

# USE A CELLPHONE LENS AS A MICROSCOPE

Get an old cellphone Camera and use it as a simple microscope.

The basic concept is to negate the refractive power of the objective lens of a cellphone camera by mounting a 2<sup>nd</sup> lens from an old cellphone camera inversely in front of the camera. This produces a -1:1 imaging system with a large field of view and a very low price.

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V0; 05.12.18



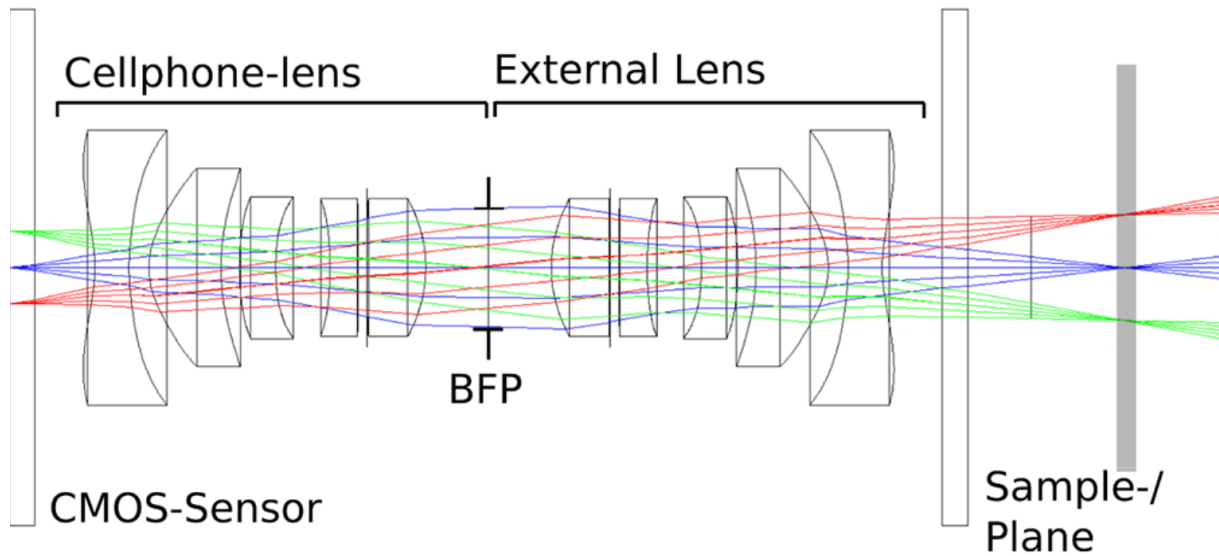
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## MOTIVATION

- Build a cheap cellphone microscope.
- How is it working
- What do we need to accomplish that?






## GOALS

At the end you should have learned the following:

- Get the lens
- Mount it on the cellphone camera
- Image stuff
- Understand the imaging theory



