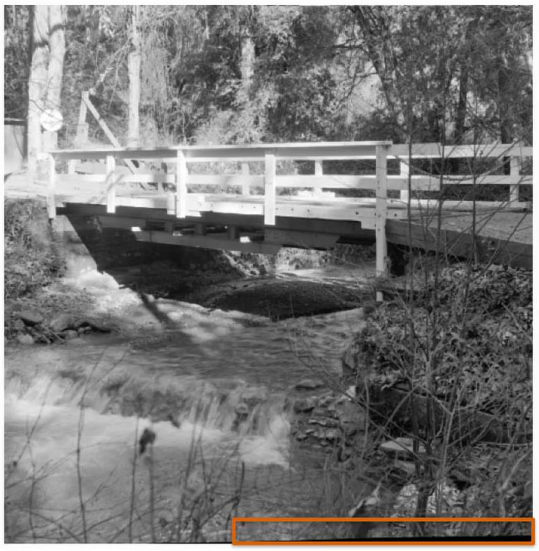
This simply consist in counting the number of pixels that have a given intensity value. This short animation shows you how histogram computed As we move through the image, we count how many pixels have a certain value, and plot this value on the right. The counts are accumulated and plotted on the live histogram on the right.

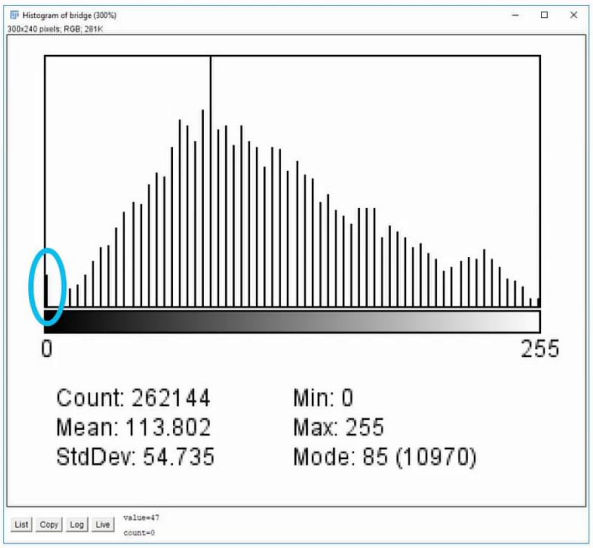
Notes

Summary

2m 12s

Histograms





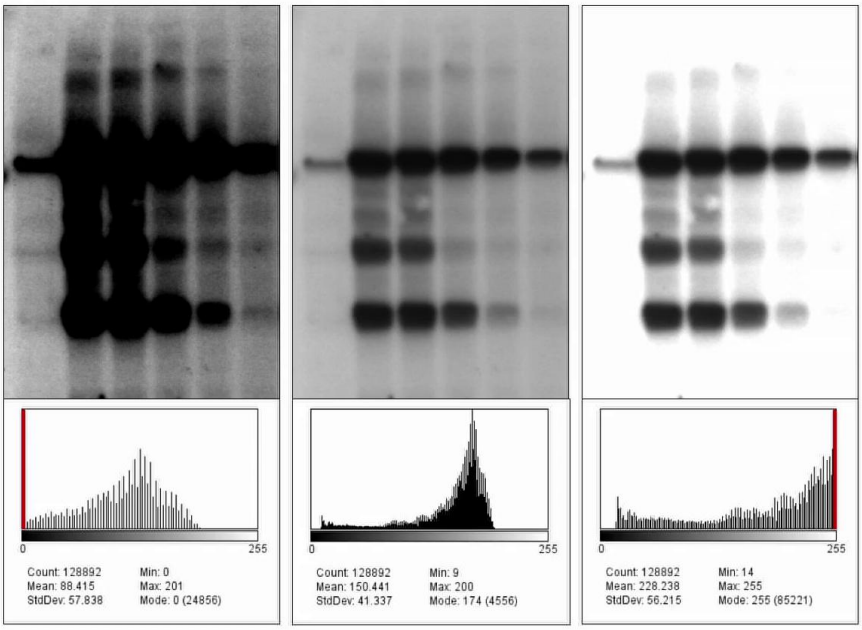
In Fiji, we can use the 'Analyse > Histogram' command to obtain an histogram plot from an open image Like in this example. The histogram does not provide any spatial information on where the pixels are, But just how many pixels of a certain value on the image On top of that, you can see that you get a lot of information at a glance from the histogram; such as the mean intensity, standard deviation count, min and max value and mode... It is interesting to note that if we focus on the the first bin of the histogram, we seem to have a lot of pixels that are exactly at 0. While not unusual in itself, it is odd that the distribution is not continuously growing from 0. There seems to be a gap in the histogram. This is because this image presents an artifact in the bottom right corner where there's a strip of pure black. Which is most likely not part of the image, but rather linked to a problem during the digitization of the image.

