

Building Your Own “Invisibility Cloak” Using Lenses

Introduction

Researchers at the University of Rochester have recently developed a new cloaking device that uses lenses. To learn more about this “Rochester Cloak”, check out [this press release](#).

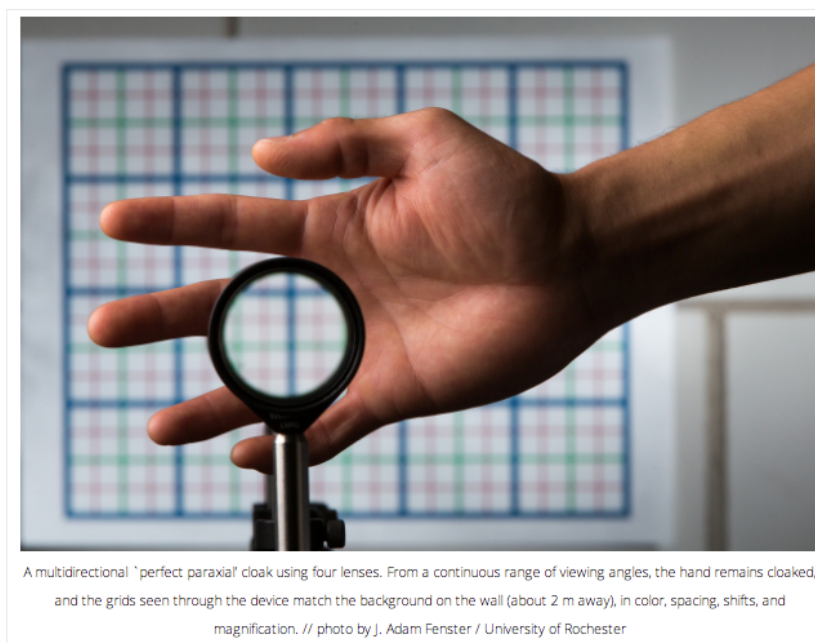


Figure 1. Photograph of the “Rochester Cloak” (University of Rochester)

This cloaking device could be a great addition to any [International Year of Light](#) event! It's also a great addition to the NISE Network's other materials related to invisibility (<http://www.nisenet.org/search?query=invisibility>).

Choosing the lenses

The [press release](#) discusses the steps involved in building the “Rochester Cloak”. Here we will review the steps and offer some tips.

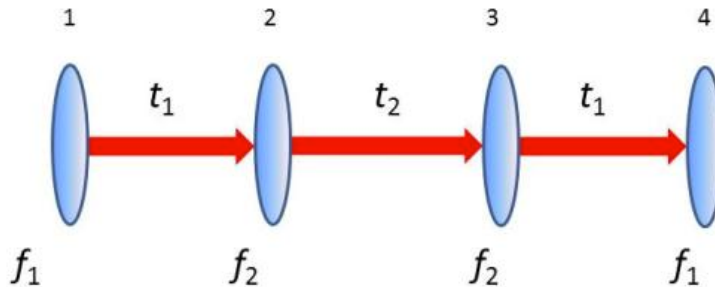


Figure 2. How to set up the “Rochester cloak” (University of Rochester)

As described in the [press release](#), you need to buy two pairs of lenses. Each pair of lenses should have a different focal length. To decide what focal lengths to buy, you need to figure out how you want to set things up. In creating our demo, we decided to buy lenses that [could be mounted onto a meter stick](#). This created the restriction that everything had to fit on a meter stick.

