Comparision of Disturbance Suppression for Servo Drives, Topic Area Code 4e

SUMMERY

1. Introduction

The main item in servo control applications is position control, which is decisive for the accuracy to be obtained. The classical cascade control of position, velocity and current (Fig. 1) is state of the art. To maintain stiff position control in order to suppress load disturbances implies the need for large gains for the velocity controller which trend to reduce system stability.

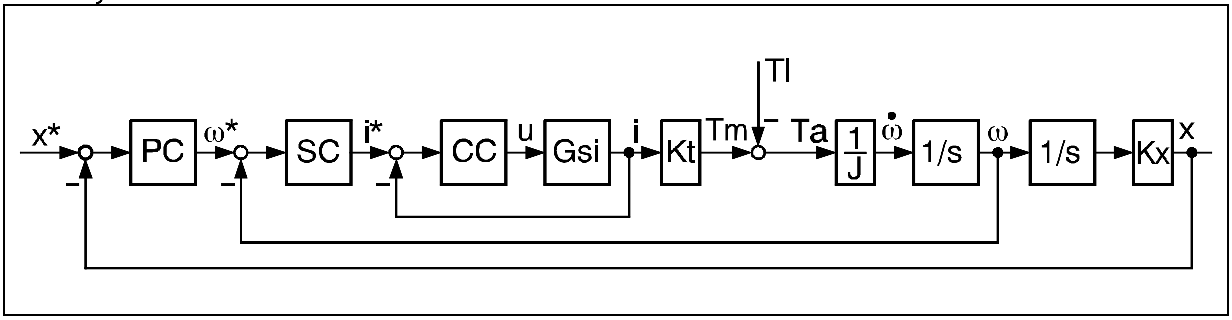


Fig. 1: cascade control structure PC: position contr.; SC: velocity contr.; CC: current contr.

Regarding Fig. 1 it is after deviations have taken place obvious, that disturbance torques can be detected by velocity and position controller only, as the current controller merely influences the motors own torque. Due to disturbing torques velocity and position will deviate from their reference values, and a restoring torque will be demanded. This torque is provided for by the current controller. With this control structure position displacements can become pretty large.

2. Alternative control structures

To overcome these disadvantages various authors proposed a faster compensation of disturbing torques by use of the total acceleration /2,3,4/. Knowing the acceleration, the disturbance torque an additional current reference component is applied. This configuration provides for better disturbance suppression than the classical cascade control structure does, because there is less delay in the closed control loop.

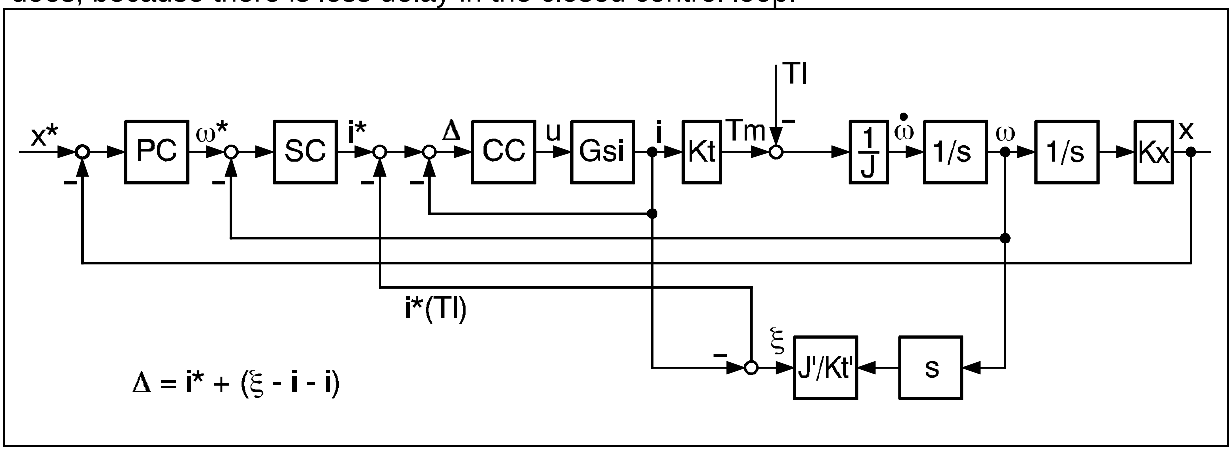


Fig. 2: Estimation of load torque; $T_m$: motor torque; $T_L$: disturbance torque; $i(T_L)$: additional current reference

Today most control algorithms are realized as microprocessor programs. Due to the necessary computing time the control algorithms are evaluated at discrete time intervals only. Usually sampling frequency decreases from inner to outer control loops. On the contrary, state variable feedbacks according to Fig. 3 are ecaluated in parallel with the same sampling frequency.

