

DIY Microscopy: Optical Mouse Lens + iPad

Luis Ibanez on April 6, 2012

Tags: [Medical Imaging](#)

Following on our series on DIY microscopy: [Part I here](#):

It turns out that the humble optical mouse of a modern computer...



is actually a small microscope:

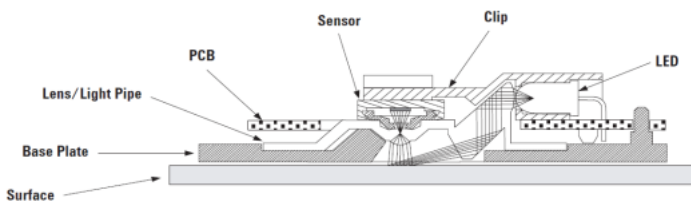


Figure 7. Sectional view of PCB assembly highlighting optical mouse components (optical mouse sensor, clip, lens, LED, PCB and base plate).

<http://web.media.mit.edu/~mellis/mouse/ADNS2620.pdf>

It contains:

- A small, semi-spherical lens of about 1mm radius.
- A small digital camera of about 13×13 pixels.
- A powerful laser diode.
- A well-crafted prism to direct light to just in front of the lens.
- A dedicated DSP chip.

This humble, little, inexpensive, and under-rated device takes about 1,000 images-per-second, and performs cross-correlation image processing on them in order to estimate your movements on the X,Y plane of your desk!!

This little device can do:

- Programmable frame speed up to 3000 frames-per-sec (fps)
- Accurate motion up to 12 ips

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- 400 cpi resolution

Time to rip that mouse apart!

Here is the under-surface of the mouse, where we can see the small lens:



and a close-up of the lens:



This is actually very easy to open, as it has a single screw on the back:



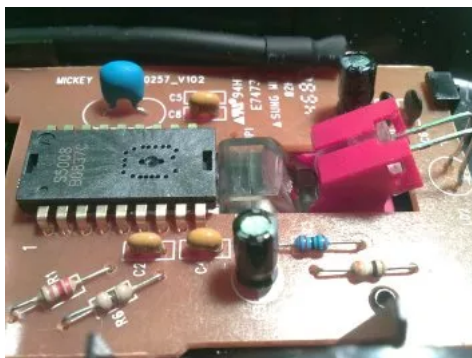
and then you lift it in diagonal, and slide the cover towards the back:



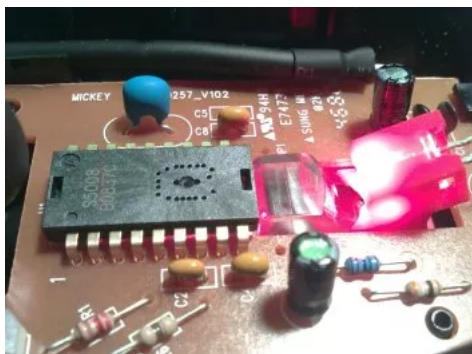
vividly exposing the mouse's internal organs:



In particular you can see the red plastic cover of the laser LED on the right, connected to the transparent, single plastic piece that contains the illumination prism and the small lens; and then towards the center, the dedicated DSP chip that contains the camera and the image processing hardware.



If we plug the USB connector of the mouse into the closest computer, we get to see the laser LED turned on:

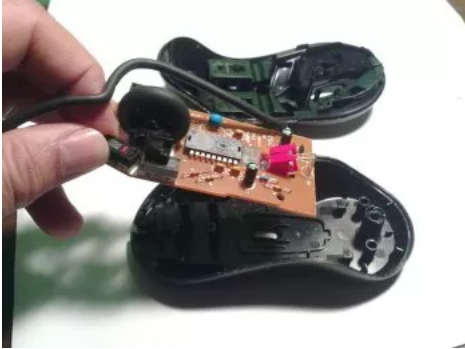


This helps to show how the light is guided by the plastic prim, towards the bottom of the mouse, as to illuminate the table surface underneath the mouse and just facing the small camera.

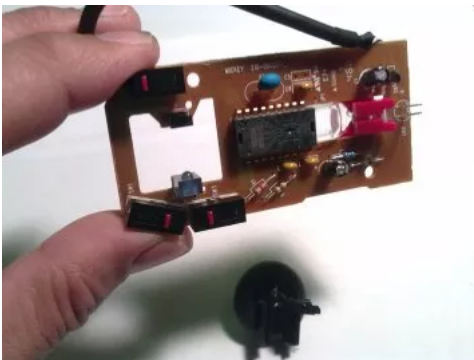
We can then lift the circuit board by pulling from the mouse head side:



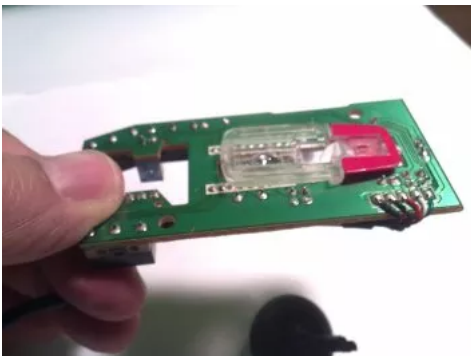
and proceed to extirpate the internal organs:



