Adaptive Mesh Methods for Elastohydrodynamic Lubrication

Martin Berzins
martin@comp.leeds.ac.uk
The University of Leeds, United Kingdom

Modelling of lubrication problems extends back to the hydrodynamic equation of Reynolds [1]. For very highly loaded cases (from 0.25 G Pa) the contacts themselves deform, defining elastohydrodynamic lubrication (EHL). Pressures in journal bearings and gears typically reach up to 3 or 4 G Pa. These cases are important to industry for the design of new oils and new components, and a formidable computational engineering challenge is therefore posed. Coupling the dense matrices of the elastic deformation of the surfaces with the highly nonlinear equations of the pressure distribution and lubricant rheology leads to an intensive computation.

Multilevel methods [2] have proved robust and highly desirable in terms of the speed-up in solving EHL problems. There is, however, a continuing drive to improve the efficiency of solvers for EHL problems. This arises from a number of issues. First, fluid effects are important in cutting edge industrial applications and there is therefore a need to capture the correct rheology of the lubricant [3]. Determination of the rheological parameters of a fluid by fitting experimental measurements of various kinds is an optimisation problem requiring many thousands of EHL solutions to be computed and efficiency is clearly a major issue. Second, accurate solutions of micro-EHL problems with realistic surface roughness require high spatial resolution so that even a single solution may be a large computational task.

In this paper we investigate the use of spatial adaptivity to decrease the computational effort required to achieve accurate solutions to point contact EHL problems. This technique is currenly very rare for EHL problems, having only been used in [4]. The potential benefits, however, especially for micro-EHL problem are enormous. In these cases the effects of low amplitude surface defects or roughness dramatically alters the solution profile.

The methods of grid adaptation to be used will be detailed, together with explanation of how these fit into the EHL multigrid framework. Results are presented showing that the computational cost of the calculation can be significantly reduced, whilst maintaining the quality of the solution.

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