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The use of animation in visualising deformations of a portolan-type map

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Summary

Animation techniques are used in order to demonstrate in a dynamic and continuous way the deformations induced by the 'rigid' comparison of a nautical portolan map with a modern cartographic counterpart. A portolan map of the Mediterranean, by Giorgio Sideris, from the second half of 16th century is compared optimally to a modern map of the same area, using a proper number of control points along the coastline of the Mediterranean, keeping unaltered the shape of the old map and leaving free, in the process of the comparison, only the parameters of scale and rotation. The two best fitted images are then introduced into an elastic comparison process for the production of an animated image showing in a dynamic way the 'motion' of the spatial field of deformation.

Introduction

When discussing the geometric-geographic representation of the old maps it is trivial to say that they suffer severe deformations with respect to the relevant geometric-geographic representation of today's maps. And this, independently of the projection system used in today's maps. The deformations of old maps, where the degree of deformation depends obviously on the historic period the map was made, usually are considered as self-evident and the question rapidly closes if we are dealing on the issue in a pure phenomenological approach. The pure map historian is usually treating the geometric component of the old maps in a phenomenological way, without entering into the 'technical' details about the deformations. In some cases it looks that the problem is not of the historian's interest, at least in a first approximation, as it is e.g. the case of the medieval OT representations where a discussion on the deformations sounds hopeless, even if we have excellent examples confirming the contrary (Tobler 1966: 35). In some other cases the treatment of the deformation problem presents some interest even to pure historians, as it is the case of the late medieval and early renaissance nautical portolan maps, where the projective basis of the representation is a thrilling question still waiting a consistent and universally accepted answer (Campbell 1987: 385). As far as the quantitative approach to the problem is concerned, a rather long list of references (see, e.g., in Forstner & Oehrli 1998: 35) shows that the scientific interest on the deformations of old maps is not new and worth taking good care, especially today, thanks to the amazing advances of the appropriate analytical and visual tools offered by modern informatics and infographics, which are operating now in 'part and parcel' mode.

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The general concept of deformation

The notion of deformation of a plane ‘figure’ or, even better, of a plane ‘form’ implies a process of comparison of this form with a counterpart, which is assumed as its model. The original form, subject of a study of deformation, is brought into a one-to-one correspondence with its model and the resulting differences, mainly ‘displacements’ or other unitless quantities, are the ‘measures’ of deformation. In other words, the one-to-one correspondence is related to a ‘transformation’ which allows the original form to ‘fit optimally’ the model. The process of ‘transformation’ and ‘optimal fitting’, in order to deduce displacements, is a standard and well-established methodology in geodetic sciences (see, e.g., Vaníček & Krakiwsky 1982: 634), together with the equally well-established methodology of deriving measures of deformation by comparing the two versions of the same form, the original and the model, each in a different metric state (Dermanis & Livieratos 1983: 41; Boutoura & Livieratos 1986: 27). This is actually our case here, when we compare an old map (the original version of the form) with a modern counterpart (the model version of the form).

Static and kinetic visualisation of deformation

The usual way of visualising deformation is the ‘static’ depiction of the point-wise field of displacements or any other spatial distributions representing relevant deformational fields. In all cases the static character of visualisation is the standard design technique widely used in graphic representation. This ‘static’ (immobile) depiction of deformation requires a strong imagination, with not always suitable results, in order to conceive the continuous spatial pattern of deformation all-over the surface of the original form, when it fits the model to which it is compared. In other words a ‘kinetic’ visualisation of the deformation is missing. This type of visualisation can be used today by applying the animated techniques available in the domain of dynamic graphics. The two images of the forms under comparison, the original and the model, are put first in a process of properly defined ‘comparableness’, well known in the literature on analytical transformations of homologous control points and then the comparable images of the two forms are introduced in a ‘morphing’ process generating thus, the animated image of the deformation.

