Improvement of Contact-Evaluation in Thin-Shell Finite Element Analysis

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The subject of this work is to evaluate an element-element contact in finite element analysis directly on the interpolated surface. In order to find the shortest distance, one needs to calculate and minimize the distance square function of the interpolated geometry over two elements. A triangular element is then considered as a finite triangular part of the interpolated geometry, which is, as a function, also defined beyond. Nearest points on the interpolated surface may therefore take values outside the valid ranges. The distance square function is thus modified by a constraint potential and minimized afterwards by a Newton solver or other minimization algorithm, guaranteeing the contact point coordinates to lie inside the the valid ranges of the triangles. In a second step the overlap of the two surfaces, equipped with a finite thickness, in three dimensions must be calculated. This is approximated by modeling the contact as two penetrating elastic spheres using Hertz' contact law for elastic objects. Since the triangles are finite objects this approximation may yield wrong results at the boundaries. This problem has been solved by weighting the result proportional to the two dimensional overlap of the two triangles projected on the tangent plane. Now the normal force, to be considered in the next time step, can be evaluated. For performance comparison, these concepts have been partially implemented and tested, using a handwritten Newton solver in the first place, and a non linear solver, taken from the OPT++ library. Surprisingly the Newton solver shows far better performance than the third party OPT++ solver, even though performing much more iteration steps.