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CASCADE APPROACH TO ESTIMATE DYNAMIC PARAMETERS

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Abstract. One of the main steps to control robots is to study the dynamical system of that robot and to analysis it. Moreover, it is essential to relate each change in the mathematical model with a physical change in the robot while it functions. In this research we study and analyze the dynamic model of manipulator UR10.

Introduction. More and more robotic applications involve contact with at least partially unknown environments. As a consequence, they require control approaches that go beyond the traditional position control. In particular, information about contact forces and torques has to be taken into account. However, integrating additional sensing equipment to obtain the required force/torque information is often technically challenging and expensive. Cartesian contact force and torque estimation allows obtaining force/torque information solely from available sensors. So, it is very important to develop a new key technology enabling force controlled robotic applications such as assembly, grinding, and deburring without the need for expensive additional sensing

Main part. The main goal of analyzing the dynamic model is to realize a new compliant control approach. The main contribution will be in the improved accuracy of dynamic parameters' estimation. Why is that needed?
The importance of accurate estimation of dynamic parameters could be shown by a brief description of a compliant control flowchart.
The flow chart consists of two parts: one is the inner loop of pure position control and the other is the outer loop of impedance/compliant control. The displacement, velocity and acceleration information of the motor that are read from manipulator driver cannot be directly used, and thus a state observer is constructed for this purpose. The state observer can calculate the displacement, velocity, and acceleration of each joint and perform Kalman filtering on the acquired joints' torque value. The input to the coordinate transformation is the Cartesian position, velocity and acceleration of the robot end-effector and its output is the angular position, velocity and acceleration of each robot joint. Based on the constructed external torque observer, the external force/torque of the Cartesian space during the assembly process can be obtained. Therefore, the dynamic parameters need to be estimated. To this end, it is essential to convert the canonical equation of dynamic system to regressor model, where the matrix of unknown variables represents a combination of links masses, lengths, center of masses locations and tensor inertia. The more accurate the estimation of the dynamic parameters, the more accurate the estimation of external forces is. The external force/torque is used as the input of the impedance control, and the compensation displacement, velocity and acceleration of each joint are written according to the impedance model in order to realize the compliance control of the robot.

Conclusion. Simulation results and figures show the effects of matrices M, C and G on robot movement. For example, the bigger the matrix M gets the slower the speed of the manipulator gets. The whole analysis of dynamic model servers as a good basis toward understanding the procedure of compliant control.

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