Automatic Banana Ripeness Assessment Using Color Detection

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Abstract

A banana goes through a drastic chemical change after being plucked from its tree. These changes start immediately and effect taste, nutritional value, and most importantly for this study color. I have applied some color detection techniques in order for us to accurately assess the ripeness of a given banana. Depending on your desired taste or nutritional intake you could change the timeframe in which you eat a given banana. I know when I make banana bread I desire slightly over ripened bananas for a softer texture and sweeter gooier texture. If you are on a strict diet then perhaps you would eat a banana that would more likely have a higher starch content or higher zinc concentration.

Keywords: Ripe, Ripeness, Color, Color Detection, Banana, Bananas, Automatic, Digital, Image, Processing,

Background

Automatic color detection has many, many applications from automatically detecting defective products, identifying certain regions on a map, medicine (Pan, 2009), facial recognition, and evaluating qualities of foods (Marchal, 2013). In this study I applied color detection across a selection of images of bananas. When putting together a project for GISC 4360K I knew that the principals and processes we had learned over the semester could be applied to things other than land use or building shadows and I wanted to display that. I chose bananas because I eat lots of them, and I recently had stumbled upon a video about shipping container logistics that used bananas as its main example of a popular shipping container product. The changes that occur in a banana can change the nutritional value of it quite drastically. A fresh banana can contain up to 25% starch while an over ripened banana can have less than 1% starch (Cordenunsi, 1995). The banana is considered to be a good source of Magnesium, but as a banana ripens the amount of magnesium decreases by approx. 40% (Adeyemi, 2009). Fresh bananas are a bright lime green color and turn to vibrant yellow within a week of being picked. Then they start to develop brown spots that spread until the majority of the banana is brown and the texture turns from a smooth waxy texture to a moist soft leathery texture as it ages. The amount of effort that goes into keeping bananas pristine for sales overseas piqued my interest. Bananas ripen to maturity in a matter of days, so finding the Ideal window of consuming this fruit is relatively narrow. I wanted to apply automatic color detection to identify the maturity of bananas by the color change they go through along their journey to your kitchen counter.

Materials and Methods

I started with finding my ideal set of pictures of bananas. These pictures had to be fairly high resolution for an accurate color assessment, and ideally had to have a plain background for more accurate extraction of the banana or bundle of bananas from the image. The less shadow and stem were in the image the better my results would be. These are my banana images:

Figure 1 (banana 1)

Figure 2 (banana 2)

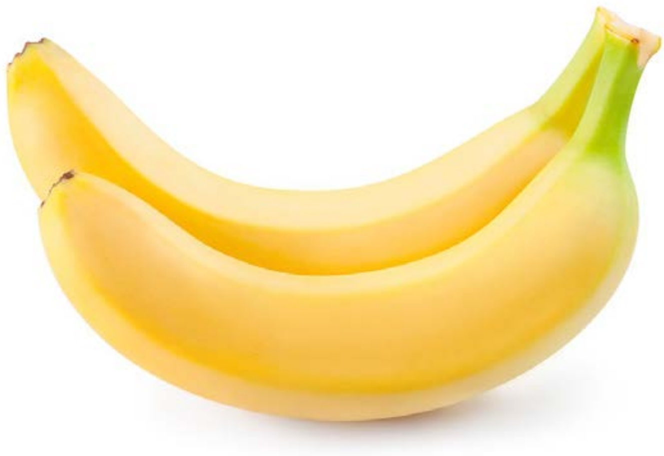

Figure 3 (banana 3)

Figure 4 (banana 4)

Figure 5 (banana 5) (Ideal Banana)

Figure 6 (banana 6)

Figure 7 (banana 7)

Figure 8 (banana 8)

Figure 9 (banana 9)

With this series of images, you can see the rapid change a banana goes through after being picked. This process happens in approximately two weeks give or take. All the images used in this study are approximately the same resolution and have white backgrounds. There are varying amounts of shadow and glare present in each image.

I chose banana 5 (Fig 5.) for my ideal banana as it landed in the middle of my range of banana images. It also looked the most appealing to me from experience. I figured this was about the middle point between not ripened to over ripened. I took a number of color samples in different areas of this banana in order to get a good range and not be biased to the stem end or the tip of the banana. The average of these samples was my target color for all my sample bananas.

I then used the RGB bands from each of my nine images to convert them to HIS. This was done in order to isolate the saturation of each image (Fig 10). This was done there would be an obvious contrast in saturation between by bananas and bright white backgrounds. The goal here being to isolate just the bananas for analysis.

