Adaptive Methods for Contact Problems

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Abstract This contribution is concerned with the adaptive finite-element-formulation of contact problems. For this, first the theoretical background of continuum mechanics and contact kinematics is given. Next the basic finite element formulation for large deformation contact processes is presented for two-dimensional problems. The development of the discretization of contact contributions follows. Here standard approaches are discussed for the case of frictional and frictionless contact. Finally different adaptive strategies involving as well residual based error estimators as error indicators based on superconvergence patch recovery are derived and formulated to include the contributions due to contact. Also error estimators based on dual principles are discussed. Examples show the performance of the different formulations and adaptive strategies.

1 Introduction

Boundary value problems involving contact are of great importance in industrial applications in mechanical and civil engineering. The range of application starts with relatively simple problems like foundations or bearings and includes metal forming processes, rubber sealings, drilling problems, crash analysis of cars, rolling contact between car tires and the road. Other applications are related to biomechanics where human joints, implantats or teeth are of consideration. Due to this variety contact problems are today combined either with large elastic or inelastic deformations including time dependent responses. Thermal coupling might have to be considered, see cooling of electronic devices, heat removal within nuclear power plant vessels or thermal insulation of astronautic vehicles. For most industrial applications numerical methods have to be applied since the contacting bodies have complex geometries or undergo large deformations. Due to that the appropriate meshing for a problem can often not be found a priori to the computation. Hence there is a need to develop adaptive methods for contact problems.

The main idea of adaptive mesh refinement is depicted in Fig. 1. It shows the basic ingredients of an adaptive method for contact problems. Part 1 is the determination of the contact, part 2 a solution of the problem with a given mesh and finally the adaptive process in part 3 leads to an automatic mesh refinement of the discretization.

Adaptive methods rely on a posteriori error estimators which estimate e.g. the difference between the exact solution \mathbf{u} and the approximate solution \mathbf{u}_h of the displacement field. For an elliptic variational problem of order m with complete interpolation polynomials of order k in a norm containing derivatives of degree s, see Strang and Fix (1973), one

New Developments In Contact Problems

Nicola Bosso, Maksym Spiryagin, Antonio Gugliotta, Aurelio Somà

New Developments In Contact Problems:

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Hamburg and Braunschweig the Pontificia Univ Catolica in Rio de Janeiro etc **Evaluating Communication for** Development June Lennie, Jo Tacchi, 2013-02-11 Evaluating Communication for Development presents a comprehensive framework for evaluating communication for development C4D This framework combines the latest thinking from a number of fields in new ways It critiques dominant instrumental accountability based approaches to development and evaluation and offers an alternative holistic participatory mixed methods approach based on systems and complexity thinking and other key concepts It maintains a focus on power gender and other differences and social norms. The authors have designed the framework as a way to focus on achieving sustainable social change and to continually improve and develop C4D initiatives The benefits and rigour of this approach are supported by examples and case studies from a number of action research and evaluation capacity development projects undertaken by the authors over the past fifteen years Building on current arguments within the fields of C4D and development the authors reinforce the case for effective communication being a central and vital component of participatory forms of development something that needs to be appreciated by decision makers They also consider ways of increasing the effectiveness of evaluation capacity development from grassroots to management level in the development context an issue of growing importance to improving the quality effectiveness and utilisation of monitoring and evaluation studies in this field The book includes a critical review of the key approaches methodologies and methods that are considered effective for planning evaluation assessing the outcomes of C4D and engaging in continuous learning This rigorous book is of immense theoretical and practical value to students scholars and professionals researching or working in development communication and media applied anthropology and evaluation and program planning

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