## BILL OF MATERIALS

QUANTITY	DESCRIPTION/NAME	IMAGE	PRICE
1	<p>iPhone 6 camera module</p> <ul style="list-style-type: none"> <li>- 1/2.4 f#, very cheap</li> <li>- <a href="https://www.ebay.de/itm/Fur-iPhone-6-Plus-HauptKamera-Ruckkamera-Rear-Back-Camera-Module-Flex-Original/153155444315?hash=item23a8c69e5b:g:q6UAAOSwQf9be44Z:rk:1:pf:0">https://www.ebay.de/itm/Fur-iPhone-6-Plus-HauptKamera-Ruckkamera-Rear-Back-Camera-Module-Flex-Original/153155444315?hash=item23a8c69e5b:g:q6UAAOSwQf9be44Z:rk:1:pf:0</a></li> </ul>		5-12€
2	<p>LG G6 H870 Medium Rückseite Kamera Modul</p> <ul style="list-style-type: none"> <li>- 1/2.4 f#, X/Y/Z voice-coil actuator</li> <li>- <a href="https://www.ebay.de/itm/LG-G6-H870-medium-back-side-camera-flex-cable-module-contact/391883007082?epid=2231365189&amp;hash=item5b3e0c246a:g:bjoAAOSwiqdao eUs:rk:3:pf:0">https://www.ebay.de/itm/LG-G6-H870-medium-back-side-camera-flex-cable-module-contact/391883007082?epid=2231365189&amp;hash=item5b3e0c246a:g:bjoAAOSwiqdao eUs:rk:3:pf:0</a></li> </ul>		15€
1	<p>Huawei P20 Camera Lite</p> <ul style="list-style-type: none"> <li>- 1/1.6 f#</li> <li>- <a href="https://www.ebay.de/itm/Fur-Huawei-P20-Lite-Reparatur-Back-Kamera-Cam-Flex-Ersatzteil-Hauptkamera-Camera/362329660012?hash=item545c87da6c:g:96kAAOSwTFhbBqtt:rk:23:pf:0">https://www.ebay.de/itm/Fur-Huawei-P20-Lite-Reparatur-Back-Kamera-Cam-Flex-Ersatzteil-Hauptkamera-Camera/362329660012?hash=item545c87da6c:g:96kAAOSwTFhbBqtt:rk:23:pf:0</a></li> </ul>		16€



1

Huawei P20 Pro

- <https://www.ebay.de/itm/Original-Huawei-P20-Pro-Haupt-Kamera-Flex-Hinten-Ruck-Foto-Main-Camera-Back-Rear/273577104409?hash=item3fb2775419:g:Rt8AAOSwlw1b-TC6:rk:26:pf:0>