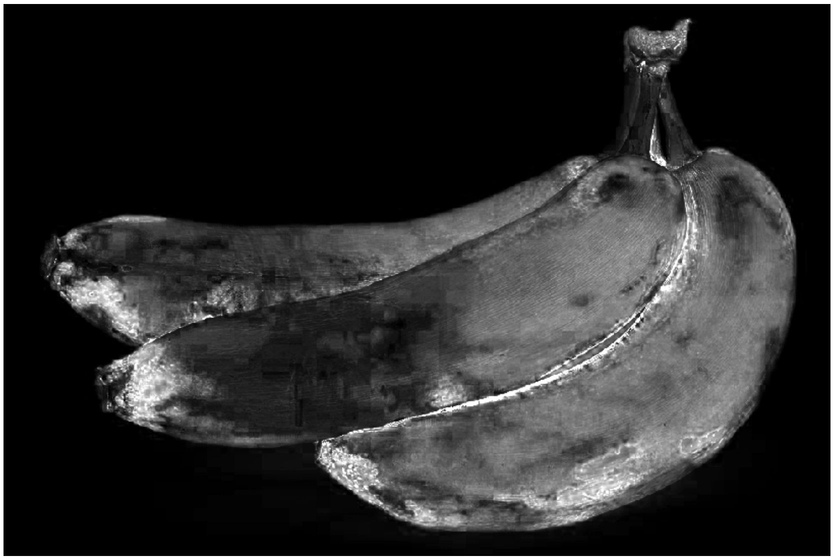

Figure 10 (banana 9 S layer)

I then use the saturation layer to reate a raster file separating the bananas and background into a raster with two different values; “0” being bananas, and “1” being everything in the image that isn’t a banana (Fig 11). This was done with the ARCPro raster calculator and using this formula: Con("Banana_s_layer" (s_value), 1, 0)

Figure 11 (banana 9 raster created from S layer)

I then turned this layer into polygons around the areas with contrasting values using the raster to polygon tool in the ARC suite and deleted the undesired areas (Fig 12).

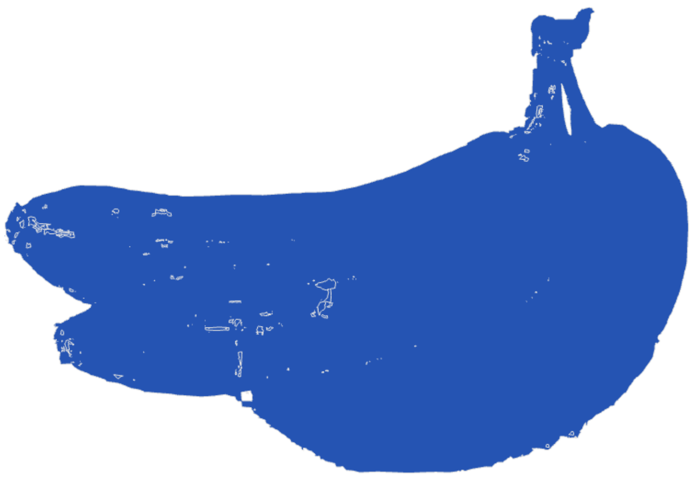

Figure 12 (banana 9 isolated polygon)

I then used this new polygon on my original image to extract the section necessary for the project. I then used the raster calculator once again to find the amount of pixels in my isolated image that were close in color to my original banana. This is the calculation used:

Con(("nana9_R" >= 240) & ("nana9_R" <= 253) & ("nana9_G" >= 204) & ("nana9_G" <= 231) & ("nana9_B" >= 77) & ("nana9_B" <= 148), 1, 0)

The result was a final raster image with pixels of two values; pixels within my range, and pixels outside the range (Fig 13).

Figure 13 (Banana 5 Final Raster)

Results

With the bananas isolate from their backgrounds and the pixels inside the mask analyzed I was able to look at what amount pixels were within my range and what amount weren't. you can see these ratio's in the table below (Fig. 14)

	outside range	inside range	total	inside range / total (ratio)
banana 1	268759	30	268789	0.000111612
banana 2	230489	44507	274996	0.16184599
banana 3	258339	28273	286612	0.098645556
banana 4	228092	27047	255139	0.106008881
banana 5	171299	191513	362812	0.527857403
banana 6	166504	10775	177279	0.060779901
banana 7	239687	9573	249260	0.038405681
banana 8	189606	1243	190849	0.006513002
banana 9	283414	851	284265	0.002993685

Figure 14 (Results)

The results do support the hypothesis, admittedly though, this may be a result of the process, as all color samples were chosen manually. Under the ratio column you can see that the ratio of my sample banana to my target color is much higher than the rest of my bananas being the only one with more than an 11% match. This may also be a result of various lighting conditions and quality of image as well. Adding in the human factor of a possible bias when selecting ideal color ranges is another factor to consider. The range on what is considered to be an ideally ripened banana may be a little narrow, leaving many of my results drastically far away from my ideal range. There could be many improvements to this process such as a controlled environment for photographing bananas with a constant source of illumination as to not distort color and reduce glare (Acharya, 2005), automatic color sampling, and perhaps a wider range of colors to define a perfectly ripened banana.

References

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