Home-made Infrared Goggles & Lighting Filters

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University Physics II

Lab: H1

4/19/10

Trying to build home-made infrared goggles was a fun and interesting project. It involved optics and electricity. The optics related to the filtering of different wavelengths of light, and the electricity related to the wiring of the infrared LEDs. Two different colored "gels" were used to block all visible light while still allowing infrared light through. The infrared LEDs are then attached to provide a light source, and the goal is to be able to see the surrounding area that is lit up by the infrared LEDs. Many theories can be found about these types of goggles and how they work and what they can be used to see. These theories, along with many other ways to modify these goggles for different functions, will be discussed later.

The visible light spectrum ranges from about 380nm (violet) to 740nm (red) (Jones). The colored "gels" used to block this spectrum of light are actually theatre lighting filters. The two best filters to block all visible light are Primary Red and Congo Blue. The Primary Red filter blocks all visible light except for the very high end of the red spectrum of light, while Congo Blue blocks all visible light except for the very low end of the violet spectrum of light. When both filters are combined with multiple layers it blocks all visible light except for a small amount if red light and infrared light (<740nm), which is also known as monochromatic light (Jones). In theory, the infrared LEDs can then be attached and allow the person wearing the goggles to see in the dark. Three LEDs are powered by a 1.5V battery to produce the necessary infrared light to illuminate the surrounding area. The theory of being able to see in the dark was proven to be incorrect. The goggles do block almost all visible light except for a small amount of red light, and they do allow infrared light to pass through as well. This was tested by changing the channels to a TV while holding the remote behind the goggles. Remote controls usually work by emitting infrared light, and if the goggle blocked infrared light, then the remote would not change the channel on the TV, but it did, so infrared light does pass through the goggles as planned. The reason that the person wearing the goggles can not see in the dark with

the infrared LEDs turned on, is because the human eye is not capable of seeing infrared light. The source of this theory states that, "At one point I started wondering just how much IR light a human eye could see. After all, if the infrared light was EXTREMELY BRIGHT (such as the IR of a sunny day,) human eyes might still detect it. And remember, if 30KHz ultrasonic sound is loud enough, you will hear it. Same basic idea" (Beaty, 2002). This source may not have been completely disproven by the project. One problem could have been that the infrared LEDs that were used were too far into the infrared spectrum and not close enough to the red section of visible light. The LEDs that were attached to the goggles peak at 950nm, and the LEDs used by other sources may have emitted wavelengths much closer to 740nm. There were also only three LEDs used, because no evidence was found that they could be seen by looking through the goggles, as opposed to using a very bright infrared LED floodlight, which is approximately $200. However; even if the infrared light was visible, the goggles would not help the person wearing them see at night, because the goggles do not enhance light in any way, they only block the visible light. However, during the day the visible light can washout some light that is right on the border of red and infrared, but with the goggles on, that light is easy to see because all the other light is blocked out. This is evident when looking at different types of light bulbs.

Incandescent light bulbs give off more red light than fluorescent lights, and fluorescent lights give off more blue light than incandescent lights. This is very evident when wearing the goggles. Incandescent lights are brighter when looking through the goggles even though the fluorescent light looks brighter to the naked eye. If the Primary Red gels are removed, then the fluorescent lights look brighter because they give off more blue light than the incandescent lights. It is also interesting to look at "black lights" or ultraviolet lights (>380nm). With only the Primary Red filters, the ultraviolet lights look like they are turned off, but with only the Congo Blue gels the ultraviolet lights still look like they are turned on. With one layer of each

gel, the fluorescent lights look blue, the incandescent lights look red, and the ultraviolet lights are barely visible. With multiple layers of each gel, all "white lights" look red and ultraviolet lights are not visible at all. It is very interesting to play around with these gels and see the wavelengths of light that different types lights give off, or to see what type of lights can be seen and can not be seen with the different filters. Specific colors of light, such as a green-faced alarm clock, do not pass through either filter at all, while a red-faced alarm clock is not dimmed at all by the Primary Red gels but can not be seen through the Congo Blue gels. Red lasers go through the Primary red gels without being dimmed at all also, but green lasers do not pass through the same filter at all. The Congo Blue gels must let some red light through, because a red laser can go through a Congo Blue gel but is very weak after passing through the filter.

There is also a theory that you can put the same filters over a regular spotlight and when it is turned on, it will glow a very dim red to the naked eye, but when the goggles are put on, that person can see everything the light is shining on as if it were much brighter. Once again, this is halfway true. At night there is no difference between goggles on and goggles off, because there is no extra "white light" to be blocked out. During the day, the light washes out the red light for the spotlight and it is almost invisible to the naked eye, but with the goggles on it is very easy to see the red light and everything it shines on. It is stated that this could be used to watch animals at night, which is true because the light is less intense (so it would not scare the animals), but the goggles would not be needed to see the light from the spotlight (MOUTUC, 2005). This will only work to see everything at night by taking out the infrared filter in a camcorder and then looking through the camcorder.

