Resources for CS445

**SfM: Structure from Motion**

<https://en.wikipedia.org/wiki/Structure_from_motion>

M. A. Fischler & R. C. Bolles (1981). "Random sample consensus: a paradigm for model fitting with applications to image analysis and automated cartography".

Structure from motion is a photogrammetric range imaging technique for estimating three-dimensional structures from two-dimensional image sequences that may be coupled with local motion signals. In biological vision, SfM refers to the phenomenon by which humans (and other living creatures) can recover 3D structure from the projected 2D (retinal) motion field of a moving object or scene.

Humans perceive a lot of information about the three-dimensional structure in their environment by moving around it. When the observer moves, objects around them move different amounts depending on their distance from the observer. This is known as motion parallax, and from this depth information can be used to generate an accurate 3D representation of the world around them.

Finding structure from motion presents a similar problem to finding structure from stereo vision. In both instances, the correspondence between images and the reconstruction of 3D object needs to be found.

To find correspondence between images, features such as corner points (edges with gradients in multiple directions) are tracked from one image to the next. You can use SIFT to match features. RANSAC can be used to remove outlier feature matching.

There are several approaches to structure from motion. In incremental SFM, camera poses are solved for and added one by one to the collection. In global SFM the poses of all cameras are solved for at the same time. A somewhat intermediate approach is out-of-core SFM, where several partial reconstructions are computed that are then integrated into a global solution.

Things we can use -  [Bundler](http://www.cs.cornell.edu/~snavely/bundler/), [VisualSFM](http://ccwu.me/vsfm/), [OpenMVG](https://github.com/cdcseacave/openMVS)

A how to: <https://stackoverflow.com/questions/39217717/in-computer-vision-what-does-mvs-do-that-sfm-cant>

**MultiView Stereo (MVS)**

After SFM is run, the output is a 3D model without much detail. The MVS algorithm is used to refine the mesh obtained by the SfM technique, resulting in what is called a dense reconstruction. This algorithm requires the camera parameters of each image to work, which is output by the SfM algorithm. As it works on a more constrained problem (since they already have the camera parameters of every image like position, rotation, focal, etc.), MVS will compute 3D vertices on regions which were not (or could not be) correctly detected by descriptors or matched. MVS usually takes into account illumination and object materials into its optimization, which SfM does not.

Here is a software that would accomplish this for us: <https://www.di.ens.fr/pmvs/>

But it’s said to be very slow. Here is a faster software: <https://www.di.ens.fr/cmvs/>

**point cloud creation by fusing depth maps**

<https://arxiv.org/pdf/1804.08912.pdf>