Positional Accuracy Improvement using Empirical Analytical Functions

C. López-Vázquez

LatinGEO Lab, SGM + Universidad ORT Uruguay, Montevideo, URUGUAY, carlos.lopez@ieee.org

Abstract. We define as Positional Accuracy Improvement the problem of putting together maps A and B of the same area, with B of higher planimetric accuracy. To do so, all objects in A might have to be slightly moved according to a mathematical transformation. Such transformation might ideally be of a specific type, like analytical or conformal functions. We have developed a theory to find a suitable analytical transformation despite it is not well defined because the only data available is the displacement vectors at a limited number of homologue control points. There exists a similar problem in fluid mechanics devoted on estimating the complete velocity field given just values at a limited number of points. We borrowed some ideas from there and introduced them into the positional accuracy improvement problem. We shall demonstrate that it is possible to numerically estimate an analytic function that resembles the given displacement at control points. As a byproduct, an uncertainty estimation is produced, which might help to detect regions of different lineage. The theory has been applied to rural 1:50.000 cartography of Uruguay while trying to diminish the discrepancies against GNSS readings. After the analytic transformation, the RMSE error diminished from 71 m to 28 m. Other problems with similar math requirements are the transformation between geodetic control networks.

Key words: *Conformal mapping – analytical functions – Positional accuracy improvement – Approximation*

1. Introduction

The Mercator, Stereographic and other projections represent in a plane the surface of a sphere while maintaining at a local level the angle of lines originally intersecting the sphere's surface. If both maps A and B are represented with such a projection, it is fit to transform one onto the other while preserving the original angles. Heine (2004) performed an interesting historical revision of the projections used since antique times. The Analytical Transformations (also denoted as conformal and homeomorphic) have mathematical properties that make them very useful in cartography, like preserving the angles between source and target. For the rest of the paper we will assume that both maps are already projected onto the plane using some angle-preserving projection reducing the problem to find a suitable transformation between planar coordinates. If A and B