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PROBABILISTIC MOTION PLANNING FOR A VARIABLE GEOMETRY TRUSS UNDER DYNAMIC LOADING

Abstract

This study addresses a probabilistic motion planning for a two or three dimensional variable geometry trusses (VGTs) under dynamic loading. In space environment, the VGTs are probably subjected to dynamic loading applied by the objectives such as a trouble satellite because the reaction wheel or control moment gyros (CMGs) in the objectives can be an excitation source to the VGTs. Also, the natural frequency of the VGTs changes during these motions because the stiffness of the VGTs clearly depends on the geometry configuration. Therefore, the difference between the excitation force and the natural frequency varies during the motion. If the difference is approximately zero, harmful resonant vibration occurs, which should be avoided in orbit. The optimization of geometry configuration of the VGTs by considering the relationship between the excitation and the natural frequencies is, therefore, one of the important issues for safe and precise control of the VGTs. The optimization of the motion planning for the VGTs can be solved with classical, deterministic optimization techniques such as a sequential quadratic programming (SQP). However, finding the optimal motion considering the natural frequency of the truss is non-linear optimization problem and it is easily affected by the initial parameters for the optimization. On the other hand, probabilistic optimization technique can give better motion planning that further reduces the vibration amplitude and the required energy for the motion. Thereby, we apply the probabilistic technique using the particle swarm optimization (PSO). The design variables are the geometric parameters of the VGTs that can be defined as the angles or the length of the truss members of the VGTs. The design variables are searched by the PSO techniques in a probabilistic manner. The evaluation function used here is a specific margin of the natural frequency of the VGTs and the frequency of the external force. Also, the minimization of the trajectory length of the end effecter of the VGTs is considered in the optimization process. The results of probabilistic optimization showed that the vibration amplitude for the optimized manipulation was drastically reduced by avoiding the resonant vibration induced by the disturbance. It was also shown that the obtained trajectory of the end effecter of the VGTs was clearly different from that obtained by the deterministic calculations such as the sequential quadratic programming (SQP). Therefore, the use of the probabilistic technique was further advantageous in the motion planning of the VGTs.