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Segmentation and Simulation of the Deformation of Objects Represented in Images using Physical Principles

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Summary

The goal of this work is to automatically extract the contour of an object and to simulate its deformation using a physical approach. In this work, to segment an object represented in an image, an initial contour is manually defined for it that will then automatically evolve until it equals the border of the desired object. In our approach, the contour is modelled by a physical formulation using the Finite Elements Method, and its temporal evolution to the desired final contour is driven by internal forces defined by the intrinsic characteristics of the material adopted for the physical model and the interrelation between its nodes, and external forces determined in function of the image features most suitable for the object to be segmented. To build the physical model of the contour used in the segmentation process, we adopted the isoparametric finite element proposed by Sclaroff, and to obtain its evolution towards the object border we used the methodology presented by Nastar that consists in solving the dynamic equilibrium equation between two consecutive instants.

As for the simulation of the deformation between two different instances of an object, after they each have their contours properly modelled, modal analysis, complemented with global optimization techniques, is employed to establish the correspondence between their nodes (data points). After the matching phase, the displacements field between the two contours is simulated using the dynamic equilibrium equation.

Our approach seems to be very satisfactory in the segmentation of objects represented in images as well as to simulate the deformation involved between two images. Moreover, it is governed by physical principles, and so its results are coherent with the expected behaviour of the modelled objects.

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