60€

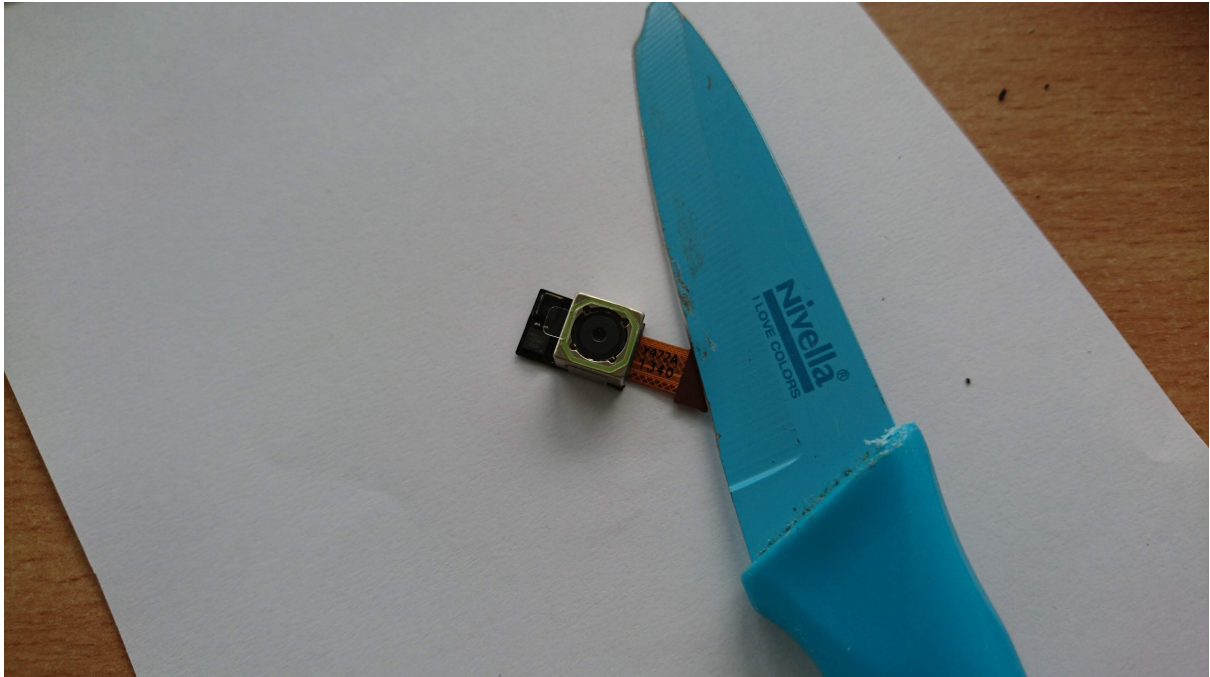


- You See Too

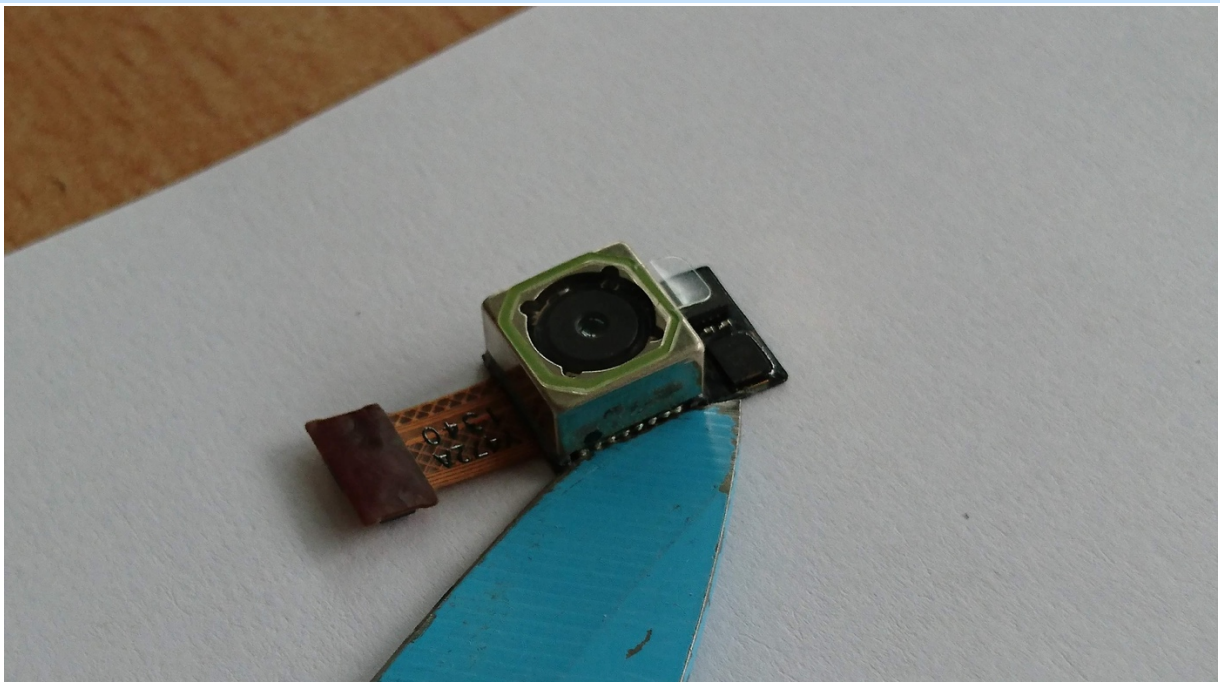
## STEP BY STEP GUIDE FOR EXTRACTING THE LENS (LG G5)

Attention: Take care of your fingers! Don't cut yourself!