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States variables are position and velocity. With impressed load torque current and acceleration characterise physically the same state. So one can decide which of them to use as third state feedback. A servere disadvantage of these structure is the fact, that there is neither active current limitaion nor current control to prevent the drive from current peaks.

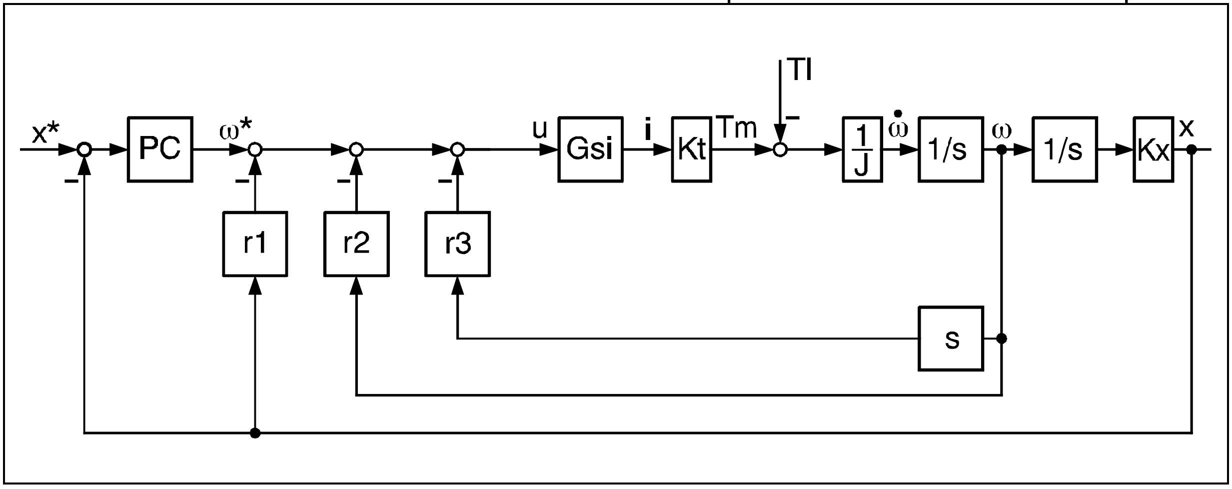


Fig. 3: State varibale feedback without current limitation

In order to provide a current limitaion a state variable structure is simulated, where current limitaion is achieved by pole assignement /1/.
A similar idea was developed in /2/. The configuration is enlarged by acceleration, velocity and position error state feedback (Fig. 4).

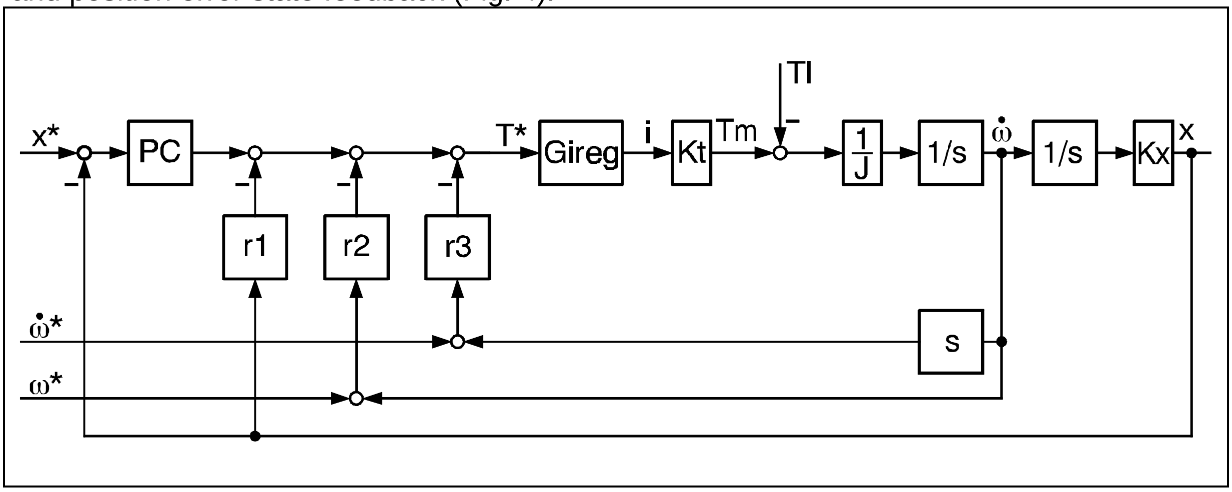


Fig. 4: State variable feedback with current control as well as acceleration, valocity and position error state feedback /2/