So far most of what has been tested has found that the goggles do not help with any sort of vision, but there is a situation where the goggles do help the person wearing them to see something that is not visible to the naked eye. This occurs when the same filters are placed over

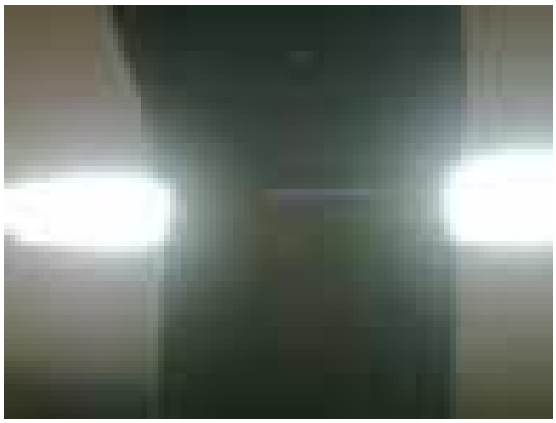
an object that is in an area of bright light (outside on a sunny day or in a bright room) where no light could shine on the object from behind the filters. To the naked eye this object can not be seen through the filters, because they look black and reflect ambient light. When the goggles are put on, they filter out the ambient light and allow the person wearing them to see right through the filters, and the object is visible again. This is very similar to how polarized glasses work to decrease glare, which is the reason trout fishermen like to wear polarized sunglasses. When the glare reflecting off the water is decreased, it allows them to see underwater at a further distance than without the glasses. On a larger scale, this same concept can be used to develop, what would essentially be, a one-way mirror except the "mirror" side would not be a very reflective mirror, and the observation room would still need to be dark. Another interesting application of this concept would be to tint all the windows of a car with these filters. No one would be able to see inside the car unless they had goggles on, and the person in the car would still be able to see out. This would only work on bright days because there would not be enough light to see well enough to drive if it was cloudy, and it would not work at all at night because there would not be enough red light to see well enough to drive.

The goggles can not be used to see at night while being undetected. They do not enhance the sight of the person wearing them, but only filter light other than red and infrared light. If humans could see infrared light, the goggles still would not help the person wearing them to see in the dark, because they would be able to see just as well without the goggles. However, when the filters are used to cover something up in a bright area, it can not be seen by the naked eye but can be seen when wearing the goggles. Everything stated about the home-made infrared goggles works with the goggles in this project. They block out visible light, and allow infrared light to pass through along with a very small amount of red light, which might be eliminated, or at least further reduced, if more layers of filters were added. The fault with the original proposal lies in

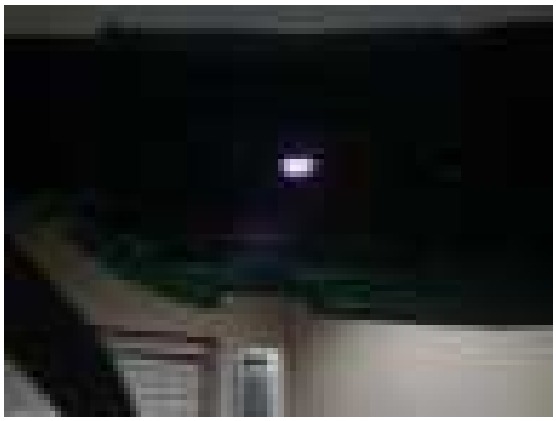
the theory. The human eye can not see infrared light. That it the sole reason these goggles can not see at night as was believed in some sources. These goggles do allow a person to see the long wavelength limit of their vision by eliminating all other wavelengths that washout the near infrared light. The only way to see infrared light at night is to use a camera that does not have an infrared filter in it. The camera can also be coupled with the spotlight covered with filters so that the infrared light emitted from the spotlight allows the camera to capture images with more clarity and at a longer distance. These gels are very interesting and they worked exactly how they were supposed to work.

Pictures

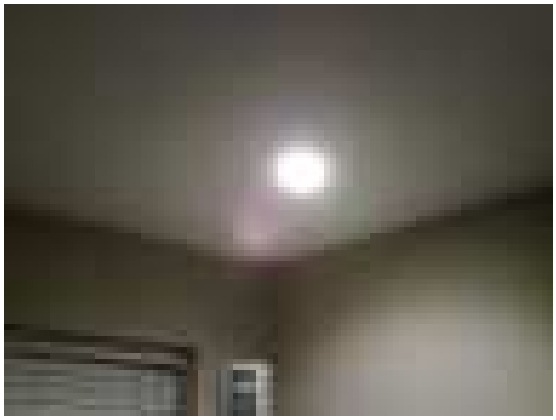
In this picture the reflective property of the filters is barely visible.



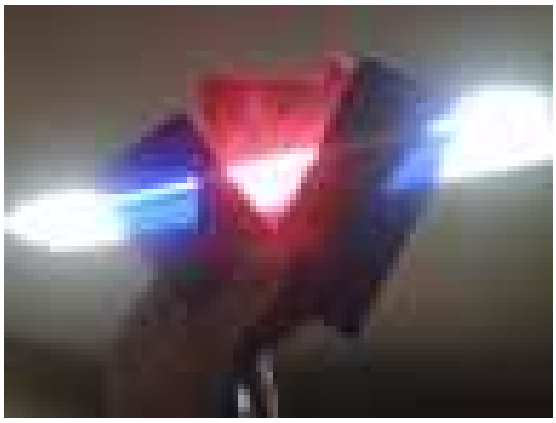
This is a picture with one layer of each filter placed in the goggles. The fluorescent light looks purple.



This is a picture with one layer of each filter placed in the goggles. The incandescent light looks red to the person looking through the goggles, but the camera does not reveal this.



Pictured here is a naked eye view of an incandescent light bulb.



This picture shows the different filters used. The red appears to look brighter, but part of that reason is the red filter is slightly more transparent than the blue filter. When the red and blue filters are combined it looks slightly purple because the fluorescent lights give off more blue/violet light than red light.

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