### 1<sup>ST</sup> STEP – PREPARE EVERYTHING



### 1<sup>ST</sup> STEP – SEPARATE SOLDERED LENS FROM SENSOR PCB

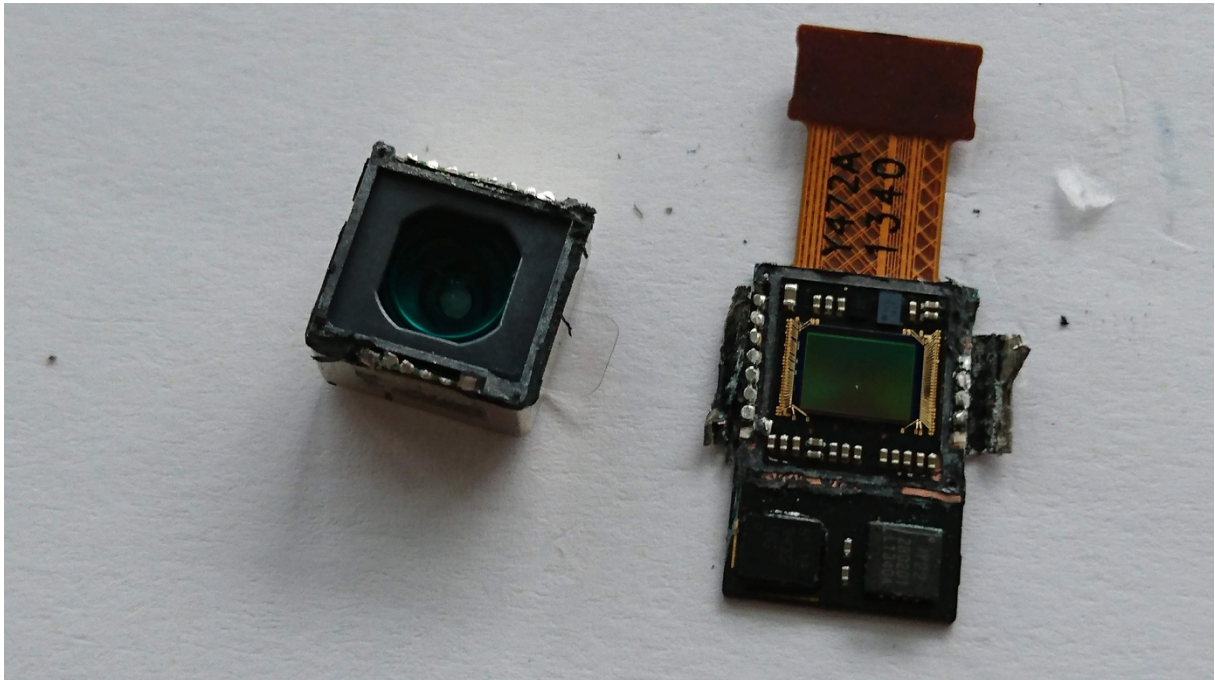


You could melt the soldering, but a sharp knife will do the same job.