Notes

Summary

2m 32s

Artifact: Image Saturation



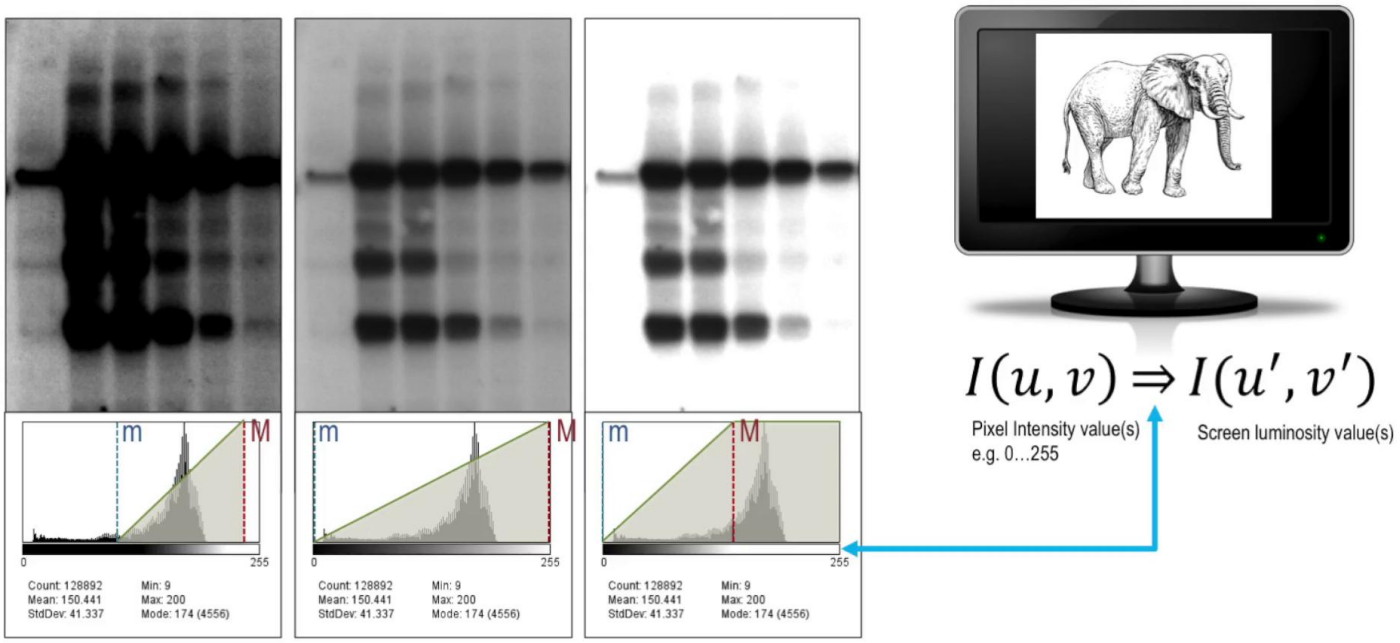
Which leads us to an interesting question What kind of artifacts can we discover with the histogram or visual inspection of an image? Here we see 3 images of western blot gel band Looking at them intuitively you might say that the left one feels underexposed or that the right one looks off, or manipulated. And you would call the central one a typical or appropriate image. But can we infer that information from the histogram in a more quantitative way? Well, it turns out we can! Note how in the left image most of the pixels are in the '0' bin Similarly, for the one on the right most of the pixels are in the last bin (255) of the histogram. You can read out this information by reading the 'mode' value that is written on the histogram. The mode is the value bin that has the most counts. Usually, histograms where the mode is exactly at 0 or 255, in the case of 8 bit images, tends to raise a red flag. why are almost all the pixel pure black or white? Usually that means we have saturation. Saturation means something went wrong somewhere. Either the chemical revelation process was too long, the detector, a camera in this case, was not able to capture the intensities adequately; or the image was manipulated somehow.

Notes

Summary

3m 27s

Brightness & Contrast (And Min & Max)



You should see a saturation as an irreversible loss of information which cannot be fixed after the acquisition. The only solution is either to re-run the experiment or reacquire the data. Bu if you look at these 3 images, you'll realize how each one enhances a different aspect of the data. The darkest image shows weak bands rather well, whereas the brightest image helps our eye exclude unwanted backgroud; and helps us focus on the strongest bands. If I show you the same 3 images again and tell you that all 3 are actually exactly the same, I believe I might have some skeptics among you. Didn't I just say we should be worried of artifacts. Well! Let's just look at the histograms! All 3 images have the same underlying histogram. What has changed is the way the pixel intensities are mapped to the screen. This famous function we were talking about! The left image considers everything below 100 values as black. The middle one uses the default mapping of 0 being pure black, and 255 being pure white. And finally, the right one considers everything above 150 as white.

