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Title : MODELING AND CONTROL OF XY TABLE USING TRAJECTORY ADAPTIVE ZPETC

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Trajectory tracking application is widely used in industry especially for manufacturing process. Control systems design for precise and high-speed trajectory tracking is challenging enough as the plant system model transfer function will be presented by non-minimum phase system. In this thesis, a new digital tracking control technique by utilizing feedforward adaptive ZPETC is proposed to solve the non-minimum phase problem. The proposed feedforward controller design was tested and applied on an XY table by simulation and real-time experiment. XY table is a flat surface mechanical system which facilitates horizontal motion in X and Y axes and normally used for machinery. Good controller design can provide precise trajectory motion of both axes and thus minimize the tracking and contour error of the XY table. The XY table plant discrete-time models were obtained from input-output experimental data using Matlab system identification toolbox. Sampling time 45 ms was used to get nonminimum phase discrete-time plant model and minimum phase system was obtained using 60 ms sampling time. Minimum phase system was also used to test the usability of the proposed control technique. In this study, adaptive feedforward ZPETC without factorization of zeroes was considered. Optimum values for gain compensation filter coefficients of adaptive ZPETC were obtained using Recursive Least Square (RLS) parameter estimation process. To widen the frequency bandwidth of adaptive ZPETC and improving the tracking performance at high frequency, model reference was introduced in this process. Adaptive ZPETC with model reference was tested by computer simulation and real-time experiment. High and low frequency reference inputs were used and the motion performances were then compared to Adaptive ZPETC without model reference, Error Filter ZPETC and Conventional ZPETC for benchmarking. The simulation results of the proposed controller using non-minimum phase system show better motion performance by almost 100% improvement compared to all benchmarking techniques for both high and low frequencies reference inputs. Real-time experiment also shows comparable results which achieved contour error for high reference input of 0.2016 mm whereas 3.6008 mm by using conventional ZPETC, 2.3003 mm for Error Filter ZPETC and adaptive ZPETC without model reference 0.2418 mm. Similar trend of results was obtained for minimum phase system. In conclusion, the proposed method can improve the tracking performance of non-minimum phase system and also can be applied to minimum phase system. This is proven by simulations and real-time experiments works.