

Automatic Control Systems

fifth edition

Benjamin C. Kuo

Professor of Electrical and Computer
Engineering
University of Illinois at Urbana-Champaign

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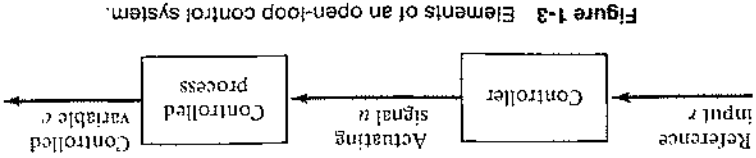


Figure 1-3 Elements of an open-loop control system.

The elements of an open-loop control system can usually be divided into two parts: the controller and the controlled process, as shown by the block diagram in Fig. 1-3. An input signal or command r is applied to the controller, whose output acts as the actuating signal u ; the actuating signal then controls the controlled process so that the controlled variable c will perform according to some prescribed standards. In simple cases, the controller can be an amplifier, mechanical linkages, or other control means, depending on the nature of the system. In more sophisticated electronics control, the controller can be an electronic computer, such as a micro-processor.

Closed-Loop Control Systems (Feedback Control Systems)

What is missing in the open-loop control system for more accurate and more adaptive control is a link or feedback from the output to the input of the system. To obtain more accurate control, the controlled signal $c(t)$ should be fed back and compared with the reference input, and an actuating signal proportional to the difference of the input and the output must be sent through the system to correct the error. A system with one or more feedback paths such as that just described is called a *closed-loop system*. The block diagram of a closed-loop idle-speed control system is shown in Fig. 1-4. The reference input ω_r sets the desired idling speed. Ordinarily, when the load torque is zero, the engine speed at idle should agree with the reference value ω_r , and any difference between the actual speed and the desired speed caused by any disturbance such as the load torque T_L is sensed by the speed transducer and the

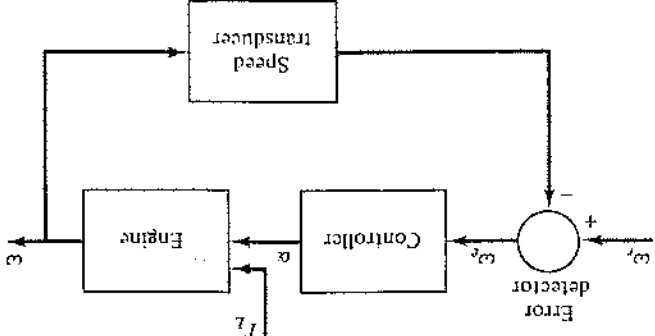


Figure 1-4 Closed-loop idle-speed control system.

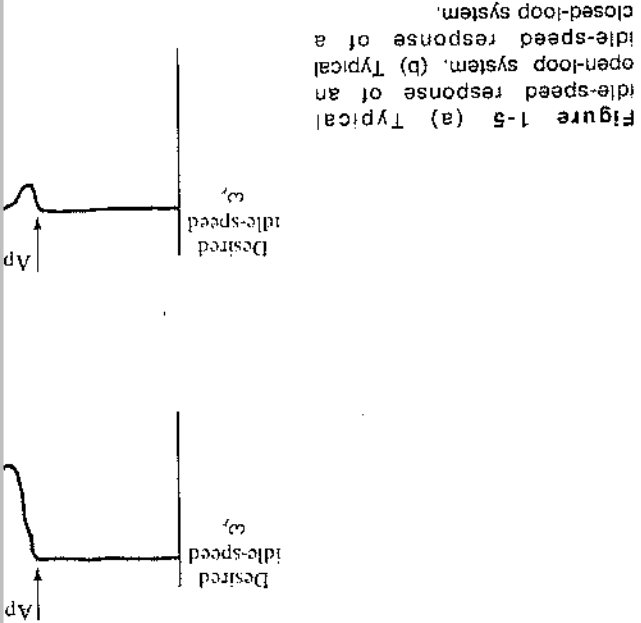


Figure 1-5 (a) Typical open-loop response of an idle-speed system. (b) Typical closed-loop response of a closed-loop system.

error detector, and the controller will operate on the difference to adjust the throttle angle α to correct the error. Figure 1-5 illustrates a comparison of the typical open-loop and closed-loop idle-speed systems. In Fig. 1-5(b) the ideal speed of the closed-loop system will drop and settle at a lower value compared with the reference input, and an actuating signal proportional to the difference of the input and the output must be sent through the system to correct the error. A system with one or more feedback paths such as that just described is called a *closed-loop system*. The idle-speed control system illustrated above is a system whose objective is to maintain the system output at a desired value. As another illustrative example of a closed-loop control system of the block diagram of the printwheel control system of a typewriter. The printwheel, which typically has 96 or 100 positions, selection is done in the usual manner from a keyboard when a keyboard is depressed, a command for the printwheel position to the next position is initiated. The microprocessor controller receives the command and outputs a control signal θ_r to a power amplifier, which drives the printwheel.

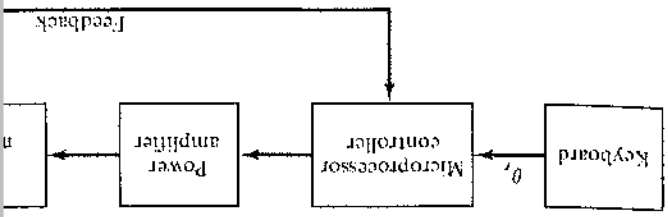


Figure 1-6 Printwheel control system.