CHAPTER-6
CONCLUSIONS & SCOPE FOR FUTURE WORK
6. CONCLUSIONS AND SCOPE FOR FUTURE WORK

6.1 Conclusions

A suitable control of a single flexible link manipulator (SFLM) has been investigated in this thesis. In this thesis initially a suitable model of a single-link flexible manipulator system has been presented. The Lagrange’s equation and modal expansion method has been utilized in obtaining an analytical model of the system characterized by an infinite number of modes. This leads to a matrix differential form of the model, which can be readily converted to a state-space form, s-function model and transfer function model.

For the proposed model a control strategy for flexible manipulator systems has been presented. The control strategies developed through combination of PID with tuning the proportion, integration and derivative gains. The proposed control schemes have been tested within simulation environment of a single-link flexible manipulator. The performances of the control schemes have been evaluated in terms of input tracking capability and displacement of theta of the single link flexible manipulator. It is clear that the PID controller doesn’t create a suitable step response for the system in both modes. Intense transient oscillation and high overshoot are the shortcoming of such controller. Moreover the parameters of this controller are constant, no adaption with system dynamical changes take place.

The results of simulation after using LQR controller for mode 1 and mode 2, the angular displacement is good but the response time is high in both cases. The amplitude of oscillation has been around zero for mode 1 and mode 2 high and damp out after sometime. Since the amplitude of oscillation persists and in order improves the transient response of the system, an ANFIS controller has been designed and simulated along with the SLFM system. From the step response of single link flexible manipulator, the vibrations of the single link flexible manipulator has been reduced. The results are presented for the both mode 1 and mode 2 operations.
It is observed that how the single link flexible manipulator behaves during the continuous operation with the pulse input. In the continuous operation the PID controller has failed in performance and whereas the LQR and ANFIS has good. The fast response with the continuous change of the input has excellent with the ANFIS controller compared with the LQR controller. So ANFIS is the best suitable controller for single link flexible manipulator compared with all the other controllers with regards to quick angular displacement (\(\theta\)) and tip deflections (\(\alpha\)) with reduced distortion.

6.2 Scope for Future Work

- Because of the extreme complexity of the dynamic equations of motion link flexibility only considered in this thesis.
- The system performance can be improved by considering both link flexibility, and joint flexibility while modelling.
- The mathematical model of Flexible link manipulator can be modelled by using Finite Element Analysis.
- These controllers can be designed with advanced controllers to reduce these errors drastically such as model matching controllers and fractional order controllers with intelligence techniques.
- The ANFIS models developed can be improved by considering other membership functions and clustering approaches.