Modeling, Identification and Simulation of Industrial Robots

A.Niglis[1,2], P.Öberg[1], S.Gunnarsson[1], A.C.Bittencourt[1], S.Moberg[2], S.Hanssen[2], H.Andersson[2], M.Norrlöf[1,2]

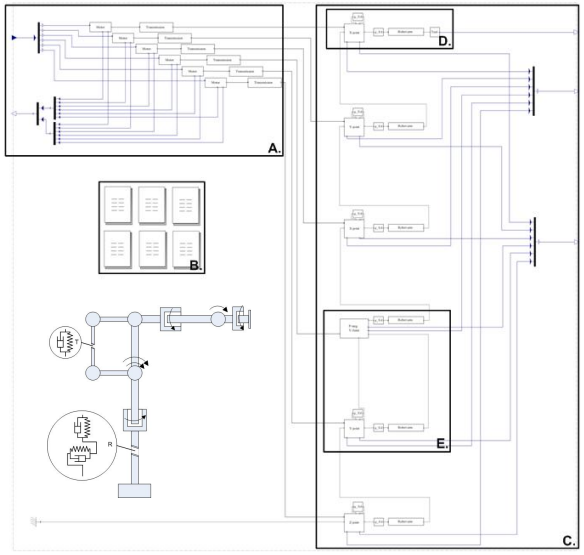
[1]Dept. of E.E., Linköping University, [2]ABB Robotics, Västerås

Objective

"Model high-fidelity robot dynamics including flexible joints, gears and friction models. The models should be easily exported and integrated with other software used for control, optimization, simulation, and system identification."

Modeling

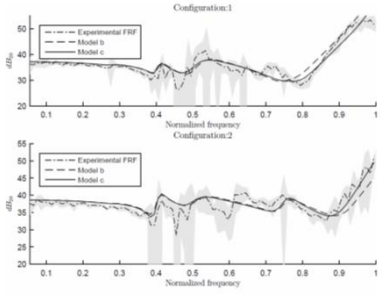
Example: parallel linkage (PL) robot. To get a high fidelity model elasticities are introduced both in regular structure and in the kinematic loop.



Manipulator model implemented in MapleSim.
Inputs: motor torque. Outputs: motor angles, motor speed, constraint forces, and TCP. (A) Models the 1D-components such as motors, transmissions, and friction. (B) Parameter blocks for each joint. (C) Includes all multibody dynamics. (D) An example of how a link is modelled with flexibilities. (E) Models the parallel linkage.

Identification

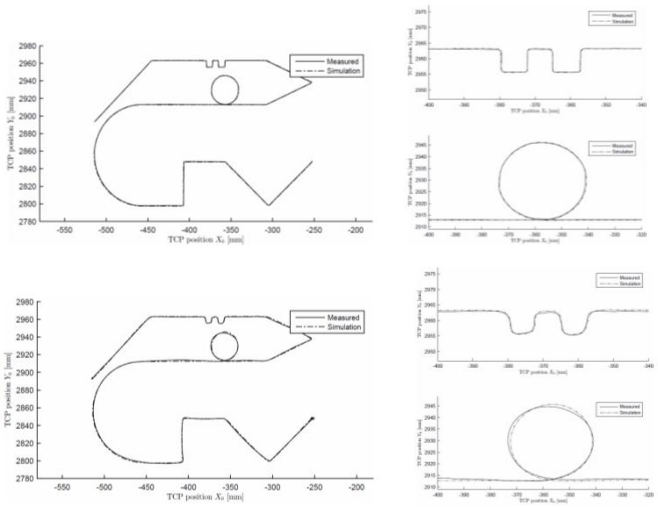
Two models globally identified.
Model b does not have enough elastic DOFs to model the FRF in all configurations.
Model c is the same as model b but with two more elastic DOFs and the result is that the compromise is much better.



Simulation

The MapleSim model is exported as an S-function and it is integrated with the control system in Simulink. Simulation time for repeated runs of the same simulation. The simulated real time is 15 s.

Run	Simulation time [s]	% of real time
1	44.2	295
2	45.1	301
3	46.4	309



(Above) Low velocity simulation of the test trajectory. Note that the circle is not perfectly circular, this is most probably due to friction and/or backlash.
(Below) High velocity simulation. More demanding for the model.

Summary

- A complete process for modeling, identification and code generation for simulation, using MapleSim was developed and tested
- Using MapleSIm many different model structures could be evaluated and compared in a short time
- The model parameters are identified using frequency domain methods (developed in previous contributions) and data from dedicated identification experiments
- A model is validated in a test cycle
- Simulation time is 300% of real time (for a >> 6 DOF robot model)