IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures Control, Dynamics and Microdynamics (4)

Author: Ms. Sarah Halabieh
MDA SPACE INC., Canada

Dr. George Yang
MDA, Canada
Dr. Paul Grouchy
MDA SPACE INC., Canada

USING GENETIC ALGORITHM TO CHARACTERIZE DYNAMIC JOINT PARAMETERS OF SSRMS

Abstract

Since the Space Station Remote Manipulator System's (SSRMS) launch to the International Space Station in 2001, its joints have been subject to mechanical wear and aging of its motor control electronics. Although joint parameters, such as friction, were characterized prior to commissioning, wear on the joints means that parameters change with time. However, it can be difficult to characterize the SSRMS' joint parameters on-orbit. There is little or no access to the physical hardware needed to run characterization testing. Furthermore, running specific controlled mission operations to characterize parameters is not a feasible solution as the hardware is often occupied with other flight operations. Having up-to-date parameter values would ensure that operators can continue to monitor the health of the arm, and take any precautionary measures if parameter values exceed a threshold. It would also ensure that any simulations of the arm are representative of the hardware they are simulating. Some parameters would benefit from characterization on a weekly basis, and so a method that is fast, and makes use of the data that is already collected by sensors onboard the arm is needed. Currently, a recursive least squares method analyzes the telemetry data measured onboard the arm. This technique, however, is sensitive to outliers in the data, and thus may not always produce accurate results. Genetic algorithm methods are evolutionary optimization techniques that iterate over a set of potential solutions until a user-defined cost function stopping condition is satisfied. For this application, we used a genetic algorithm to estimate friction values in a simulation. A cost function compared the simulated arm behaviour to the telemetry data, encouraging the GA to improve its fitness in producing a set of friction parameters that allow the simulation to mimic the telemetry data. Using this approach, we have been able to characterize the friction in the joints of SSRMS after the arm has reached steady-state conditions, i.e., the simulation can mimic the actual arm's behaviour. When compared against the recursive least squares method, the genetic algorithm method is able to produce friction values that better emulate the arm's behaviour. This approach of comparing simulation data to telemetry data in an optimization algorithm is applicable beyond the SSRMS to characterize parameters in other aerospace applications. Next steps for development include capturing the dynamics of the arm within the cost function, to enable a more diverse telemetry data to be used with the genetic algorithm.