A GRÖBNER-SYLVESTER HYBRID METHOD FOR CLOSED-FORM DISPLACEMENT ANALYSIS OF MECHANISMS

A.K. Dhingra, A.N. Almadi, and D. Kohli
Department of Mechanical Engineering
University of Wisconsin-Milwaukee
Milwaukee, WI 53201

ABSTRACT

The displacement analysis problem for planar and spatial mechanisms can be written as a system of multivariate polynomial equations. Elimination theory based on resultants and polynomial continuation are some of the methods that have been used to solve this problem. This paper presents a new approach to displacement analysis using the reduced Gröbner basis form of a system of equations under degree lexicographic (dlex) term ordering of its monomials and Sylvester's Dialytic elimination method. Using the Gröbner-Sylvester hybrid approach, a finitely solvable system of equations F is transformed into its reduced Gröbner basis G using dlex term ordering. Next, using the entire or a subset of the set of generators in G, the Sylvester's matrix is assembled. The vanishing of the resultant, given as the determinant of Sylvester's matrix, yields the necessary condition for polynomials in G (as well as F) to have a common factor. The proposed approach appears to provide a systematic and rational procedure to the problem discussed by Roth (1994) dealing with the generation of (additional) equations for constructing the Sylvester's matrix. Three examples illustrating the applicability of the proposed approach to displacement analysis of planar and spatial mechanisms are presented. The first and second examples address the forward displacement analysis of the general 6-6 Stewart mechanism and the 6-6 Stewart platform, whereas the third example deals with the determination of the I/O polynomial of an 8-link 1-DOF mechanism that does not contain any 4-link loop.

Appeared in ASME Journal of Mechanical Design, Vol. 122, pp. 431-438, 2000.