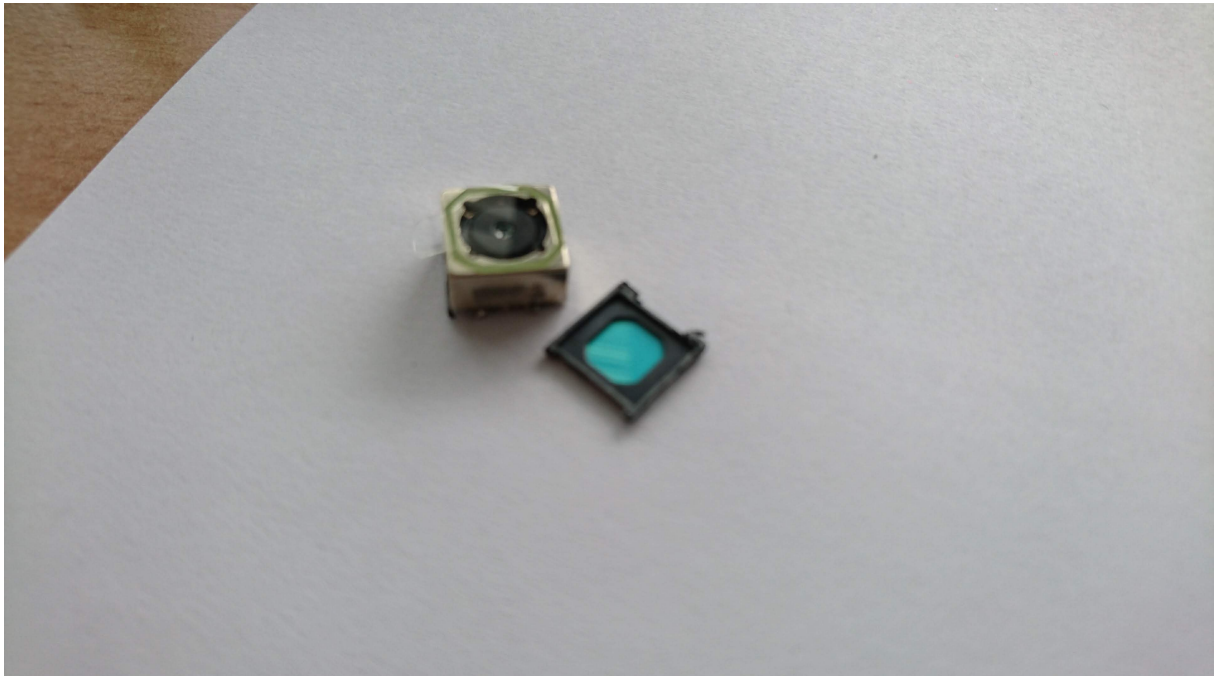




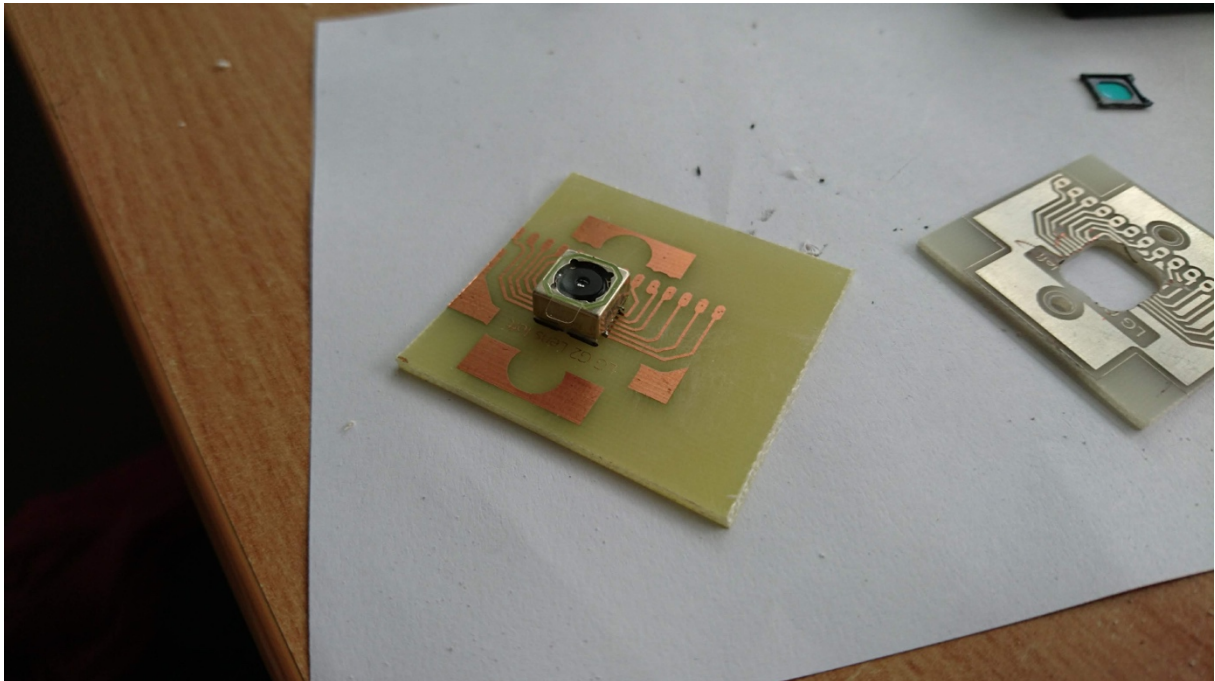
### 3<sup>RD</sup> STEP – SEPARATE SENSOR AND LENS