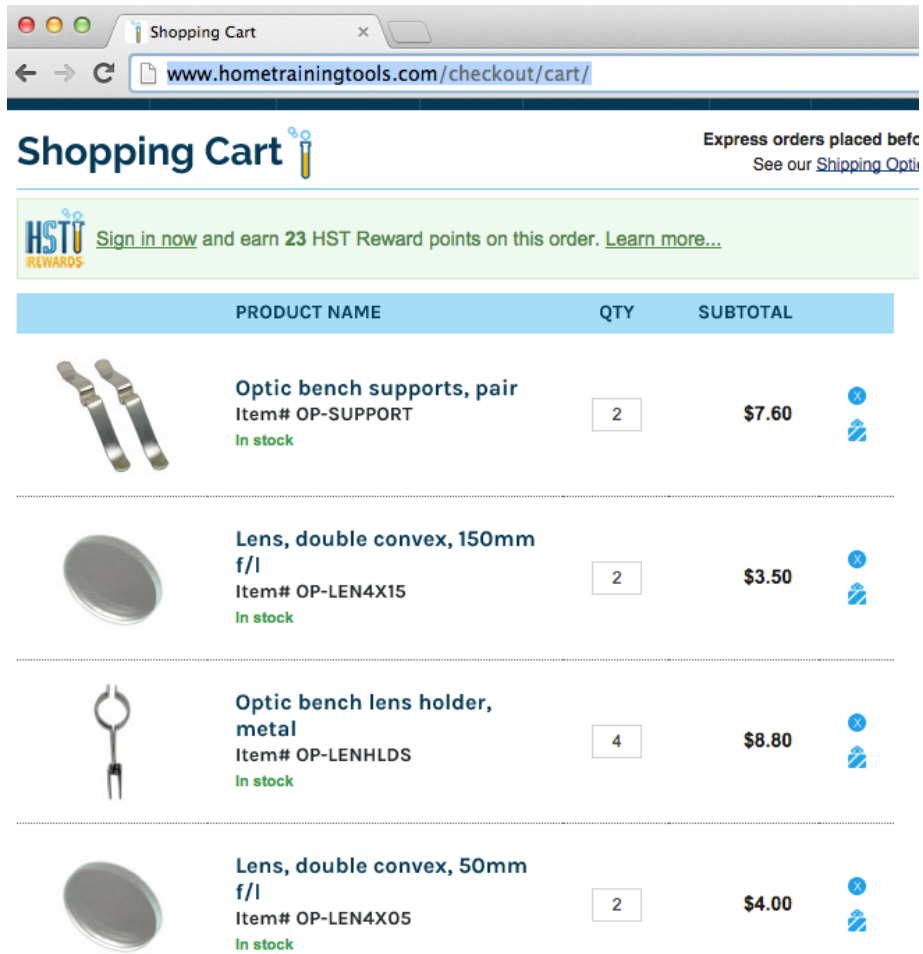
After looking for possible lenses, we decided to buy one pair of 150mm focal length lenses and one pair of 50mm focal length lenses. Following the math in the press release:

$$t_1 = 150\text{mm} + 50\text{mm} = 200\text{mm}$$

$$t_2 = (2)(50\text{mm})(150\text{mm}+50\text{mm})/(150\text{mm}-50\text{mm}) = 200\text{mm}$$

So in our case, it turns out that $t_1 = t_2 = 200\text{mm}$. The total distance between the first and last lenses is $(200\text{mm} + 200\text{mm} + 200\text{mm}) = 600\text{mm}$, so everything will fit on a meter stick (1000mm).

Many companies sell optics bench kits and lenses, but there are often not many choices for lens focal lengths. We bought our materials from Home Training Tools because they offered the lenses we needed (see Figure 3).



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	PRODUCT NAME	QTY	SUBTOTAL	
	Optic bench supports, pair Item# OP-SUPPORT <i>In stock</i>	2	\$7.60	 
	Lens, double convex, 150mm f/l Item# OP-LEN4X15 <i>In stock</i>	2	\$3.50	 
	Optic bench lens holder, metal Item# OP-LENHLDS <i>In stock</i>	4	\$8.80	 
	Lens, double convex, 50mm f/l Item# OP-LEN4X05 <i>In stock</i>	2	\$4.00	 

Figure 3. These are the materials we ordered.

Building the “Rochester Cloak”

Note: The instructions don’t appear to indicate which lenses should go on the outside and which should go on the inside. But the equation for t_2 indicates that $f_1 > f_2$, since this is the case that produces a positive value for t_2 .

Once you have the positions of the lenses, you’re ready to set everything up. Use the diagram in Figure 2 and calculate the values for t_1 and t_2 for the lenses you have (see Figure 4 for an example). Try to align everything as carefully as possible. If your meter stick is too skinny and the lens holders are moving around too much, try using two meter sticks.

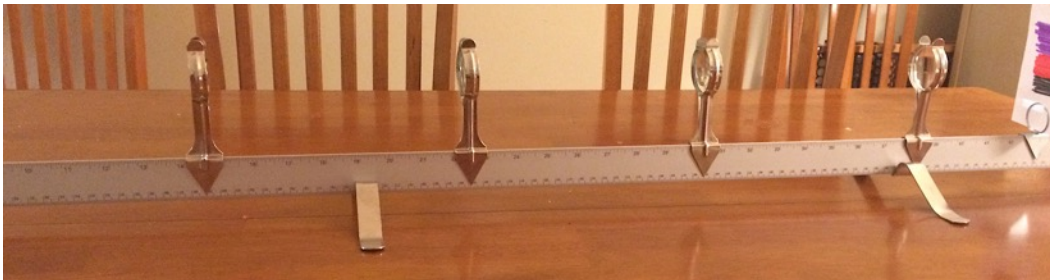
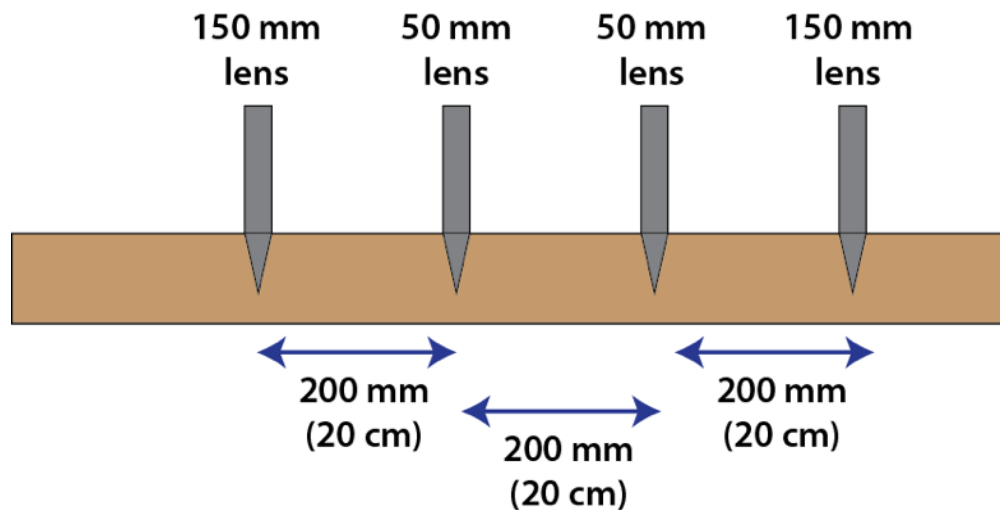


