

Honors 208W

Fall 2011



Campus Mall
- Evan Golub, 2004

Photographic Stitching

Field of View

If we think of everything around us as being projected on the inside of a sphere, then the field of view is the part of that sphere that we can see at a given moment.

- The average human pair of eyes has a useful field of view of around 140° horizontally and around 80° vertically.
- A 35mm film camera with a 50mm focal length lens has a field of view of approximately 40° horizontally and 27° vertically.

To capture the equivalent field of view of the human eye, a 35mm camera would need to use a wide angle lens with a focal length of about 7mm!

Larger Images: Stitched Panoramas

Another option would be to take a series of pictures and join them together.

- This was often done with individual printed photographs using tape.
- Now more common to use software to do it.



Panoramic Cameras and Lenses

There have been cameras and lenses made that are designed to help take panoramic pictures.

- An extremely wide-angle or fisheye lens used on a regular camera followed by post-processing.
- The APS “panoramic” shot was actually just a normal frame enlarged with the top and bottom cropped off.
- A rotating lens can be used to expose several “frames” of film while sweeping across a scene.
- Digital cameras with a “panoramic preview” mode to allow you to line up sequential shots.

Segmented Panoramas

When taking the pictures that will be used to create the panorama, you will want between a 20% and 35% overlap between images.

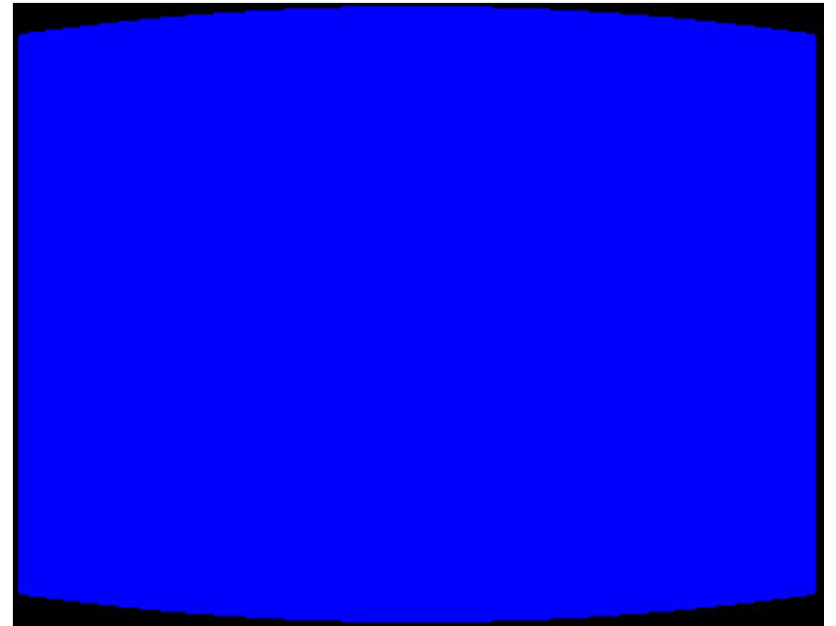
The top and bottom of your images will probably not align perfectly, which will cause a shorter panorama than you might expect.

- Using a tripod with a panoramic head leveled in both vertical and horizontal planes will minimize this.
- Another way to address this is to take the pictures in portrait orientation rather than landscape.

Cylindrical Projection

If you take the pictures by standing in one place and rotating the camera the images need to have some level of cylindrical projection (based on the focal length) applied for things to line up correctly.

- This will also decrease the effective height of the panorama.



The 360° Panorama

There are a few ways to achieve a full 360° view, such as...

- A special lens with reflector that can be used to capture a 360° view on the sensor and software can then be used to convert it back from polar coordinates.
- Get a fairly wide-angle lens (more than 90° horizontal field of view) and take four shots (NESW).
- Do a full circle (actually, one or two frames more than full) of many overlapping shots very carefully.

13 photos – 1 “lawn”



Some Free Stitching Tools

The mostly automated tool Microsoft ICE.

(<http://research.microsoft.com/en-us/um/redmond/groups/ivm/ice/>)

Three tools that work together to give more control.

- Panorama Tools (<http://panotools.sourceforge.net>)
- Hugin GUI (<http://hugin.sourceforge.net/>)
- Autopano (<http://autopano.kolor.com/>)

Some pitfalls...

One problem that is common is to have people moving between individual shots. When merging frames, a person might appear in more than one shot, or might be placed along a seam and end up either blurred, or partially missing.

- One useful option is to output to a layered file (eg: layered TIFF or Photoshop PSD file) and then adjust the overlap masks manually.

Changing lighting and related white balance changes can also introduce challenges.

- Locking the auto-exposure levels (AE Lock) on taking the first shot can help with this.
- Utilities such as *Enblend* can also assist with this after the fact.

“Seamless” Gigapixel Digital Shots

There have been a variety of “seamless-looking” multi-billion pixel images within the past decade.

- 2003: 1.0 gigapixels

<http://www.tawbaware.com/maxlyons/gigapixel.htm>

- 2008: 17.6 gigapixels

<http://www.yosemite-17-gigapixels.com/>

- 2010: ~80 gigapixels

<http://www.360cities.net/london-photo-en.html>

A robotic gadget from GigaPan has made it easier to create these with the push of a button (and lots and lots of time).

Non-traditional Gigapixel

Would you consider something such as Google Maps in satellite-view mode to be an *extremely large* panorama?

How would you classify a gigapixel PhotoMosaic creation such as the 1.5GP image of Van Gogh's "Starry Night"?

<http://www.andreaplanet.com/mosaic/starrynight/>

Digitally Stitching Fabric

So far we have been discussing situations where (hopefully, for the most part) the only thing moving is our camera.

The Cloisters in New York have a set of seven tapestries known collectively as “The Hunt of the Unicorn”.

- In 1998 they were taken down during renovations and sent to have their backings replaced.
- This opportunity was used to photograph each tapestry section by section (front and back). The files filled over 200 CDs (well over 100 gigabytes).
- Two challenges the images presented were
 - ...the sheer amount of data that needed to be processed.
 - ...the fact that as a sheet of paper was moved beneath the tapestries as they were photographed, the warp and weft threads shifted so they could not be smoothly matched.
- In 2003 two mathematicians began work on algorithms to help assemble the images (even with these, it took over three months of computations for a single tapestry).

Some resources:

http://www.archives.gov/exhibits/panoramic_photography/panoramic_home.html

<http://www.hitl.washington.edu/publications/p-93-2/>

<http://www.tawbaware.com/maxlyons/calc.htm>

<http://www.panoramicphoto.com/timeline.htm>

<http://www.0-360.com/>

<http://www.kaidan.com/Detail.bok?no=101>

http://www.dpreview.com/learn/?/Image_Techniques/Barrel_Distortion_Correction_01.htm

<http://www.path.unimelb.edu.au/~dersch/barrel/barrel.html>

<http://www.ddewey.net/pics/vpt/technical/>

<http://www.cs.ubc.ca/~mbrown/papers/iccv2003.pdf>

<http://research.microsoft.com/~cohen/>

<http://www.pbs.org/wgbh/nova/sciencenow/3210/04-moving.html>