Towards a multigrid solver for finite elements applied in contact problems

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Introduction

The interaction between a tyre and the road surface is one of the major noise sources from road traffic. In order to reduce this tyre/road noise accurate predicting models are needed. The currently used contact models lack either accuracy or calculation speed, since a high spatial resolution is required. Therefore a new contact algorithm is developed which can be applied in finite elements, is accurate, and can be speed up using multigrid methods [1].

Contact model and algorithm

The contact model consists of a contact condition, stating that the tyre cannot penetrate the road surface, and a friction model. In the newly developed contact algorithm contact and the dynamic equations are solved together. This is illustrated in figure 1, where as an example one tread block is considered. When a node of this block is displaced under the road surface, it is put back onto the road surface and corrected for friction. This process is repeated for all the other nodes until convergence is reached. A bouncing ring as given in figure 2 illustrates the algorithm's working in dynamic cases.

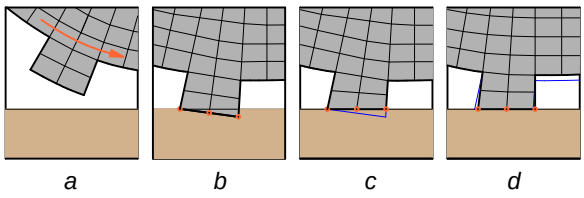

Figure 1 : Simplified working of the contact algorithm: a tread block (a) is displaced under the road (b), is put back on the road (c) and is corrected for slip (d).

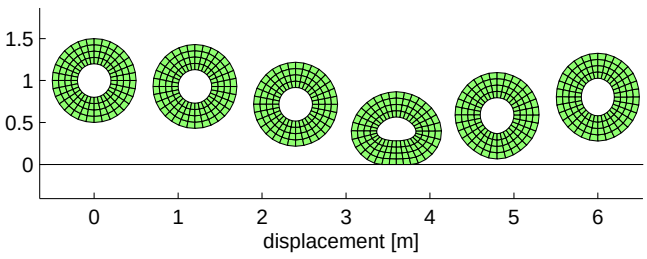

Figure 2 : Bouncing ring on a frictionless surface

Multigrid

In the current contact algorithm nodal updates are calculated by Gauss-Seidel relaxation. Although Gauss-Seidel is considered as a good smoother, it is not an efficient solver. Multigrid methods on the other hand are efficient iterative solvers [2]. In these methods a problem is solved using multiple meshes as given in figure 3. The residuals are transferred between the meshes. Multigrid has two benefits: (1) the number of degrees of freedom is reduced and (2) low frequency residuals become high frequency residuals on a coarse grid. A multigrid solver has been applied to finite elements.

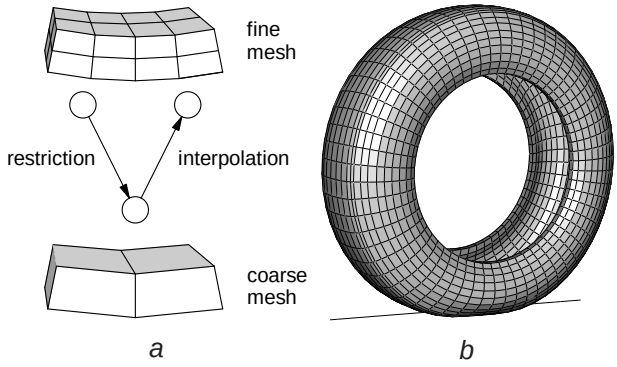

Figure 3 : Multigrid cycle (a) and coarse tyre mesh (b)

Conclusions and future work

The new contact algorithm has successfully been applied in finite elements. A multigrid solver is currently being developed. In the future the model the model will be extended to three dimensions.

References

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2. Venner, C.H. (1991) *Multilevel solvers for the EHL line and point contact problems*, University of Twente, PhD thesis, University of Twente, Enschede, The Netherlands.

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