The example

In order to illustrate the method and test the results in the light of animation, we have used the image of a nautical portolan map of the Mediterranean, by Giorgio Sideris (Tolias 1999: 187), from the second half of 16th century[1]. This map (Fig. 1) is considered as the original form using as a model a modern coastline map of the Mediterranean (Fig. 2).
The original image undergoes a transformation by fitting optimally to the model image-map under the strict ‘condition of conformality’, which means that the transformed original image keeps its shape unaltered allowing only a change in scale and orientation. This is done by selecting a proper number of homologous and well defined control points in

[1] Bibliotheque Nationale de France, GE.D. 4497

the two images the pixel-wise coordinates of which are introduced into the optimal fitting process. After the transformation the two images, namely the transformed original and the model, are ready to be compared for the determination of deformations.

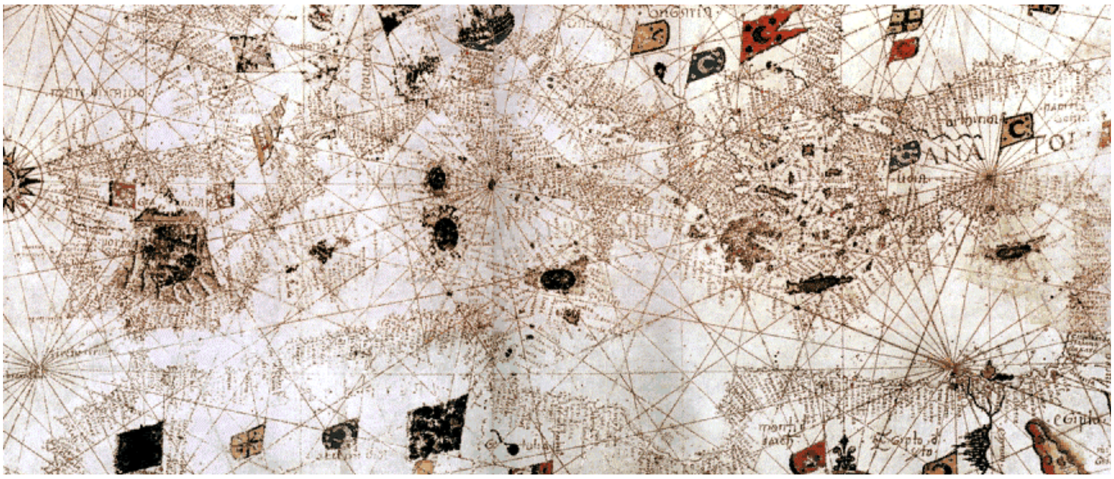

Figure 1. The Mediterranean part of Sideris' map used as the original image in the study.

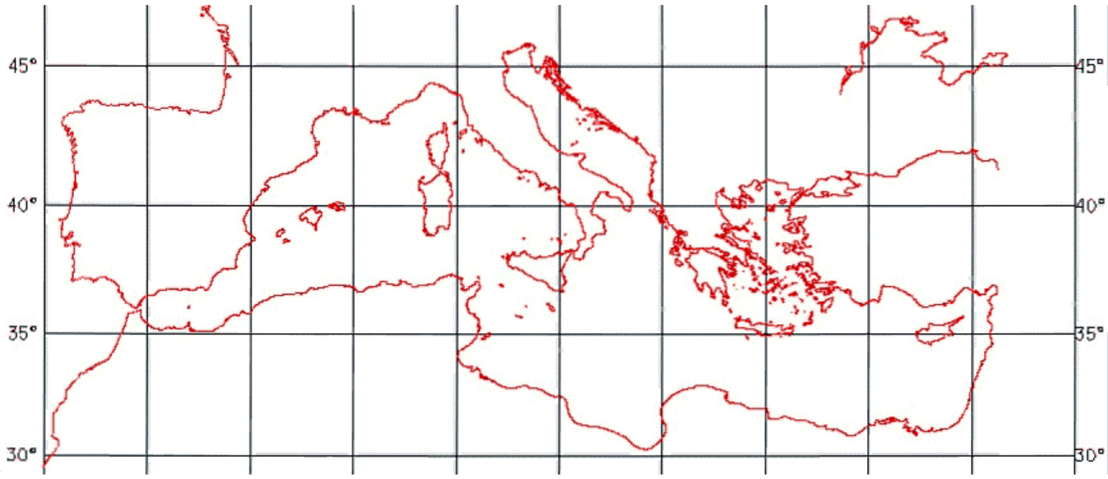

Figure 2. The coastline of Mediterranean in a modern map.

