An optimization method for elastic shape matching. Applications to forensic facial reconstruction

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This talk addresses the following shape matching problem: given a 'template' shape Ω_0, numerically described by means of a computational mesh, and a 'target' shape Ω_T, known only via a signed distance function to its boundary, we aim at deforming iteratively the mesh of the template shape into a computational mesh of the target shape. To achieve this goal, we rely on techniques from shape optimization. The proposed method may be used as a means to appraise how much Ω_0 and Ω_T differ from one another - for instance in shape retrieval, classification or recognition - or to achieve physically the transformation from Ω_0 to Ω_T (in shape registration, reconstruction, or shape simplification).
Under the sole assumption that both shapes share the same topology, the desired transformation is realized as a sequence of elastic displacements, which are obtained by minimizing an energy functional based on the distance between the two shapes. In doing so, it is expected that the deformation will be easier to achieve in numerical practice, and in particular by limiting the troubles due to mesh tangling. The proposed method has been implemented in a finite elements setting and numerical examples in two and three dimensions are presented to illustrate its efficiency.
We compare the above method with its surface counterpart, discussing the advantages and limitations of both methods. The two approaches are then combined for dealing with partial matching.
Finally we show how the proposed method has been used to address the craniofacial reconstruction problem : we aim at virtually reconstructing a face starting fro the sole datum of the underlying raw skull.

Références

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