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memo on stacking ground photos using QGIS
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You are going to "georeference" your new photo to the old photo, using a free program called QGIS. This is sometimes known as warping or rubbersheeting because the computer will squish (rotate and scale) your new photo to match the old one. Until someone builds a proper rephoto app this is the kind of bumpy thing you just have to figure out by Googling for hints. But here's an informal guide for QGIS for Mac. Windows etc. may be different. Please send me any errors/improvements.

I. Summary instructions

Install QGIS and turn on its Georeferencer plugin. Load the old photo into QGIS and the new one into the Georeferencer. Georeferencer will "warp" the new image to the old one, according to matching points in the photos that you will point out to it. Specify each point-pair by doing "Add Point" in the new photo then the old one. Set the settings of the mathematical transformation, and run it to create a new image. To make a pretty pair, stack them in Photoshop. If QGIS created the new warped image at a different scale than the old photo, you'll have to rescale the new image in Photoshop.

II. Longer instructions

A. Install QGIS

Go to GQGIS.org and follow the links and install the following (apparently in this order):

1. GDAL (complete), a library of geography routines that QGIS uses. Note that it includes NumPy.
2. Matplotlib, a library of plotting routines that QGIS uses.
3. QGIS (standard, not any "development builds"). QGIS gives names (e.g. Chugiak) to each version; don't worry about it.

B. Start QGIS and do some setup

1. QGIS will offer you helpful tips upon startup until you tell it to stop. They don't matter.

2. I would turn off all toolbars/panels except the Layers panel and the Map Navigation toolbar. Do this under View > Toolbars or by right clicking a toolbar/panel.

3. I would put copies (not your only copies!) of the old photo and the new photo in one folder by themselves, someplace handy like the desktop. Be organized and give the folder a good name like "2014-06-07 warping my new photo to ABHL 196".

4. Under Plugins > Manage and Install Plugins, turn on the plugin called Georeferencer GDAL. This just makes it able to be run later.

C. Operate the Georeferencer plugin

1. Load old photo: Before using the Georeferencer plugin, click on Layer > Add Raster Layer to load the old photo into the main QGIS window as our "base" layer. (Raster means a normal image saved as pixels like a TIFF; vector means an image as a fancy mathematical model like a font.)

2. Coordinate reference systems: These are like map projections. QGIS will pop up and ask you for one every time you load an image. Ground photos don't have them, so just click OK to accept the default CRS, which is WGS84.

3. Start Georeferencer: Click Raster > Georeferencer. It opens as a second window. On a big monitor I arrange the two windows side-by-side; on a small monitor you may have to view just one at a time.

4. Load new photo: Open Raster (checkerboard-plus button, or Command-O) to load the new photo into the Georeferencer window.

5. Pan and zoom: Knowing how to pan and zoom will make it much easier to pick points (the next step). So try these: Zoom Full / Zoom to Layer (Shift-Command-F), Zoom In and Zoom Out (the magnifying glasses, or the mouse wheel), and Pan Map (the hand).

6. Pick points: You need to show the computer what points the two images have in common.

- Click "Add Point" and select your first point quite precisely on the NEW image.
- A dialog box will ask for map coordinates; select "From map canvas" to pick the corresponding point from the base image (i.e. the old photo) in the main QGIS window. (The Georeferencer window will minimize; if this bugs you you can bring it right back.)
- Click on the corresponding point on the old photo in the QGIS window, and click OK in the dialog box to accept those coordinates.

7. GCP panel: Each set of coordinates you pick goes into the GCP (Ground Control Points) panel at the bottom of the Georeferencer window. Don't worry about these unless you want to remove one (right-click). I usually make this panel as small as possible.

8. How many points? You need some minimum number, depending on what transformation you use (next step). In my opinion some people waste time picking points all day, as I did when I started. But in rephotography, especially with a gap of many decades, you'll often find only a few anyway. The main thing is to have good, accurate points, spread fairly evenly around the image.

9. Set transformation settings: When you have enough points, select "Transformation Settings" (button with the yellow cog).
   Transformation type: Projective
   Resampling method: Cubic
   Output raster: click on the button and it will suggest the name of the new photo plus "_modified". Fine.
   Set target resolution: yes, horizontal 1 and vertical -1.
   Load in QGIS when done: yes

Thin-plate spline: Great if you can get lots of points. Very local; like a network of transformations, each tailored to that region of the image.
Projective: can be useful for rephotography. Looks less distorted than Polynomial 1.
Linear: does nothing
Helmert: just scales (by the same factor horizontally and vertically) and rotates

Polynomial: Classic ninth-grade algebra; 2 and 3 are way too warping for rephotography

10. Run the transformation: select "Start georeferencing" (the button with the green arrow). You should see a progress bar and then the warped new image load on top of the old photo in the QGIS window. If the transformation refused to run (with an error message saying it was unsolvable), try running it again with the Target Resolution turned off, or with more points.

D. Clean up in Photoshop

1. Stack in Photoshop: I can't teach you Photoshop here. But you open both images in Photoshop, check Image > Mode to see they're the same mode (e.g. you can't stack a color image onto a black-and-white one), and drag the new image on top of the old one. Slide (Move Tool: V) the new one until hopefully it lines up with the old one. Then you can crop the new one, put a pretty border around it (I like to copy the border from the old photo), do a caption, etc.

2. If the new image is too big or too small: I don't mean that it has a wider view that extends past the old photo's edges. I mean that it has a different scale-- that each object in the new image is more pixels wide and tall than that same object in the old image. This is a QGIS problem that I do not yet fully understand. I believe that the "Set target resolution" checkbox will make a new image with a proper scale, but that option operates in a way I don't understand. Even when it worked, it would appear unchecked the next time I opened the Transformation Settings dialog box. Worse, the transformation often refuses to run when it is checked. In those cases I have to rescale the new image in Photoshop.

3. If you have to rescale the image in Photoshop: You could just measure (I for Ruler tool, then Window > Info) something in each image. Essentially from one GCP to another. Then scale the new image by the ratio. In practice I actually make three measurements and average them, just to be safe. Here's one I did yesterday:

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old     new     ratio
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 524  /  447  =  1.172
1806  /  1526  =  1.183
2193  /  1861  =  1.178
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These were the number of pixels between various corners of various windows on a dorm. I tried for a variety of measurements: vertical, horizontal, different parts of the image-- but you notice it made little difference. The ratios averaged to 1.178, so to the new layer (i.e. with the new-image layer selected and visible) I transformed (Command-T) to 117.8% of its original size. Then it stacked perfectly.

This rescaling is only five minutes of fifth-grade math, but it's annoying and I'm going to find a better solution. Let me know if you have one.