Dual Loop Position and Force Feedback Control

In force and tension control applications, there is a force (or torque or tension or pressure) sensor feedback in a servo motor control system, in addition to the position feedback. If the force sensor is ON/OFF type, it serves as simply a trigger switch input for the control logic, i.e. to change the commanded position or speed of the servo motor. If the force sensor is a proportional sensor, then it can be used to regulate the force control (Fig. A-16).

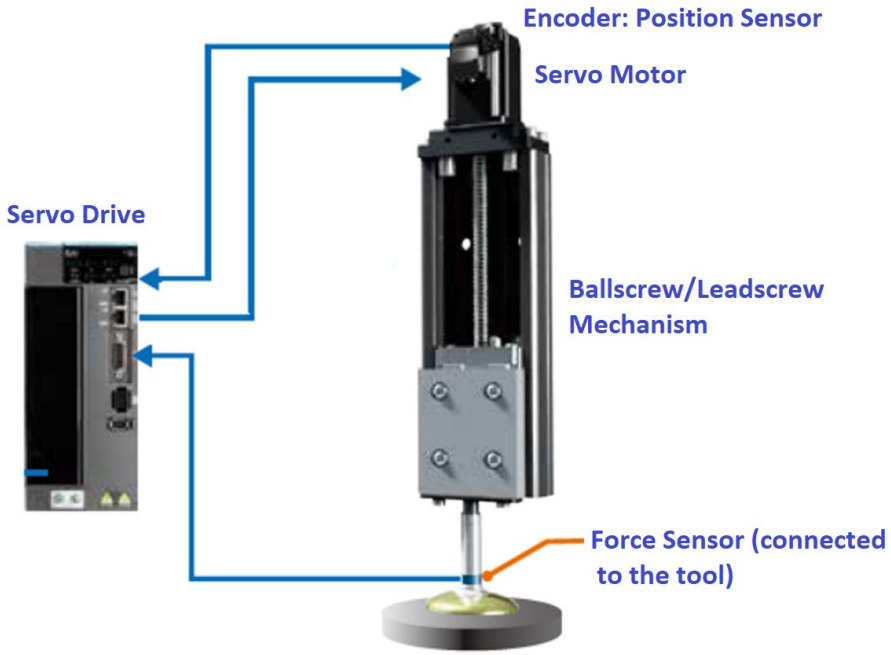


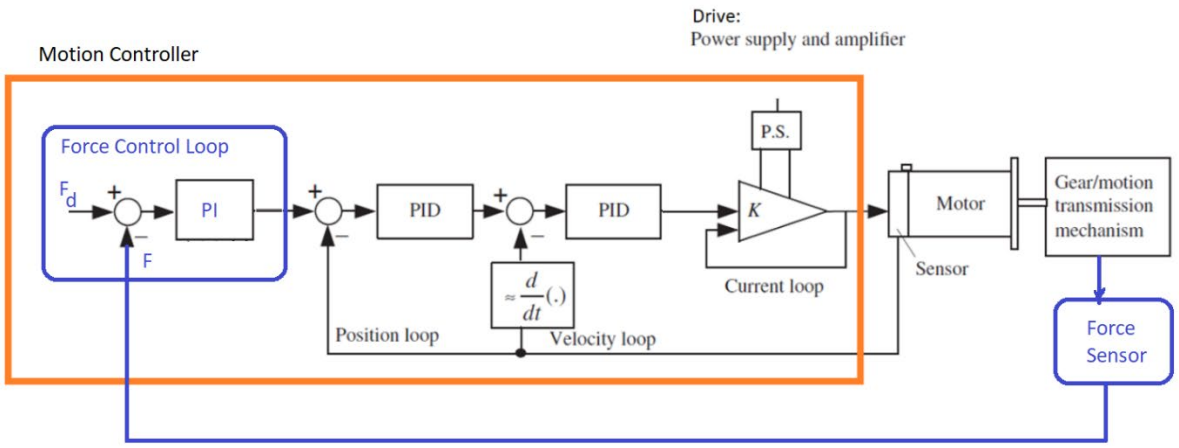
Fig. C-1: Single axis servo motion control system with both position and force feedback sensors.