## 3. Results

The above described structures were examined with regard to their reaction on rectangular disturbance torques. All control algorithms were simulated as time discrete algorighms with constant sampling time. The reference value for position was set to zero. Fig. 5 and 6 demonstrate the performance of different control structures; simulation values of position and demonstrate the performance of different control structures; simulation values of position and velocity are plotted versus time. Obviously the cascade control scheme shows the largest position displacement, as the disturbance torque can be detected via velocity and position loops only.
An enormous reductrion of position error is achieved by using a disturbance torque estimation. State feedback shows the best perfomance. An oscillation free disturbance step response of position can be achieved. Compared to the cascade control structure position error has become very small.

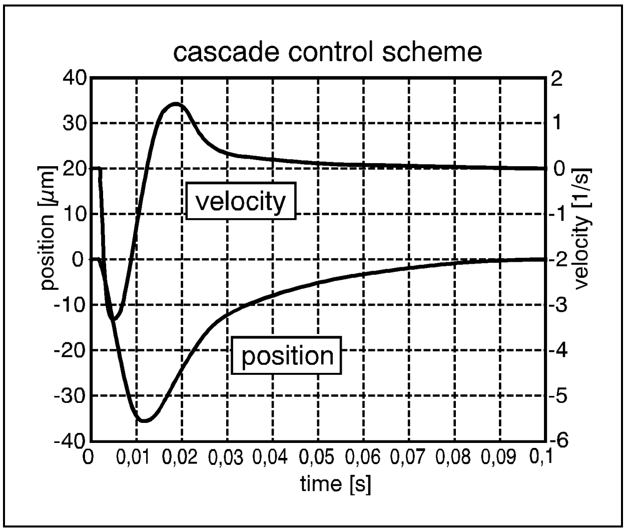


Fig. 5: cascade control; disturbance step response

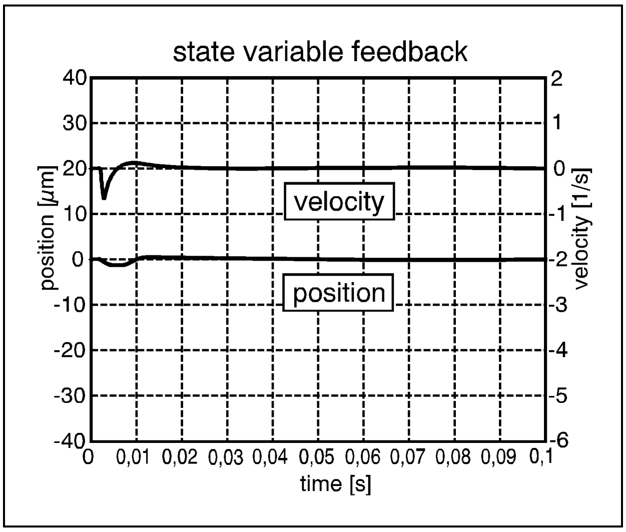


Fig. 6: state control; disturbance step response

## 4. References


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# Comparision of Disturbance Suppression Strategies for Servo Drives

Topic Area Code: 4e; Simulation of positioning drives


## ABSTRACT

The objective of this work is the comparision of different control structures for servo drives regarding their load disturbance suppression.
Starting with the classical cascade control for position, velocity and current alternative concepts are reviewed. Despite of a low moment of inertia of the servo drive some of these control structures provide a high dynamic stiffness against disturbance torque.

The total acceleration is directly influenced by the disturbing torque. So the sensing and the feedback of the acceleration is important for disturbance supression. Sensing of acceleration can be done by differentiation of velocity of the use of observers.
All presented control strucures are simulated using different kinds of acceleration sensing. The simulation results are analysed, and comparision of the control strategies is done with respect to a performance index for the position errors occuring after applying a rectangular disturbance torque.
Finally simulation results are compared to experimental data.