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The Invisible Revealed: Using Digital Photography to Determine a Material's Ability to Reflect Near Infrared Wavelengths

Research

Visible light, the light we see, is only a small part of the electromagnetic spectrum. There is a wide range of different wavelengths and frequencies of light that we cannot see. One of these invisible lights is called near-infrared.

Near-infrared light is the closest light on the red side of the visible light spectrum, or what we might call the rainbow of light. Near-infrared is a refection or an absorption of energy that comes from the sun but can not be detected by the naked eye.

Infrared light is usually divided into three sections: near-infrared (NIR), mid-infrared (MIR) and far-infrared (FIR). Near-infrared light is closest to the visible spectrum.

Problem

So how do colors react to this invisible light? Although black fabric appears black in visible light, does all black fabric absorb or reflect the radiated energy in the same way? I decided to try photographing black fabrics with different contents using a near infrared filter to see how they reacted to NIR rays.

Hypothesis

Based on my research, I believed the black fabric when photographed with a NIR filter would indeed show different signs of absorption or reflection of near infrared light energy. I believed that the contents of the fabric would affect how the material absorbed or reflected the near infrared rays. I believed that fabrics containing mostly natural materials would be more reflective than the synthetic materials.

Materials

I gathered the materials I needed to test my hypothesis. I needed the following items: Canon PowerShot S3IS digital camera, Hoya 58mm Infrared (R72) camera filter, HP Photo Printing software, eighteen different black materials, and my remote control (to test camera NIR sensitivity).

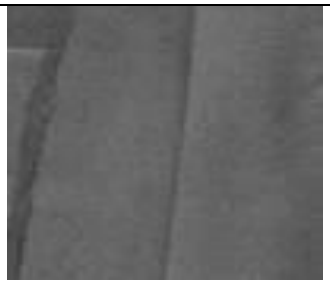
Experiment

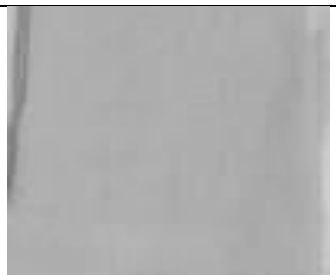
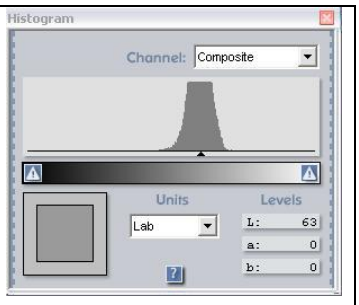
I tested my digital camera to make sure it would detect NIR light. Next, I took pictures of eighteen different black fabrics using a Hoya R72 NIR filter. Then I uploaded the pictures to my computer and compared my results.

I found that many of the black fabrics appeared quite light in NIR. And I found that it was difficult to tell which fabric reflected the most NIR rays. So, to truly decipher which

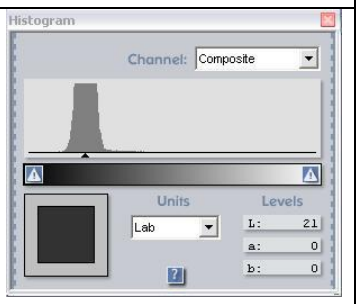
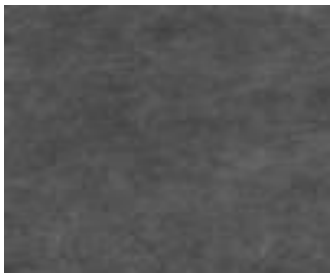
reflected the most NIR, I used a histogram that compared the Luminosity of each pixel in the picture. This was done with HP Photo Printing Software.