The next step is the introduction of the two comparable images into a 'morphing' process in order to produce the animated visualisation of deformation.

The static case

In the traditional case of depicting the static field of displacements, one can use the well-known design as shown in Fig. 3. In this case we notice a strong field of displacements in the east part of the Mediterranean, with a dominant southwest direction, reaching 3.5 to 4 degrees of arc. In the west part, the field of displacements is 40 per cent weaker, almost uniformly directed northwards. Smaller displacements are register in the central part, of the order of half degree of arc, almost 8 times smaller compared to the east displacements and 4.5 times smaller to those in the west. No other information can be extracted from such illustration unless we proceed to a kinetic visualisation.

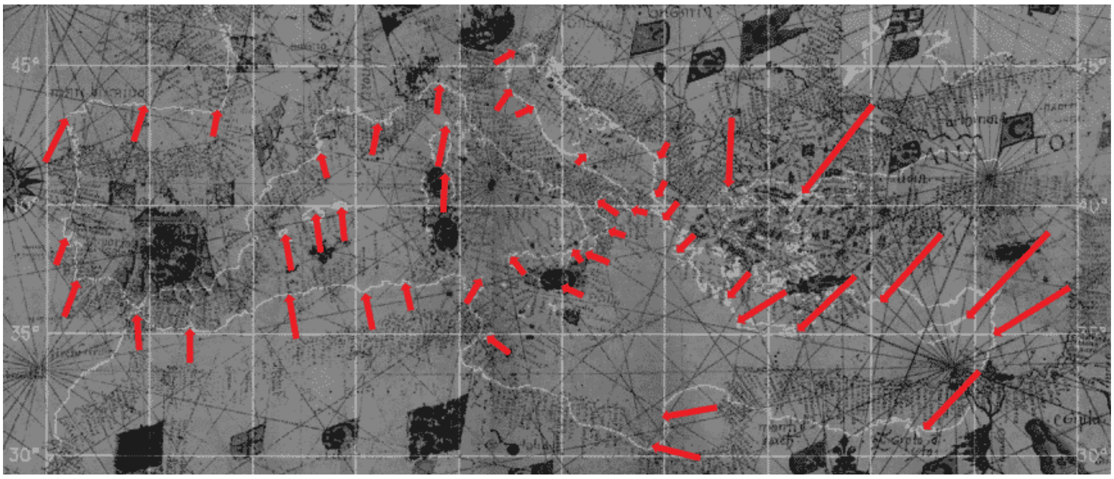

Figure 3. The point-wise vector field of displacements resulted after the comparison of the original and the model images. The almost southwest displacements in the eastern part of the Mediterranean are much stronger than the displacements in the western part, which are almost all directed northwards. In the central part, the displacements are much smaller.

The kinetic case

In this case, an animation is constructed using morphing algorithms widely available in the software market. The two best fitted images, the original and the model, are ‘forced’ to reach a stepwise full congruency. In terms of animation, this is done, frame by frame, during a given time duration. The result is a video clip which shows, of course in a relative way, all the kinetic spatial properties of the deformation field, as far as its magnitude, direction, areal shrinkage or expansion and rotation is concerned.
In Fig. 4 the strip of frames are shown, which compose the video clip of the kinetic visualisation of deformation.

