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COMBINATION OF INTERIOR-POINT METHOD AND SEMISMOOTH NEWTON METHOD FOR LARGE-SCALE FRICTIONLESS CONTACT PROBLEMS

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ABSTRACT

In this paper, a solution scheme for frictionless contact problems of linear elastic bodies is proposed. The present method is a combination of the interior-point method and semismooth Newton method. The systems of linear algebraic equations that are derived in these two methods are solved by iterative solvers in order to perform large-scale analyses of frictionless contact problems.

When the elastic bodies are discretized using the finite element method and the contact problem is modelled by node-to-node or node-to-segment contact model, the problem is reduced to that of finding pairs of nodes or node and segment in contact. Wriggers [1] introduced major algorithms for solving contact problems. The simplest method for solving this problem is an iterative correction of the active set until converging to a solution satisfying the complementarity condition between the gap and contact force. This method is sometimes called a trial-and-error approach.

The family of interior-point methods [2] has been shown to be effective for solving the convex quadratic programming problems. This can be applied for solving contact problems. Christensen et al. [3] applied a semismooth Newton method and an interior-point method to linear elastic contact problems with Coulomb friction, and found the advantage of the semismooth Newton method. The primal-dual active set strategy is proposed for solving linearly constrained quadratic problems, and can be applied to frictionless contact problems. Hintermüller et al. [4] showed that the primal-dual active set strategy is classified as a special form of the semismooth Newton method and converges if the problem has some particular coefficient matrices. Recently, this method is often applied to frictionless contact problems [5][6].

In this paper, an approach combining the interior-point method and semismooth Newton method is presented. In this method, an initial active set for the semismooth Newton method is obtained from the approximate optimal solution by the interior-point method. The method is compared with the interior-point method and semismooth Newton method. In order to solve the large-scale problem, the systems of linear algebraic

equations derived in these two methods are solved by using the conjugate gradient method or conjugate projected gradient method.

A numerical example of frictionless contact problem that is difficult to solve by using the semismooth Newton method is solved by the present combined method. Figure 1 shows the convergence histories for the proposed method (IP+SSN), the semismooth Newton method (SSN), the semismooth Newton method without the line search (the primal-dual active set strategy) and the interior-point (IP) method. It is observed that the present method converges quickly.

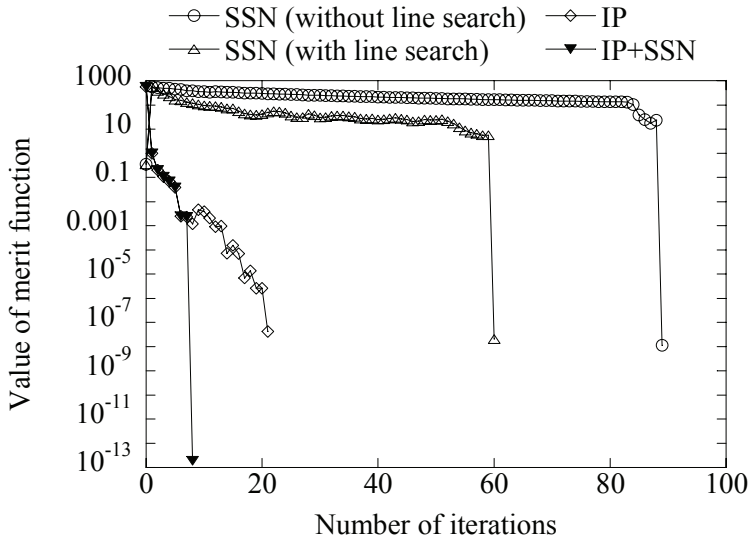

Figure 1: Comparison of convergence properties

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