GEOMETRIC SENSITIVITY OF RIGID GRAPHS

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Consider a rigid structure (a bridge, a roof, or any other bar-and-joint framework) which resolves a so-called equilibrium force system acting on its joints. This generates stresses in the bars. When the location of a joint v is slightly perturbed, and the same force system is applied, the resolving stress will change in some of the bars. We call the set of these bars the *influenced zone of* v (with respect to the force system and the joint configurations).

We show that for two-dimensional frameworks without geometric degeneracies (and for typical force systems) the influenced zone of v depends only on the graph of the framework and can be computed by efficient combinatorial methods (using graph orientations and techniques from matroid optimization).

These results may be useful when one needs to recompute the stresses due to minor changes in the geometry of the framework. Identifying the influenced zone by a quick combinatorial algorithm can serve as a preprocessing step which reduces the size of the problem.

Our results may also be used in the analysis and design of highly geometrically sensitive (non-sensitive, resp.) frameworks, in which a small perturbation of any joint results in the change of stresses in the whole (resp. in just a small part of the) framework. For example, if the goal is to attach (a small number of) devices to some of the bars that can observe a small perturbation of some joint by sensing the change of stress in the bar, a highly sensitive framework seems more advantageous. On the other hand, recomputing the stresses is easier if the framework is non-sensitive.

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