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Segmentation and simulation of objects represented in images using physical principles

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Summary

The main goals of the present work are 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 reaches the border of the desired object. In this approach, the contour is modelled by a physical formulation using the finite element method, and its temporal evolution to the desired final contour is driven by internal and external forces. The internal forces are defined by the intrinsic characteristics of the material adopted for the physical model and the interrelation between its nodes. The external forces are 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, the isoparametric finite element proposed by Sclaroff is adopted, and to obtain its evolution towards the object border the methodology presented by Nastar is used, that consists in solving the dynamic equilibrium equation between two consecutive instants.

To simulate 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 this matching phase, the displacements field between the two contours is simulated using the dynamic equilibrium equation that balances the internal forces defined by the physical model, and the external forces determined by the distance between the two contours.

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