An Effective Method to Estimate Performance of Parallel Manipulators

Kidar Nath Rustagi, S.S.Rattan, Gian Bhushan Arora

Abstract

In this paper we suggest an effective method to measure dexterity index of parallel manipulators. A commonly used criterion for dimensional synthesis is the dexterity, which refers to the capacity of a Parallel Manipulator (PM) to provide a large range of orientation to its end-effector and describes a PM's motion accuracy, controllability (singularity) and manipulability. The earliest definition of dexterity is introduced by Salisbury and Craig , in which the dexterity is evaluated by the Local Condition Number (LCN) of kinematics Jacobian matrix. As LCN is configuration specific, various authors have used Global Condition Number (GCN) or Global Condition Index (GCI) which is reciprocal of GCN as the performance index. While studying the effect of change in design parameters, on performance of a 6-dof fully parallel manipulator, of Stewart Platform Architecture, we have found that GCN does not quantify the actual corresponding change in performance. We have tried to establish this by comparing change in GCN and change in frequency of various ranges of LCN. In cases, where we see a considerable change in frequency of undesirable ranges of LCN value due to dimensional changes, there is very little change in GCN, may be because of averaging effect. As we are more interested in examining if there are higher LCN values, GCN is unable to bring out this fact clearly. We suggest a concept of Weighted Average Condition Number (WACN) which can more effectively bring out this fact and can be used for optimization purpose.

Keywords: Parallel Manipulators, Dexterity, Local Condition Number, Global Condition Number, Weighted Average Condition Number

Kidar Nath Rustagi(Corresponding author)
Department of Mechanical Engineering, ITM University, Palam Vihar, Gurgaon, Haryana, India
Email: knrustagi@itmindia.edu.

S.S.Rattan
Department of Mechanical Engineering, NIT Kurukshetra, Kurukshetra, Haryana, India
Email: ssrattan@nitkkr.ac.in.

Gian Bhushan
Department of Mechanical Engineering, NIT Kurukshetra, Kurukshetra, Haryana, India
Email: aroragian@yahoo.com