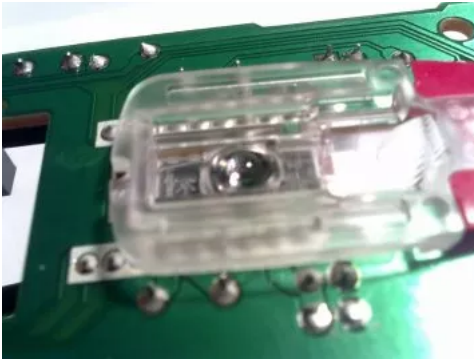
by removing the wheel, we can also take a closer look at the infrared LED and facing photo-detector that tracks the movements of the rolling wheel:



by turning over the circuit board we can inspect the other side of the transparent plastic that forms the illumination prism, and the small lens:



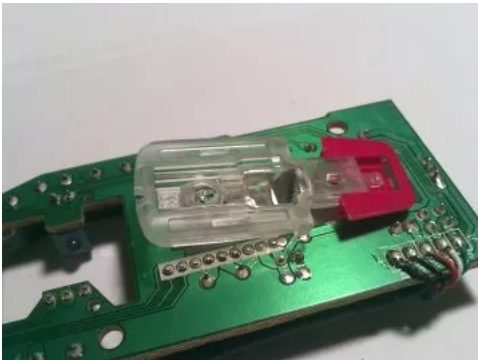
and a closer look at the small lens, where we can appreciate its high curvature:



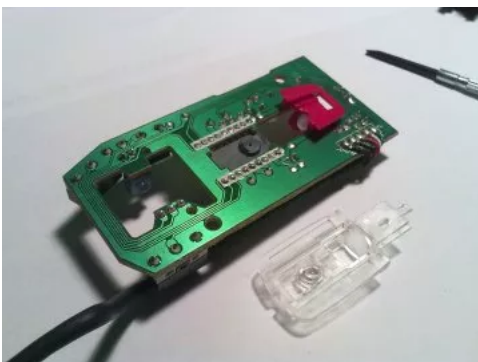
With a flat screwdriver, we can persuade the translucent piece to be separated from the red plastic piece that holds the laser LED:



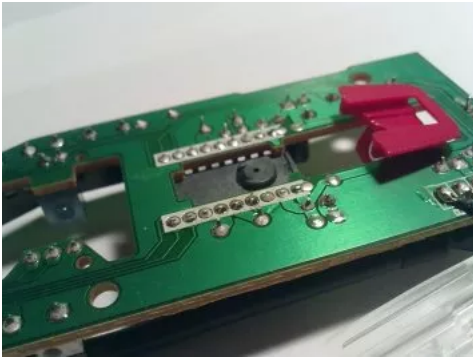
After which you can slide the plastic lens:



and finally expose the small camera under the dedicated DSP chip, which is inside the small circular hole in the bottom of the DSP chip:



Here we have a closer look at the camera:



and a closer look at the lens plus illumination prism:



This piece has been carefully crafted to put a flat surface at just the point where the image of the surface will be focused by the lens on the camera inside of the DSP chip.

After an Evil laugh, we proceed to transplant this mouse organ onto front eye of the closest iPad:



Then, using a book as sample holder, we place an object very close to the lens:



and place on it one of the most mysterious substances known to man: dog hair!



Here is the image captured with the iPad (at its 640×480 pixels resolution):



Dog hair typically has a width of about 10 microns.

Also, its video version on YouTube:

and a similar inspection of the tip of a precision screwdriver:

In 1665, Robert Hooke wrote in his book [Micrographia](#), his observations of a razor blade under a microscope:

"I have, when the Sun has shone well on them, discovered their surface to be variously razed or scratched, and to consist of an infinite of small broken surfaces, which reflect the light of very various and differing colors. And indeed it seems impossible by Art to cut the surface of any hard and brittle body smooth, since Putte, or even the most curious Powder that can be made use of, to polish such a body, must consist of little hard rough particles, and each of them must cut its way, and consequently leave some kind of gutter or furrow behind it."

<http://www.gutenberg.org/files/15491/15491-h/15491-h.htm>

REFERENCES

Cellphone Microscope UCLA

TEDxBigApple – Aydogan Ozcan – Microscopy on a Cellphone: An Emerging Telemedicine Platform

Microscope made from cellphone camera and CD-ROM lens:

Hack an optical mouse into a camera with the Arduino board:

[Part III](#) covers Microscopy with a webcam.

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2 Responses to *DIY Microscopy: Optical Mouse Lens + iPad*



Rakesh Aggarwal says:

April 20, 2015 at 3:24 am

Hi,

I need to get 1000 fps from mouse. Please help me get all the pixel directly through mouse optical camera.

[Reply](#)



Julia Truchsess says:

May 11, 2018 at 9:47 am

Great article, and thank you for mentioning Hooke. Just to clarify, though: it's not a laser, it's not an Infra-Red LED, and it's not a "laser LED". It's just a regular, visible-light, red LED. Laser mice do exist, but I don't think this is one of them.

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