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ISOGEOMETRIC CONTACT ANALYSIS USING A THIRD MEDIUM

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Summary: this work presents an isogeometric formulation for contact between deformable bodies based on the recently proposed concept of the third medium. This concept relies on continuum formulations not only for the contacting bodies but also for the intermediate medium in which the bodies can move and interact. Key to the formulation is a suitable definition of the constitutive behavior of the third medium. In this work, non-uniform rational B-splines (NURBS) are adopted as basis for the geometry parameterization and the analysis. This brings some advantages over conventional Lagrange discretizations, including the possibility to derive the geometry parameterization directly from CAD, and an increased degree of robustness for severe mesh distortions. The formulation is presented and its performance demonstrated with some examples.

1 Introduction

Recently, Wriggers *et al.* [1] proposed a new approach for contact analysis, based on the concept of the so-called third medium. With this approach, the two contacting bodies are assumed to be embedded in a third continuous medium, described as a fictitious material featuring an isotropic/anisotropic behavior with changing directions and characteristics.

Isogeometric analysis (IGA) was recently proposed by Hughes *et al.* [2] with the original purpose to fill the gap between computer-aided design (CAD) and finite element analysis. In place of the standard Lagrange polynomial basis functions used in the finite element method (FEM), IGA typically adopts non-uniform rational B-spline (NURBS) basis functions, resulting in exact geometry representation (i.e. exact reproduction of the CAD geometry) and arbitrary order approximation, with maximum inter-element continuity C^{p-1} for order-p parameterization. Recent attempts to solve contact problems within the IGA framework (see [3] among others) demonstrated significant advantages of IGA over conventional FEM, especially for contact problems involving large deformations and large sliding.

The combination of the third medium approach with IGA appears promising for a few reasons. First, IGA is capable of importing the geometry parameterization directly from CAD. Thus the geometry of the two contacting bodies and of the third medium can be defined directly in the

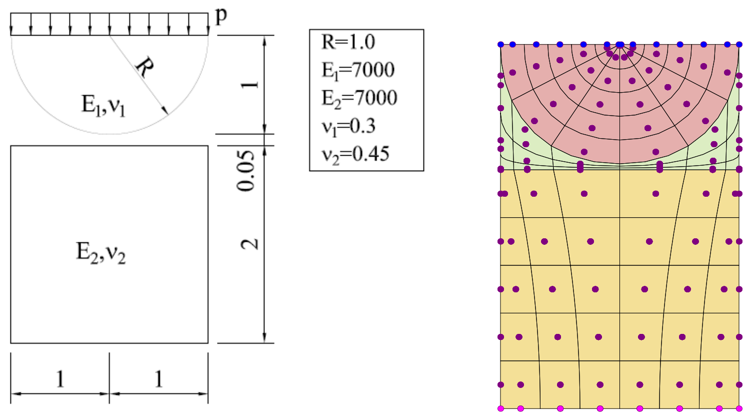

Figure 1: Geometry and coarse mesh for the Hertzian contact problem.

CAD environment. Second, IGA has been shown to deliver an increased degree of robustness over FEM under severe mesh distortions [4]. This is expected to be useful for contact problems with large deformations and large sliding, whereby extreme distortions typically take place in the third medium. Finally, IGA offers the possibility to flexibly increase the order of the discretization without any geometry and parameterization change.

In the present work, we explore the use of the third medium approach for the contact description within the IGA framework. Some significant examples are presented involving normal contact and tangential sliding in 2D and 3D.

2 Examples

The first example is the Hertzian contact problem, for which an analytical solution is available. This example is used to explore the role of the various parameters in the constitutive description of the third medium, and to examine the order of convergence of the method. The material and geometry parameters adopted for the latter are shown in Fig. 1.

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