Data

Material	Photographed in NIR	Luminosity readings	Luminosity graphs
1. Stretch Poplin		65	Because of the size of the file when sending via email, I only include the histograms for the fabric with the highest Luminosity reading and the one with the lowest Luminosity reading.
2. Gabardine		41	
3. Suraline		69	
4. Organic Cotton		60	

5. Organic Cotton Knit		71	
6. Organic Bamboo Cotton		63	
7. Linen		54	
8. Polyester		63	
9. Polyester		50	

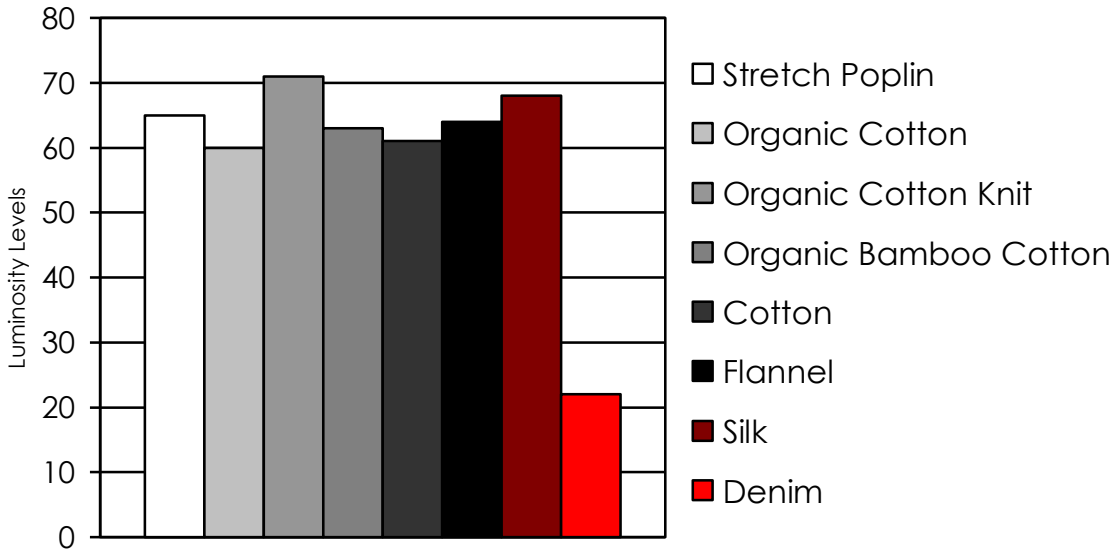
10. Fleece		69	
11. Cotton		61	
12. Flannel		64	
13. Silk		68	
14. Denim		22	