A servo motor control system using both position and force feedback can be operated in two different closed loop control modes:

Mode 1: closed loop position control using encoder

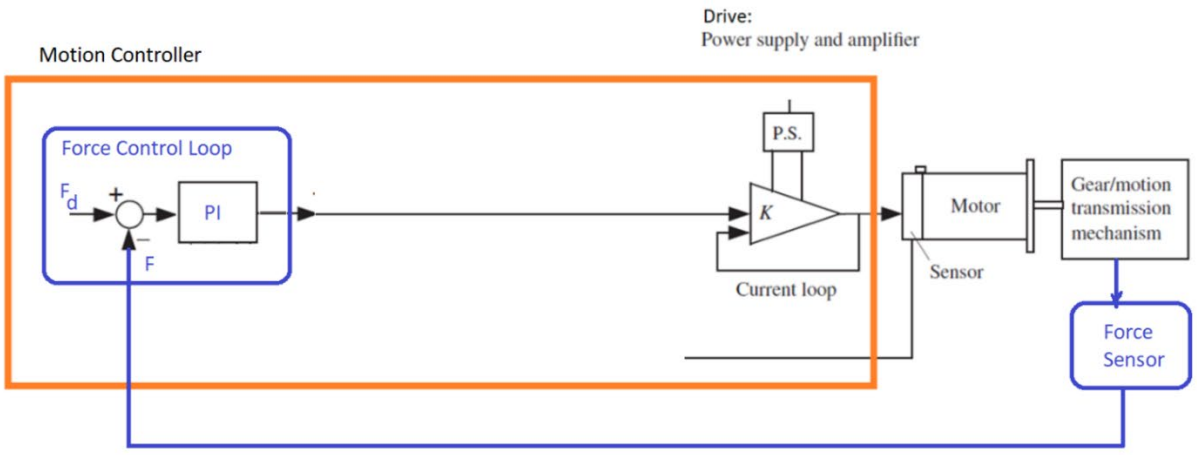
Mode 2: closed loop force control using force sensor.

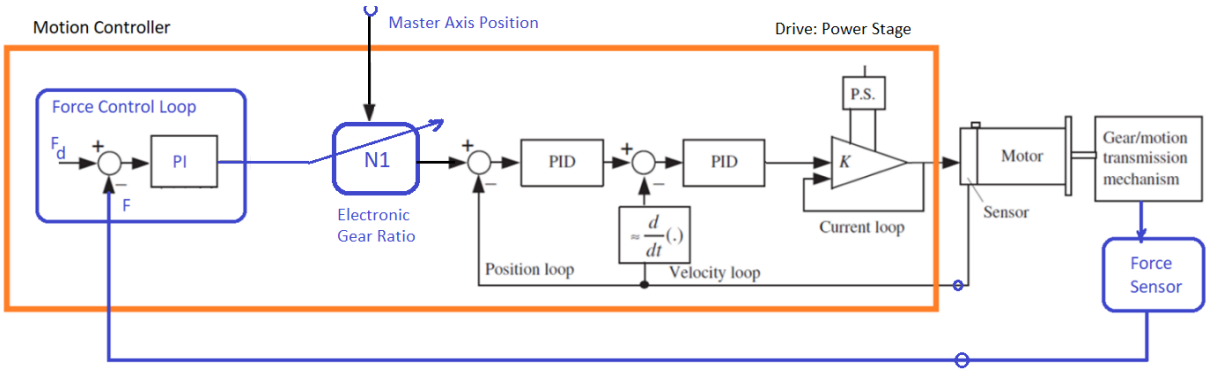
In practically all applications, the closed loop force control algorithm is implemented as an outer loop whose output signal becomes the command signal to the position or speed closed loop (Fig. A-17).



