

AN OPTIMIZATION-BASED APPROACH TO DETERMINING DC MOTOR AND DRIVE PARAMETERS FROM MEASURED QUANTITIES

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Abstract

It often happens that information about the parameters of a DC motor and even more frequently the load parameters is unknown or only approximately known. These parameters can be determined by measuring the current and rotational speed. A DC motor drive can be described by a system of two coupled differential equations. Parameter identification is performed using an optimization method by solving an inverse problem. A direct approach to solving the inverse problem is applied.

The optimization method leads to parameter values for which the simulated responses, obtained from the system of differential equations, best match the measured current and speed responses. Differential evolution was used for parameter estimation. The parameters to be identified are the armature resistance, armature inductance, motor constant, drive inertia, and three coefficients defining the load characteristic. These are the constant load torque, the load torque coefficient proportional to speed, and the load torque coefficient proportional to the square of the speed.

The method can also be used solely for determining motor parameters if measurements are performed on the motor alone. In this case, the motor inertia and three parameters defining the torques due to friction and ventilation are identified. If the motor is coupled to a load during measurement, the drive inertia and the parameters defining the torques due to friction and ventilation of the motor together with the load torque are identified.

In the literature, authors typically use current and speed measurements during a step change of the supply voltage, which is feasible only for low-power motors. In the proposed approach, voltage measurement is additionally included, allowing parameter identification for motors or drives supplied by a power converter. The desired parameters are obtained through simulation based on solving a system of two differential equations. The fourth-order Runge–Kutta method was used.

The objective function is defined as the square of the difference between the simulated and measured current, normalized by the maximum measured current, plus the square of the difference between the simulated and measured angular velocity of the drive, normalized by the maximum measured angular velocity.

Normalization ensures that the influence of the current response is equal to the influence of the angular velocity response on the value of the objective function.

Measurements were performed on a laboratory drive equipped with a Siemens DC-Master power supply feeding a Siemens DC motor. Another Siemens motor was used as a load. It is important that excitation is established before switching on the motor, so that it is not necessary to simulate the transient phenomenon during field excitation and the system of three differential equations can thus be reduced to a system of two differential equations. For DC-supplied motors, it is common practice to energize the armature after the excitation field has been established.

The measurements were carried out on a DC motor drive with known parameters for the purpose of verifying the procedure. The results show good agreement between the calculated and the actual parameters of the motor and the load.