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USING EMPIRICAL MAP PROJECTIONS FOR MODELING EARLY NAUTICAL CHARTS

GASPAR J.
Universidade de Lisboa, LISBOA, PORTUGAL

A numerical model based on the concept of empirical map projection is presented and tested, with the objective of simulating the main geometric features of early nautical charts. Starting with a sample of distances and directions between places on the spherical surface of the Earth, the process consists in re-arranging their positions in a plane so that the differences between the initial (spherical) and final (planar) values are minimized. The input to the model can be either a sample of meridian and parallel intersections defined in a regular geographic graticule or, alternatively, a set of tracks between given points, supposedly representative of the routes underlying the construction of the chart being simulated. Restrictions on the initial pairs of points can be imposed concerning their absolute and relative positions. Also, the weight given to directions and distances in the numerical optimization process can be calibrated. These parameters make possible to simulate particular types of map projections with certain geometric properties, such as equidistance or conservation of directions. Two types of spherical lines are considered: arcs of great circles (orthodromes), along which the shortest distances between pairs of points on the sphere are defined; and rhumb-lines (loxodromes), which make constant angles with all meridians and are used in marine navigation. All directions used by the model can be subjected to the effect of magnetic declination, whose spatial distribution is estimated for various dates, using historical observations and a modern geomagnetic model.

In the first part of the paper an introduction is made to the geometric features associated with the charting methods of the Middle Ages and Renaissance, and to the navigational methods underlying the construction of pre-Mercator charts, as described in the contemporary sources. In the second part, the numerical model is described and tested using theoretical examples, where the geometry of some well-known map projections is simulated. In the third part the model is used to replicate the geometry of the Cantino planisphere (1502). The outputs are compared with the graticule implicit to the original chart, which was previously interpolated on the basis of a set of control points of known geographic coordinates. The results are considered satisfactory, in the sense that the main geometric features of the chart, which result from the methods used in its construction and the effect of magnetic declination, are well simulated.

It is concluded that this kind of numerical modeling is an effective and easy-to-use research tool that can be used, not only for simulating and assessing the various factors affecting the geometry of early nautical charts, but also for educational purposes e.g. for illustrating the properties of map projections.