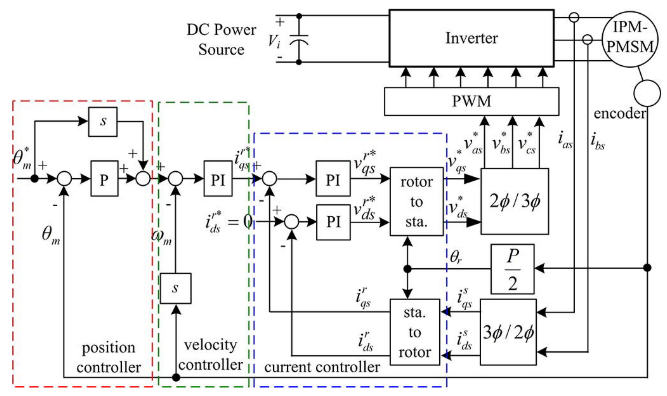
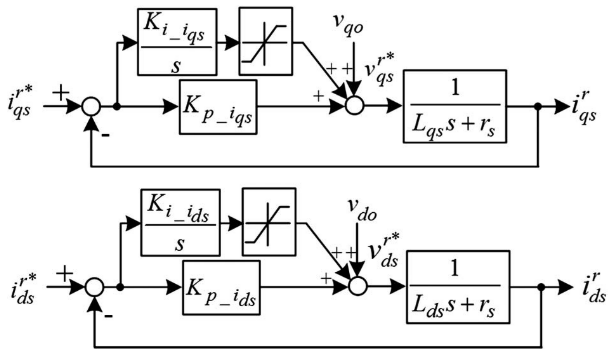
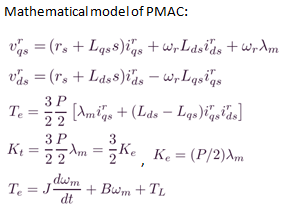
**AUTO-TUNING ALGORITHMS – FOR SUMMER WORKS IN ARCELIK**

This report contains practical and easy to use auto tuning algorithms for servo drive systems.

**1. OFF-LINE METHOD by Yang S.M., Lin K.W., Automatic Control Loop Tuning for PMAC Servo Motor Drives**

Used motor control – drive system:

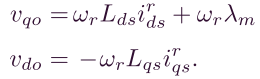
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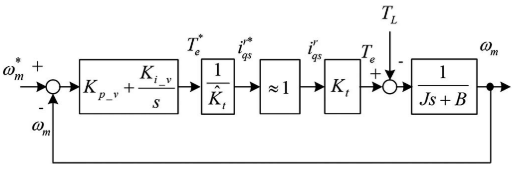
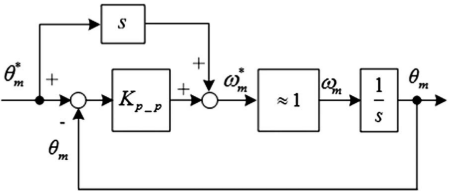
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Where,

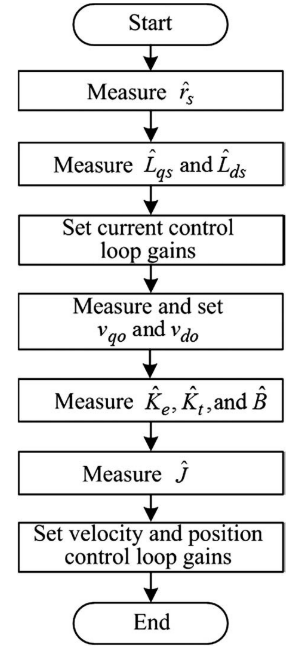
|  |  |  |
| --- | --- | --- |
| **Variables:** | **Electrical Parameters:** | **Mechanical Parameters:** |
| : rotor pole number | : Series resistance | : Electromechanical torque |
| : rotor electrical speed | : d-axis inductance | : Disturbance load torque |
| : rotor mechanical speed | : q-axis inductance | : Torque constant |
| : Laplace operator | : Back EMF constant | : Rotor and load inertia |
| : Back EMF+Cross coupling | : Rotor PM flux linkage | : Viscous friction coeff. |

The *cross-coupling voltages* ( )and the back EMF voltages are decoupled using the estimated electrical parameters and rotor speed.



Simplified velocity control loop: Simplified position control loop:** **

**Algorithm:**

****

|  |  |
| --- | --- |
| **1.**  Electrical Parameter Estimation | **A) Series resistance**  To avoid error caused by rotor movements, resistance is measured by applying a *d-axis voltage pulses* as shown:  🡪  **B) Inductances ()**  The inductances are measured by applying voltage pulses to the q-and d-axes, and the peak currents are then measured for calculating the inductances.  🡪h<100us, d axis excitation time x2  Measure the peaks  Excite  of q axis excitation. Because of  Preventing the rotor movement.  Resistance drop neglected.  The d-q axes voltages are simplified as:  Inductances are approximately:  🡪 |
| **2.**  Current controller gains set after electrical parameter estimation | **A) Current PI Controller gains set**  The gains of the current controllers are designed for the ratio between the proportional and integral gains to cancel out the pole.  🡪 After this cancellation, q-axis closed loop transfer function :  🡪 : cutoff freq., it can be  set 10 of velocity loop.  The gains can be set as:  🡪 The d-axis gains can be similarly determined.  **B) Velocity PI Controller gains set**  🡪 After this assumption, velocity closed loop transfer function :  🡪 : cutoff freq., it can be  Higher than position loop.  The gains can be set as:  🡪 must known for initial set  **C) Position P Controller gain set**  🡪Similarly, assuming that the bandwidth of the velocity control loop is  much higher than that of the position control loop.  **Remark:** |
| **3.**  Feedforward voltages and torque constant, mechanical parameters | Although the resistance and inductance measurements are static, the rotor must move to measure the feedforward voltages, torque constant, and mechanical parameters. So we apply current when is set to zero.    Note that is approximately half of the rated speed because the integrator voltages are limited to half of the rated phase voltage.  @t=t1, Back EMF - torque constant, and PM flux are estimated as:      @t=t2, calculate:    @t=t3, when the motor speed reaches a preset speed , the current command is set to zero for a short period of time to end the acceleration, the speed control loop is closed, and the command is set to . Estimate , assume =0, =slope to :  🡪 is not accurate,  temporary value up to t4-t5  During [t3,t4],average is calculated and denoted as  @t=t4, the motor reached a steady-state speed. can be calculated as:    After the estimation of , all of the controllers were switched off, and the motor decelerated down to zero speed.  @t= t4~t5, the motor speed in this region can be expressed as:    The inertia calculated using curve fitting is more accurate than because it is less sensitive to measurement noise. After that, the velocity and position control gains were calculated using step 2. |