Notes

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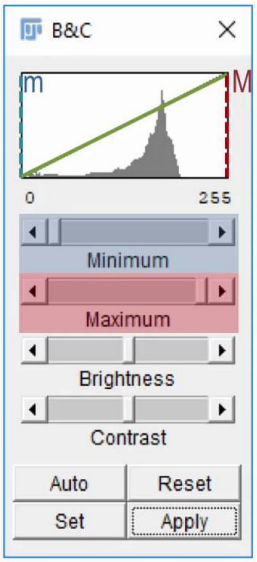
4m 43s

Brightness & Contrast (And Min & Max)



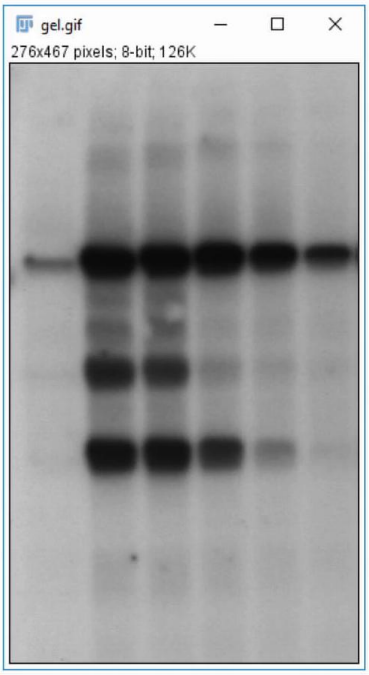


Image > Adjust > Brightness & Contrast

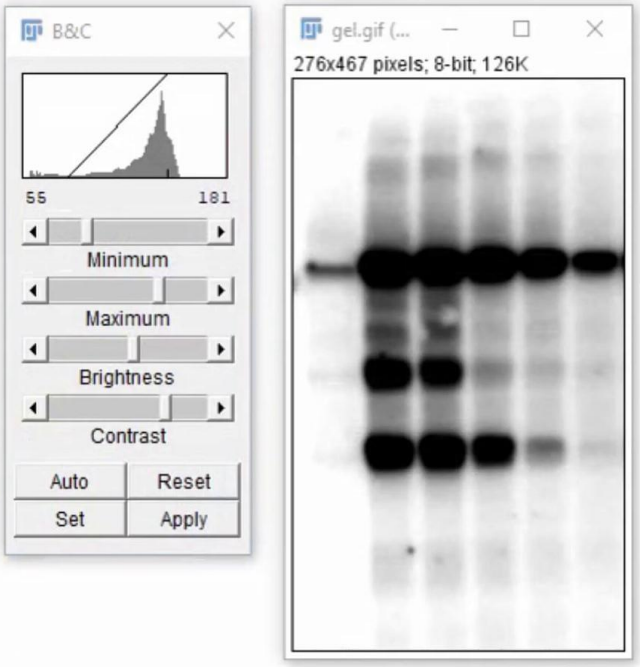
In Fiji, the brightness and contrast tool looks like this. On the top, you have a histogram as well as a line that shows how the pixel values are mapped to intensities on the screen. The 'Min' slider defines which values will be black. The 'Max' slider defines which values will be white. The last 2 sliders modify what we call brightness and contrast. But they're less easy to manipulate accurately for scientific data manipulation.

Notes

Summary

5m 48s

Brightness and Contrast in Fiji



If I show you what that looks like in the software, you can see what happens when I move the minimum slider... the maximum slider You also see how this affects the brightness and contrast sliders. If I move the brightness, we see that I'm changing the offset of that mapping curve Moving the contrast, however, affects the slope of that curve. So, we see why using the minimum and maximum can be a lot more intuitive than trying to first adjust the slope of the curve, and then trying to adjust the offset. Which is why we are not going to use those last two. Moreover, you'll notice that there are 4 buttons at the bottom of the brightness and contrast menu. And the more important one for you would be the 'Set' button which will allow you to precisely set the minimum and maximum values via a text prompt.

Notes

Summary

6m 16s

Conclusion

- Images are represented by their intensities
- Histograms allow for quantitative data to be extracted
- How to adjust brightness and contrast
- Careful of image saturation

Alright! So, in this video, we touched base with how images are displayed based on their pixel intensity; and on how we can already obtain relevant statistical data using histograms. We've also seen how to use Fiji to adjust an image's brightness and contrast for visual inspection. Finally, I hope that you understand the problem with saturated images; which is an irreversible loss of information on your image that makes quantification impossible. We will follow up this video with a few exercises to familiarize yourself with the Fiji commands and so that you can experiment for yourself. Thank you for your attention.

Notes

Summary

7m 11s