15. 65% Poly 35% Cotton		69	
16. Vinyl		21	
17. Stretch Fleece		63	
18. Felt		37	

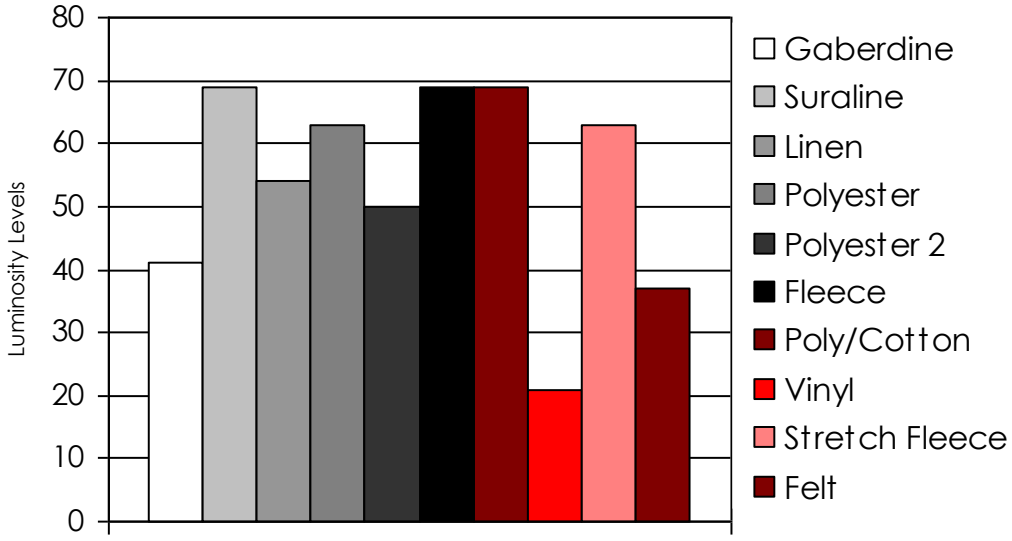
Results

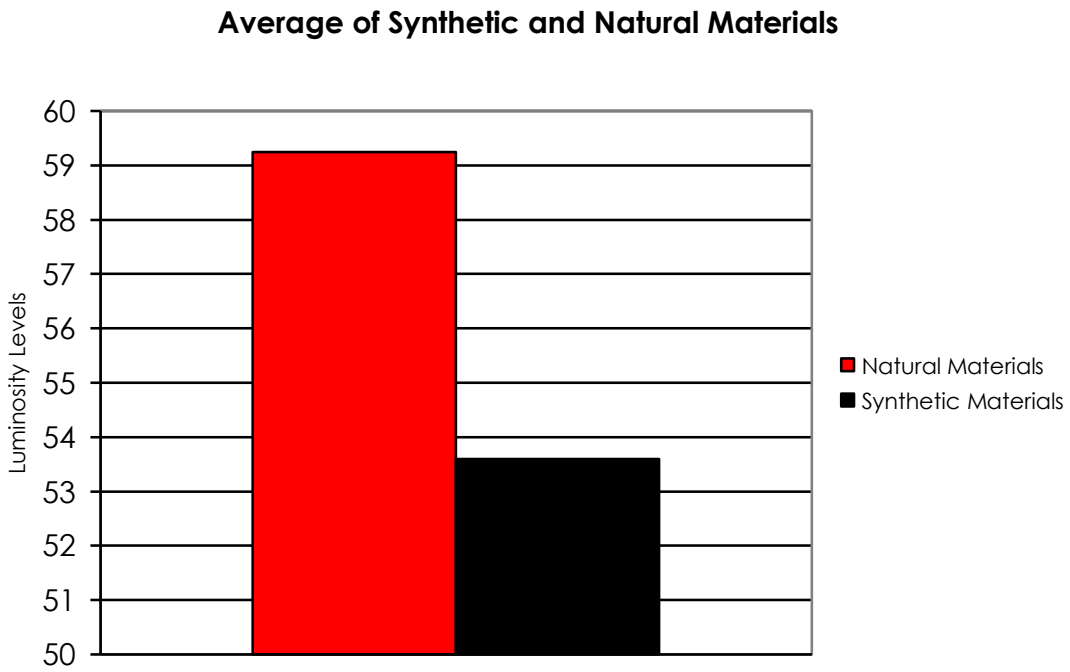
My experiment proved the contents of a material do affect its NIR light absorption. On the average those containing natural materials reflected more NIR rays and those containing synthetic materials. But, there were still some results that varied from my hypothesis such as two 100% polyester fabrics having different Luminosity levels and two 100% cotton levels having a difference of 38 in their Luminosity levels.

Luminosity Levels of the Natural Materials



Luminosity Levels of Synthetic Materials





Conclusion

This lead me to believe that perhaps there were other factors contributing to the results. This could possibly have been the dye or the characteristics of the fabric itself like the density of the weave or the height of the pile.

I can see where this information on black fabrics can come in quite handy. Whether you're working outside or you're wearing your sports uniform, the kind of fabric used can come into factor when out in the blazing sun. Through more research and fine tuning you could find a black soccer uniform that would reflect NIR energy from the sun, and that would have your team mates sweating less.

NIR photography could be used in more than just analyzing black fabrics. It could be used to test building materials to see which roof or brick reflects the most NIR rays. This could save on cooling costs here in Texas. It could even be used in law enforcement to see through those sunglasses.

What I Would Do Differently

To continue with this project, I would most definitely make sure I washed and ironed all my fabrics. I also think it might be interesting to compare different white fabrics. I could

also test other materials using the same idea but on something other than fabrics--maybe roofing materials, brick, or paint. I could even take a look at skin color.

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