Towards high-resolution large-scale multi-view stereo

Resume

The text describes a large-scale reconstruction algorithm. The input is a set of calibrated images and the output is a triangle mesh describing a surface on the images.

Algorithm outline

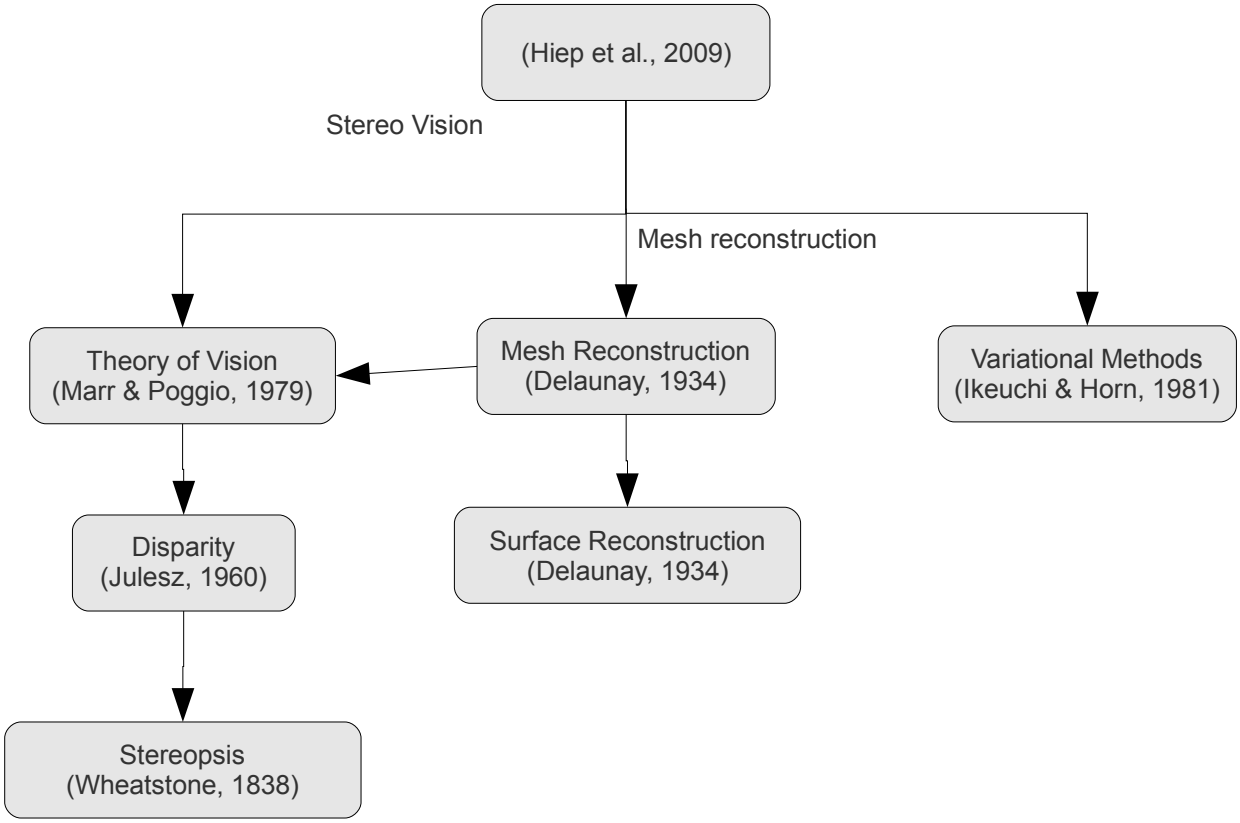
First, a dense point cloud is extracted from image pairs using feature points and stereo triangulation.

Then, an initial mesh is built using Delaunay triangulation and tetrahedra are labelled inside or outside the object.

The surface is extracted as the one that minimizes some Energy function using s-t cut minimization.

Finally, the mesh is refined using Variational methods.

Tree


(Hiep et al., 2009)
Stereo Vision
Mesh reconstruction
Theory of Vision
(Marr & Poggio, 1979)
Mesh Reconstruction
(Delaunay, 1934)
Variational Methods
(Ikeuchi & Horn, 1981)
Disparity
(Julesz, 1960)
Surface Reconstruction
(Delaunay, 1934)
Stereopsis
(Wheatstone, 1838)

Tree outline

The proposed text is an improvement of a work presented in (Labatut, Pons, & Keriven, 2007). This concrete reconstruction algorithm is divided in three parts, i.e, initial point reconstruction, mesh generation and mesh optimization.

The initial point reconstruction is performed using stereo triangulation methods. The stereopsis first appeared in the work of (Wheatstone, 1838). He realized that the images that are formed in human eyes have some differences, known as disparities, that are used by the brain to build the depth perception. In order to demonstrate this, he built a device called stereoscope that can show one image to each eye creating a depth feeling. Later, in 1960 Julesz noted in his work (Julesz, 1960) that humans could see disparity defined depth information in complex scenes, like in his random dot stereograms. This fact led to the work of Marr and Poggio that formalized the correspondence problem from a computational viewpoint (Marr & Poggio, 1976) (Marr & Poggio, 1979). They stabilished the uniqueness and continuity constraints. These constraints appear in the text as "visibility consistency" and "surface smoothness". In order to demonstrate this, they implement a computer program that could generate depth from random dot patterns.

The first attemp to interpolate a complete mesh was done by a Phd. Student of Marr (Grimson, 1980) based on his theory of human vision. In this work, the initial mesh is obtained from a Delaunay triangulation (Delaunay, 1934). The initial mesh is obtained from the Delaunay tetrahedra using s-t graph cuts. This mesh is refined using variational techniques in order to obtain the final mesh. These kind of methods were used for first time in shape reconstruction in (Ikeuchi & Horn, 1981).

References

Delaunay, B. (1934). Sur la sphere vide. *Izv. Akad. Nauk SSSR, Otdelenie Matematicheskii i Estestvennyka Nauk*, *7*(7), 793–800. doi: 10.1051/jphysrad:01951001207073500.

Grimson, L. (1980). Cumputing shape using a theory of human stereo vision. *Archives*. Retrieved from http://hdl.handle.net/1721.1/44237.

Ikeuchi, K., & Horn, B. (1981). Numerical shape from shading and occluding boundaries. *Artificial Intelligence*, *17*, 141-185.

Julesz, B. (1960). Binocular depth perception of computer generated patterns. *Bell Systems Technical Journal*, *39*, 1125-1162.

Labatut, P., Pons, J., & Keriven, R. (2007). Efficient Multi-View Reconstruction of Large-Scale Scenes using Interest Points, Delaunay Triangulation and Graph Cuts. In *2007 IEEE 11th International Conference on Computer Vision* (pp. 1-8). Ieee. doi: 10.1109/ICCV.2007.4408892.

Marr, D., & Poggio, T. (1976). Cooperative computation of stereo disparity. *Science (New York, N.Y.)*, *194*(4262), 283-7. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/968482.

Marr, D., & Poggio, T. (1979). A Computational Theory of Human Stereo Vision. *Proceedings of the Royal Society B: Biological Sciences*, *204*(1156), 301-328. doi: 10.1098/rspb.1979.0029.

Wheatstone, C. (1838). Contributions to the Physiology of Vision. Part the First. On Some Remarkable, and Hitherto Unobserved, Phenomena of Binocular Vision. *Philosophical Transactions of the Royal Society of London*, *128*, 371-394. doi: 10.1098/rstl.1838.0019.