MODELING AND CONTROL OF BALL AND BEAM SYSTEM USING MODEL BASED AND NON-MODEL BASED CONTROL APPROACHES

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Abstract— The ball and beam system is a laboratory equipment with high nonlinearity in its dynamics. The aims of this research are to model the ball and beam system considering nonlinear factors and coupling effect and to design controllers to control the ball position. The LQR is designed considering two Degrees-of-Freedom and coupling dynamics. The parameters of the LQR are tuned using Genetic Algorithm (GA). Jacobian linearization method is used to linearize the system around operating-point. Due to the noise of the sensor in the experimental setup, a state observer is designed to observe the velocity of the ball. In order to compare the performance of the LQR and study the effect of simplifying assumptions, two control strategies are designed and implemented: Proportional Derivative Integral (PID) as non-model based control strategy, hybrid PID and Linear Quadratic Regulator (LQR) as combination of model based and non-model based control strategies. The experimental results of this research prove the model based control strategies outperforms the non-model based or hybrid controllers in a nonlinear and noisy ball and beam system. In addition, it is shown that the coupling dynamics cannot be eliminated as a simplifying assumption in designing the controller.

Index terms: Ball and beam, proportional derivative integral controller, linear quadratic regulator, genetic algorithm