Figure 4. Example of a “Rochester Cloak” (schematic and photo)

Does it work? Can you cloak things?

After everything is set up, try it out. Are there places where you can “hide”/“cloak” objects? If not, try looking at Figures 5 and 6 to get an idea of the optimal cloaking positions. If you are using the same objectives that we chose, try a position 150mm from the first lens. It’s also good to keep in mind that objects aligned with the centerline can’t be cloaked. For more about this, go to time 2:00 in the video from the [press release](#).

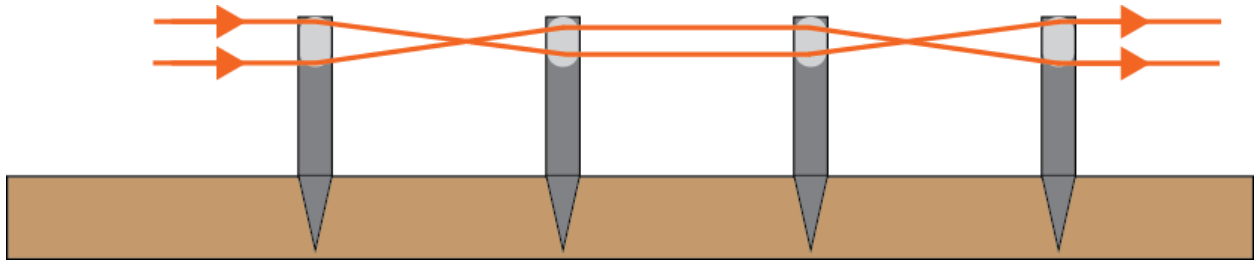


Figure 5. Simplified path of light rays through “Rochester Cloak”

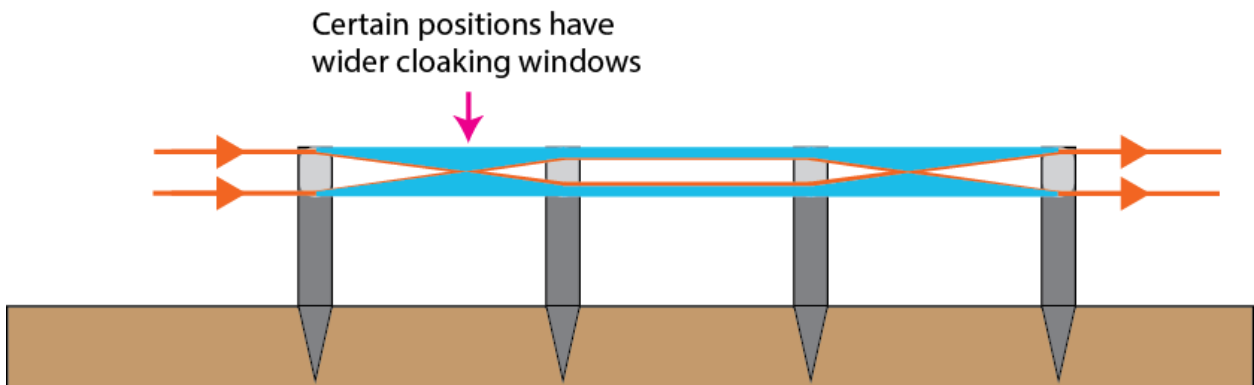


Figure 6. Simplified picture of cloaked areas of a “Rochester Cloak”



Figure 7. Photos showing the ability of a “Rochester Cloak” to cloak objects



Figure 8. At certain positions objects can be cloaked, while at other positions they can't. Here are a couple examples where the object doesn't get cloaked. For more about this, start the video in the press release at 2:00.