Integrated Design of Feed Drive Systems Using Discrete 2-D.O.F. Controllers (I) - Modeling and Performance Analysis -

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Abstract

High-speed/precision servomechanisms have been widely used in the manufacturing and semiconductor industries. In order to ensure the required high-speed and high-precision specifications in servomechanisms, an integrated design methodology is required, where the interactions between mechanical and electrical subsystems will have to be considered simultaneously. For the first step of the integrated design process, it is necessary to obtain not only strict mathematical models of separate subsystems but also formulation of an integrated design problem. A two-degree-of-freedom controller described in the discrete-time domain is considered as an electrical subsystem in this paper. An accurate identification process of the mechanical subsystem is conducted to verify the obtained mathematical model. Mechanical and electrical constraints render the integrated design problem accurate. Analysis of the system performance according to design and operating parameters is conducted for better understanding of the dynamic behavior and interactions of the servomechanism. Experiments are performed to verify the validity of the integrated design problem in the X-Y positioning system.

\[ K_I \]: 운동방향(축방향) 등가강성, \( N/m \)
\[ K_p \]: 위치제어기 비례이득, \( V/V \)
\[ K_r \]: 토크상수, \( N \cdot m/A \)
\[ K_{ip} \]: 속도제어기 비례이득, \( V/V \)
\[ K_{id} \]: 속도제어기 적분이득, \( V/V \)
\[ K_\theta \]: 회전방향 등가강성, \( N \cdot m/\text{rad} \)
\[ M_t \]: 테이블 및 가공물의 질량, kg
\[ R \]: 적선oidal 변환 상수
\[ R_c \]: 원호보간 운동의 지령반지름, m
\[ R_s \]: 원호보간 운동의 실제반지름, m
\[ T_s \]: 틱택타기 주기, sec
\[ x_o \]: 지령위치, m
\[ x_i \]: 난트 적선운동거리, m
\[ x_r \]: 테이블 적선운동거리, m

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