



The Use of the Nelder–Mead Method in Determining Projection Parameters for Globe Photographs

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A photo of a terrestrial or celestial globe can be handled as a map. The only hard issue is its projection: the so-called Tilted Perspective Projection which, if the optical axis of the photo intersects the globe's centre, is simplified to the Vertical Near-Side Perspective Projection. When georeferencing such a photo, the exact parameters of the projections are also needed. These parameters depend on the position of the viewpoint of the camera.

Several hundreds of globe photos had to be georeferenced during the Virtual Globes Museum project, which made necessary to automatize the calculation of the projection parameters. The author developed a program for this task which uses the Nelder–Mead Method in order to find the optimum parameters when a set of control points are given as input.

The Nelder–Mead method is a numerical algorithm for minimizing a function in a many-dimensional space. The function in the present application is the average error of the control points calculated from the actual values of parameters. The parameters are the geographical coordinates of the projection centre, the image coordinates of the same point, the rotation of the projection, the height of the perspective point and the scale of the photo (calculated in pixels/km).

The program reads the Global Mappers Ground Control Point (.GCP) file format as input and creates projection description files (.PRJ) for the same software. The initial values of the geographical coordinates of the projection centre are calculated as the average of the control points, while the other parameters are set to experimental values which represent the most common circumstances of taking a globe photograph. The algorithm runs until the change of the parameters sinks below a pre-defined limit. The minimum search can be refined by using the previous result parameter set as new initial values.

This paper introduces the calculation mechanism and examples of the usage. Other possible other usages of the method are also discussed.