

Dynamic control design for five degrees of freedom robot manipulator

**K.M.I.P. Amarasekara* , T.I.U. Weerasinghe, G.K.L. Wickramasinghe,
B.G.L.T. Samaranayake and M.P.B. Ekanayake**

*Department of Electrical and Electronic Engineering
University of Peradeniya, Sri Lanka
ireshmini@gmail.com

In automated manufacturing lines or in any other application where Robot Manipulators (RM) are used, the high controlling ability of the RM is required for fast and accurate functioning. Nonlinearities in motors, drives, gears, friction between joints, weight distribution in robot arms, motor parameters, and many other facts make the task of controlling the RM a hard process. Basic controllers like P, PID, and many other controllers which give high controllability have been developed to overcome such complications. Basic controllers only use measured tracking error of the RM, but they do not offer high controllability because the mentioned nonlinearities caused by the dynamics of the RM are not considered. Hence, Dynamic Based Controllers (DBC) are used in robotics to achieve high controllability.

For an application like pick and place, average controllability over the robot's arms is enough. However, for applications like painting, welding or to handle tiny objects, smooth, fast and accurate functioning of the robot arm is mandatory. Hence, DBC can be used in such special purpose robots

This paper, presents a methodology for designing and implementing a DBC for an RM which can provide high controllability over large nonlinearities of the system. First, dimensional measurements of a system were taken and a CAD model of the system was implemented in Solid Works TM. It was then utilised to understand the workspace and system limitations. In order to design the DBC, a mathematical dynamic model of the RM is derived using the Euler-Lagrange equations. To get the overall dynamic model of the system, motor dynamics and RM dynamics are combined. Then, two inverse DBCs are designed with and without considering error dynamics. Next, those controllers are implemented and simulated in Simulink TM along with the mathematical model of the RM. From the simulations, it was observed that the error dynamics based approach delivers better results in reference tracking. However, both derived DBCs can compensate the dynamic behaviour when compared to the existing kinematic based controllers. With regard to the results, it can be suggested that a DBC is more suitable to overcome nonlinearities and for the proper functioning of the RM.