Kinematic Analysis of a Threaded Fastener Assembly

by

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(Abstract)

The demands for an increase in productivity and reduced assembly costs require engineers to automate solutions that replace manual labor. This work concentrated on a common assembly primitive, threaded fastener insertion, in an effort to determine the nature of contact between a bolt and nut during thread mating. The assembly problem was initially simplified as a two-dimensional analysis to gain an understanding about how contacts between the bolt and nut change during counter-clockwise motion. Tessellated solid models were used during three-dimensional collision analysis in such a way that the approximate location of the contact point was enumerated. The advent of a second contact point presented a more constrained contact state since we are interested in maintaining both contacts; thus the bolt rotated about a vector defined by the initial two contact points until a third contact location was found. By analyzing the depth of intersection of the bolt into the nut as well as the vertical movement of the origin of the bolt reference frame, we determined that there are three types of contacts states present: unstable two-point, quasi-stable two-point, stable three point. Though the unstable case remains to be deciphered, the parametric equations derived in this work can be used without modification to create a full spectrum of maps at any point in the history of a threaded assembly problem. We investigated 81 potential orientations, each of which has its own set of contact points. From this exhaustive examination, we are capable of detailing a contact state history and, from this, have the potential to develop a constraint network.