



Smartphone Microscope

Turn your smartphone into a powerful microscope with the groundbreaking and innovative mobile smartphone microscope!

The invention of the smartphone microscope

Why did two researchers at the Department of Energy's Pacific Northwest National Laboratory (PNNL), located in Richland, Washington, come up with their design for a smartphone microscope?

They were trying to solve a problem.

Rebecca Erikson and Janine Hutchison describe how they identified a problem and used creativity, innovation, and technology to solve it.

"We interviewed a lot of first responders, public health labs, and civil support teams. They told us, when confronted with a suspicious white powder, the first thing they do is send a sample to the lab, where it is put under a microscope. An inexpensive yet powerful microscope in the field could be used to quickly determine whether the material is a threat or a hoax. Listening to their needs, we were quickly reminded of a very early microscope—the Leeuwenhoek Microscope—which used a single glass sphere to provide magnification.

"The inexpensive and mobile device, developed at PNNL, allows anyone with a smartphone to effortlessly explore the world's tiniest and most fascinating objects, ranging from bacteria to grains of sand. Its streamlined design easily slips over the vast majority of smartphones."

– FederalLabs.org

"Taking his lead, we used an inexpensive glass sphere and put it into a housing or clip that we designed and printed on a 3D printer. Combining this microscope with the great cameras found on cell phones and tablets, we were able to create a very inexpensive microscope that has applications beyond first responders."

Combining a modern smartphone with a 400-year-old concept

Learn more about how and why the smartphone microscope was developed. Watch the video on YouTube at <https://youtu.be/Qlh9dnwnt7Y>.

About the smartphone microscope's capabilities

The smartphone microscope slips over the camera lens of the smartphone and is no thicker than a phone case. The material cost, not including the printer, is between less than \$1 and as little as 5 cents.

The PNNL team has made a 350x version—adequate to identify parasites in blood samples or protozoa in drinking water—and a 100x version, which enables users to investigate common items, like salt grains and flower petals, in much greater detail.

Using glass spheres as a microscope lens is not a new idea, optically, but the small size of the housing combined with very high magnification and extremely low cost is what makes this device practical. Low cost was a driver in the research and development project targeting a specific Department of Homeland Security need for rapid bio detection technologies. The microscope needed to be so inexpensive it could literally be thrown away in case it gets contaminated.

To share the smartphone microscope technology with those who could make use of it, PNNL decided not to go the traditional route of commercializing this technology via patents or licensing. Instead, PNNL posted the design specifications free and online in an easy-to-use file format in 2015; anyone can download the file and print a smartphone microscope on their 3D printer by visiting <https://availabletechnologies.pnnl.gov/technology.asp?id=393>.

“We feel there are many uses out there including human and veterinary medicine in developing countries. We are also really excited about engaging kids in science. School districts have a hard time providing enough microscopes for students. Our science education staff is getting it into the hands of local school children.”

– Janine Hutchison
PNNL Researcher

Users will find links to the exact 3D printer beads PNNL used to create the smartphone microscope, plus additional bead sources, on that website. Those who do not have access to a 3D printer are encouraged to check with their local library or connect with vendors who offer the service.

Using your smartphone microscope

Step 1: Gather your materials, including your smartphone, smartphone microscope, clear tape, and some items that are at least semi-transparent to examine, such as human hair, table salt, sand, money (paper bills), or bug wings.



Step 2: Remove your cell phone case, then slip the clip over your device, lining up the small glass lens with either the front- or back-facing camera center. Open the camera app. It is often easier at first to learn to use the smartphone microscope in selfie mode.



Step 3: Move the clip slowly around until a uniform white image appears on the screen. For this step, the smartphone microscope cannot be laying on a table; some light must pass between or through the objects, otherwise there will be no image. Work in a well-lit area.



Step 4: Hold the smartphone microscope very close (only a few millimeters) to the object of interest. It is best to touch the smartphone microscope to the object and slowly move it away to focus. Light must be able to pass between or through the objects and the lens, otherwise there will be no image. The more you can see through the object you're examining, the better the picture you will see.

Troubleshooting tips: If the camera is having trouble focusing on an object, double-check the lens placement to make sure the lens is fully seated in the plastic. If the image has blurry or dark spots that never change no matter what you are imaging, it could be from a dirty lens or defects in the lens. Try to clean the lens using water or rubbing alcohol and a soft cloth or tissue.

SOURCES:

Girls of Energy
www.energy.gov/diversity/girls-energy

FederalLabs.org
www.federallabs.org/successes/awards/awards-gallery/2017/smartphone-microscope

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