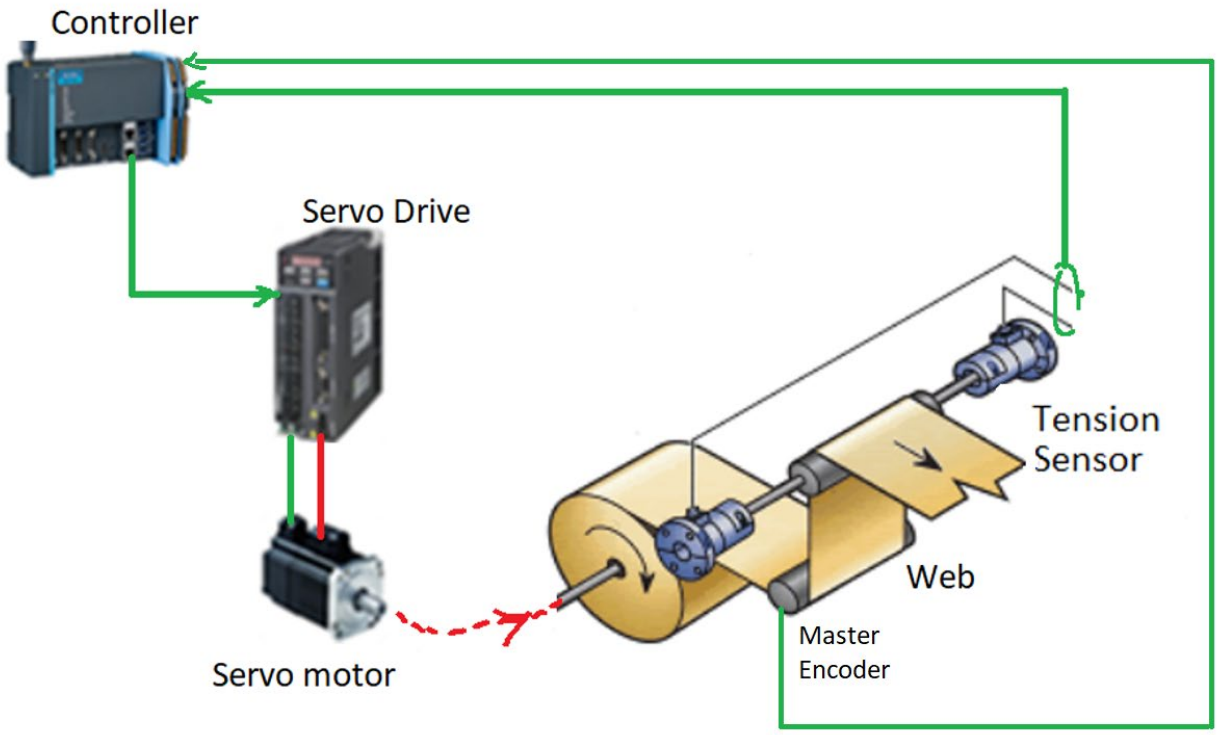
In some applications, the force sensor is used to detect a certain level of resistance just to switch from a high speed motion to a low speed motion. For example, this is the case injection molding machine motion control applications.

Technically, it is possible to use only the force feedback loop and then send that output to the current loop (Fig. A-18). However, this mode generally results in very high gains and quickly develops stability problems. Hence, the mode shown below is rarely used; drive is in current mode, and motion controller only uses a closed loop PI or PID algorithm on force feedback, not position or velocity feedback; closed loop on position/velocity is not used.

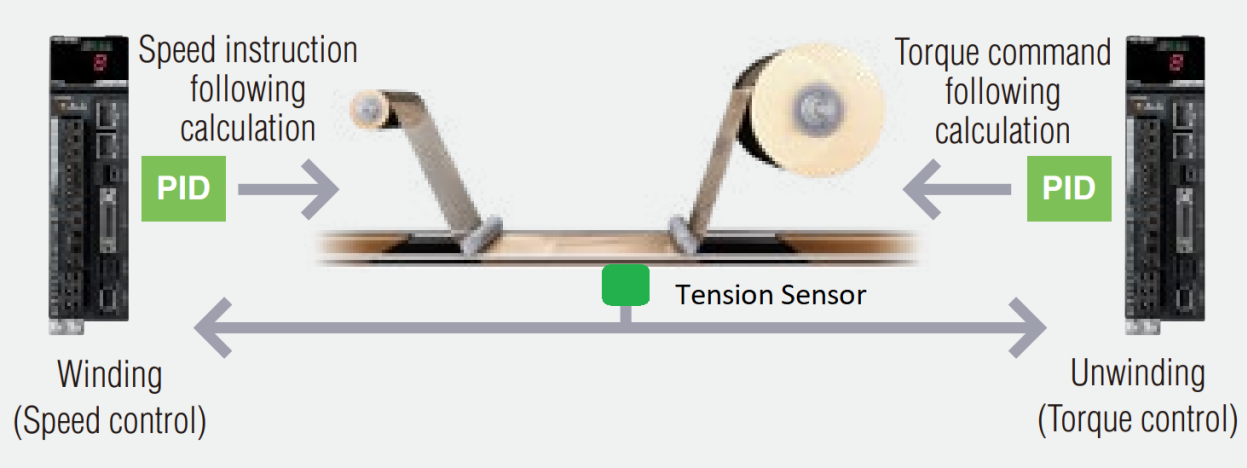




The identical concept is used in tension control in web handling applications. In web tension control applications, the force sensor is replaced by "tension sensor" and the output of the "tension control loop" is a modification to the position loop, i.e. increase decrease in commanded position and/or speed either directly or in the form of modified electronic gear ratio.



For example, in the above hardware configuration, the web may be pulled by a motor-drive down-stream in the machine to set the line speed. The web line speed is measuredby the Master Encoder. The servo motor-drive mechanism that controls the unwind roll is electronically geared to match the line speed while maintaining a desired tension. Hence, the tension control loop is the external loop to the electronic gearing and position control servo loop of the servo motor. The commanded position to the servo loop is generated by electronic gearing algorithm that matches the line speed. The tension control algorithm output is either modification (increase/decrease) the gear ratio or add/substract increamental moves.



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