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Proportional and Integral Controller-Based Direct Current Servo Motor Speed Characterization

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Abstract : Direct Current (DC) servo motors, or simply DC motors, play an important role in many industrial applications such as manufacturing of plastics, precise positioning of the equipment, and operating computer-controlled systems where speed of feed control, maintaining the position, and ensuring to have a constantly desired output is very critical. These parameters can be controlled with the help of control systems such as the Proportional Integral Derivative (PID) controller. The aim of the current work is to investigate the effects of Proportional (P) and Integral (I) controllers on the steady state and transient response of the DC motor. The controller gains are varied to observe their effects on the error, damping, and stability of the steady and transient motor response. The current investigation is conducted experimentally on a servo trainer CE 110 using analog PI controller CE 120 and theoretically using Simulink in MATLAB. Both experimental and theoretical work involves varying integral controller gain to obtain the response to a steady-state input, varying, individually, the proportional and integral controller gains to obtain the response to a step input function at a certain frequency, and theoretically obtaining the proportional and integral controller gains for desired values of damping ratio and response frequency. Results reveal that a proportional controller helps reduce the steady-state and transient error between the input signal and output response and makes the system more stable. In addition, it also speeds up the response of the system. On the other hand, the integral controller eliminates the error but tends to make the system unstable with induced oscillations and slow response to eliminate the error. From the current work, it is desired to achieve a stable response of the servo motor in terms of its angular velocity subjected to steady-state and transient input signals by utilizing the strengths of both P and I controllers.

Keywords : DC servo motor, proportional controller, integral controller, controller gain optimization, Simulink
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