LINEAR CONTROL STRATEGIES FOR ROBOT TRACKING APPLICATIONS

BY

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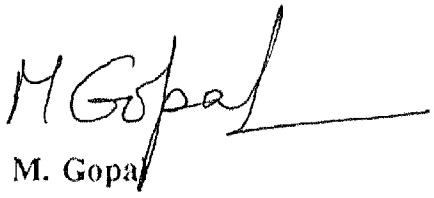
DEDICATED

TO

MY LATE FATHER

CERTIFICATE

This is to certify that the thesis entitled "**Linear Control Strategies for Robot Tracking Applications**" being submitted by **Akhilesh Swarup** to the Department of Electrical Engineering, Indian Institute of Technology, Delhi, for the award of the degree of **Doctor of Philosophy**, is a record of bonafide research work carried out by him under my supervision and guidance. The results contained in this thesis have not been submitted to any other university or institute for the award of any degree or diploma.



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ABSTRACT

The spectrum of research in robotic control includes the techniques: computed torque control, pole-placement and optimal control, adaptive control and intelligent control. The recent advances in control theory lack general analytical tools to study the stability, convergence and robustness of respective control algorithms. The research work presented in this thesis is concerned with the investigation of linear control strategies for robot tracking applications. The linearized dynamic robot models are used to develop linear control methods. A comparative account of linearization schemes for robot dynamic model is presented in this thesis. Also, a simple scheme of dynamic linearization is proposed for higher accuracy at reasonable computational effort. In this work, a feedback control design method is developed for exact eigenstructure assignment which optimizes a quadratic performance index. This algorithm gives relatively robust performance. Robustness of robot tracking performance with respect to payload variations has been the key issue in the present investigations. Design procedures based on exact eigenstructure assignment are computationally involved. This thesis also presents a computation-effective control design procedure for eigenstructure assignment using aggregation. In the proposed algorithm, the system is aggregated to a second order system for which the desired dominant eigenvalues are placed at specified locations in the complex plane; the remaining eigenvalues are treated as nondominant and are assigned within a disk at a desired location. To provide the performance robustness to relatively large payload variations, a compensation scheme has been developed using trajectory tracking error-pattern. An alternative to eigenstructure assignment is covariance assignment in shaping the system dynamics. An algorithm for covariance control with optimum performance has been presented for robot tracking application. This thesis

also includes investigations on decentralized control schemes for robot manipulators. It has been shown that a constrained state feedback control in conjunction with the proposed compensation scheme results in improvement of the robustness with respect to payload variations.

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