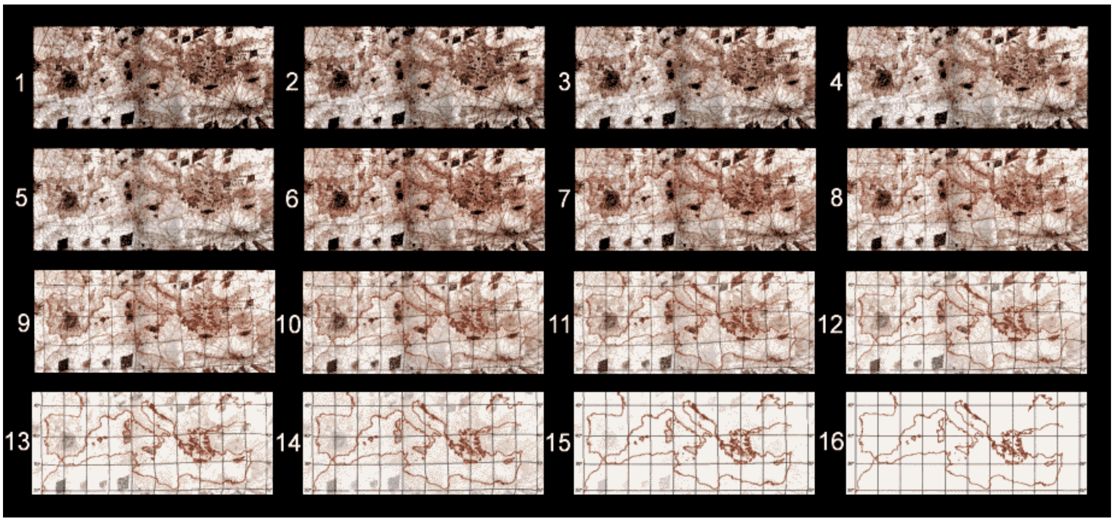

Figure 4. The string of the sixteen frames of the video clip constructed for the kinetic visualisation of the deformation.

The frame by frame comparison, by trasparent superposition, shows some significant differences which are worth to mention. In Fig. 5, for instance, the frames 1 and 4 are compared demostrating, in a different visalization than in Fig. 3 (the grayscale shading shows the directional trend of the shift), the spatial shifting of the east part, which is much stronger than the one in the west. In reverse, the central part is almost unshaded, which means practically no deformation.

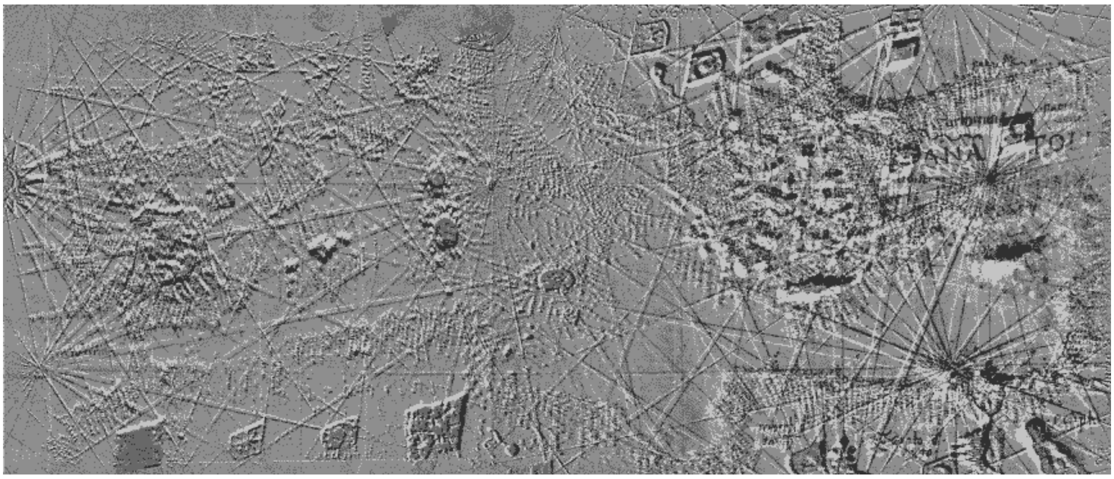

Figure 5. The comparison, by trasparent superposition, of frame 1 and frame 4 of the video clip sequence.

