Formulating a lower semicontinuous shell model for the matching of level set surfaces

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Methods for finding a 'natural' deformation matching two smooth surfaces embedded in $\mathbb{R}^3$ have multiple applications in computer vision, computer graphics, and even computational anatomy. Creating such a method essentially amounts to formulating a selection criterion among deformations that fit the given data. A recent trend is to use variational models of nonlinear elasticity for this purpose, since they manage to balance geometric consistency with being amenable to both analysis and numerical simulation.

A difficulty in posing such a surface model is that straightforward membrane terms penalizing the deviation from identity of the tangential strain tensor are not lower semicontinuous. This not unexpected, since the problem of finding low-regularity isometric immersions admits a large number of solutions.

In this talk, we will discuss how the additional information from a level set formulation and the matching scenario (as opposed to the purely mechanical one) can be used to obtain lower semicontinuous functionals involving only first-order derivatives. For these models, global existence of minimizing deformations is guaranteed and low-order finite element discretizations can be used, while still capturing much of the original geometry.