### 4<sup>TH</sup> STEP – REMOVE IR FILTER (OPTIONAL)



#### 5<sup>TH</sup> STEP – SOLDER LENS ON PCB FOR CONTROLLING XYZ-MOVEMENT (OPTIONAL)



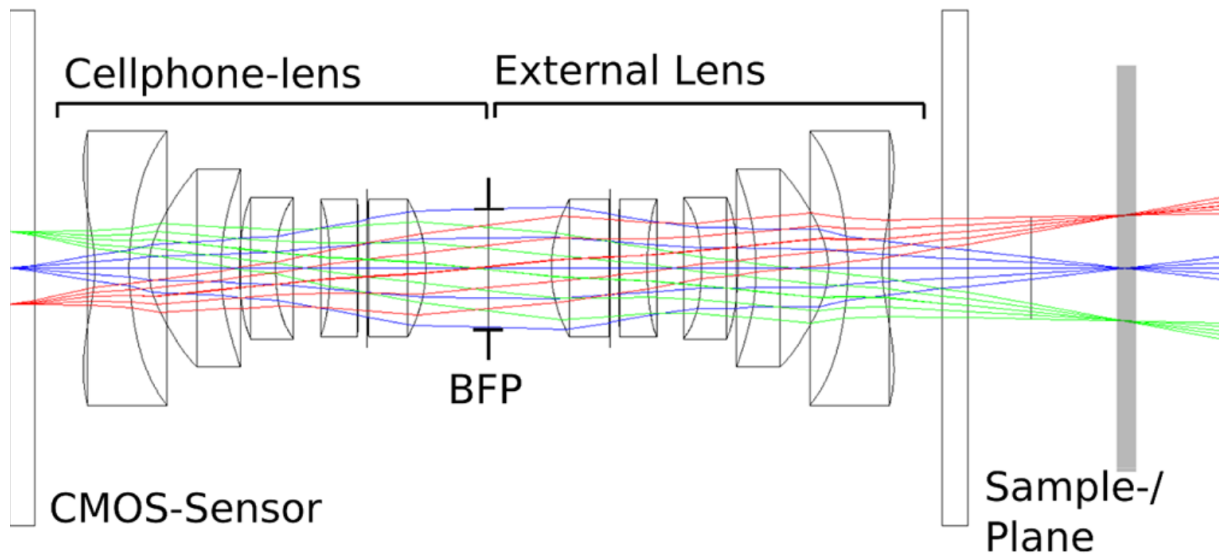
#### 6<sup>TH</sup> STEP – TESTING



You can simply take some blutek or double-sided sticky tape to mount the lens directly in front of the cellphone camera. The image above is the blade of the knife we used above. The better the entrance pupil of the cellphone matches the exit pupil of the cellphone lens, the better the image gets.



## THEORETICAL



The lens assures a -1:1 imaging system and is almost free of any aberration up to an NA of  $1/(2 \cdot f\#) = 0.315$  in Case of the Huawei P20. The field of view – depending on which camera is used – can be up to  $12 \times 7 \text{ mm}^2$ .

More theoretical aspects are coming soon!

## USEFUL LINKS AND RESOURCES

### LINKS

- Cellphone Microscope relying on setup above:
  - o <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0192937>
- Cellphone Microscope where idea originally came from:
  - o <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4031072/>
- FPM Setup where they used cellphone lenses:
  - o <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4206303/>
- 