In Fig. 6, the trasparent superposition of frames 13 and 16 shows a remaining deformation in the east part of the map, while in the rest of the map the fitting is almost perfect.

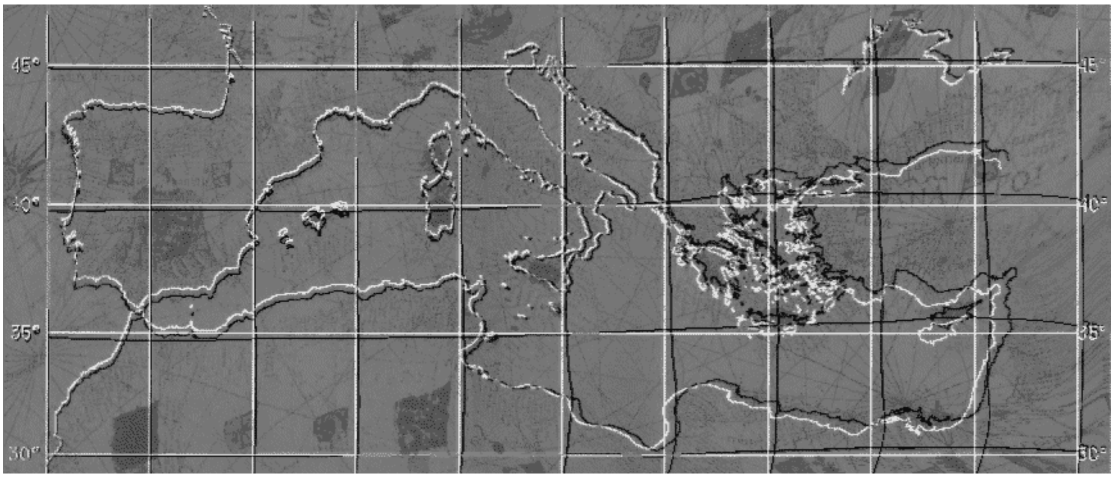

Figure 6. The comparison, by trasparent superposition, of frame 13 and frame 16 of the video clip sequence.

In the last two figures, given in animated format, the kinetic visualisation of the deformation is explicitly shown in two frame velocities

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Figure 7. The animated visualisation of deformation. Each frame of the video clip is displayed for 0.2 of a second.

Figure 8. The animated visualisation of deformation. Each frame of the video clip is displayed 3 times slower.

Conclusion

The use of animation in illustating deformations allows a new conception in unveiling and understanding some fundamental geometric properties of old maps. In our case here, the application of animation on the study of deformation in a portolan-type map's layout shows in an explicit way the overall strain induced in drafting the map by the map maker. In the specific map of our key study, we clearly see the complete properties of strain in the depiction of the three partial regions of the Mediterranean, namely the west, the central and the east. The major deformation is observed in the east part, which expands rapidly to the southwest implying a clockwise rotation at the area of the Aegean. In the west part, comprising the Iberian block to the Corsosardinian complex, the deformation is smaller and slow northwards, while the central longitudinal part of the Italian peninsula remains almost unaltered functioning as the 'pivot' in the motional trend of the east and west regions.

The argument that similar conclusions are also derivable from static depiction of deformation using e.g. the vectorial representation or the digital transparency is partially valid. But in these cases, which was the normal case of deformation depiction in the pre-animation period, the dynamic character of deformation was missed. The complete motional properties of deformation, including rotational and velocity patterns, as well as the direct perception of the spatial continuity of deformation, offer a superior understanding of the geometric alterations of old maps. This leads to a new and more complete understanding relevant to the construction of the geometric or projectional basis of old maps, offering at the same time efficient tools to old map specialists and curators in order to build new and attractive communication channels between the old map heritage and the interested public.

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