LINK-SIC — Industrial Robotics Projects

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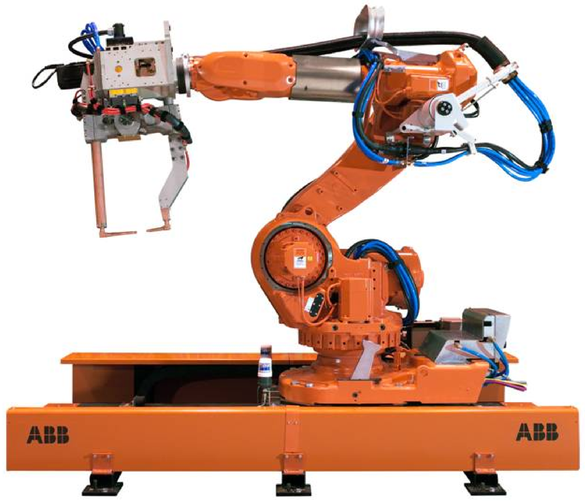
Background

Industrial robots are today used in an increasing number of applications, which introduce new requirements on motion performance as well as sensing and interacting with the environment.

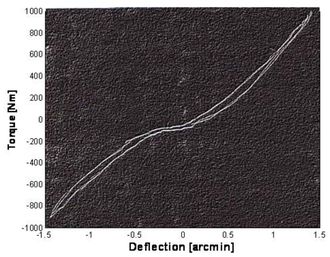


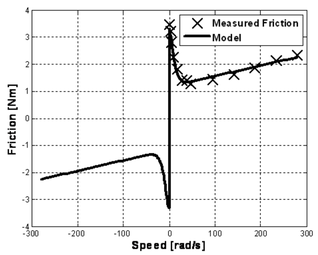
Due to a fierce competition between robot manufacturers, there is also a continuously ongoing **product cost reduction**:

- reduced weight of the manipulator arm
- more cost effective robot components (speed reducers, motors, sensors, bearing assemblies, transmissions etc.)

Cost reduction implies:

- more compliant robot structures with lower eigenfrequencies
- higher friction
- more nonlinear behavior
- larger backlash
- more complex vibration modes
- larger dynamic parameter variations between otherwise identical robots.





Challenges

One challenge is to keep or increase the robot performance, despite the previously mentioned problems.

- The model-based control must therefore be further refined, for example to adapt model parameters to robot individuals and to take care of more complex robot dynamics.
- Today the robot arm control is based only on motor angle measurements and the control must rely on accurate dynamic models to control the arms of the robot.
- In high performance applications it will also be necessary to increase accuracy and robustness by using additional sensors.

Low-cost robots is not enough, the manufacturer must also guarantee a low life cycle cost.

- Improved diagnosis is then very important in order to be able to plan maintenance without disturbing the production.
- Accurate robot models are also needed for reliable diagnosis and the problems with increasing model complexity and larger model variations must be handled in the diagnosis case as well.
- Additional sensors will open up for improved tracking accuracy but also for more precise diagnosis functions.

LINK-SIC Projects

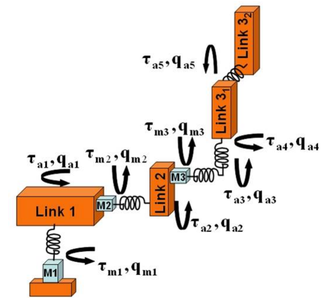
Within LINK-SIC, research concerning industrial robotics will be conducted in several joint projects between **Linköping University** and the two industrial partners **ABB Robotics** and **ABB Corporate Research**. The activities can be separated into the **four areas**:

- System Identification
- Control
- Sensor Fusion
- Diagnosis

The research results within all four areas can be applicable to other mechanical systems such as vehicle powertrains, camera gimbals, cranes, excavators, airplanes, etc.

System Identification

Cost reduction implies increasing model complexity and larger model variations. This inherently requires effective methods to identify the unknown model parameters. Effective methods are particularly important since the parameter variations might require tuning of each individual robot.



Activities:

- **Additional sensors** enable identifiability of more complex model structures, reduced measurement time, and increased model accuracy. This will be thoroughly investigated, as well as questions about optimal sensor location, experiment design, etc.
- **Accurate modeling and identification of nonlinearities** such as friction, nonlinear stiffness, torque ripple in motors and speed reducers. Many of these phenomena are also time varying (e.g. temperature dependent), which either require recursive identification or models that describe these variations.
- Earlier, identification of elastic parameters has mainly been carried out in the frequency domain (Wernholt, 2007). **Time domain identification** will be given much attention to enable identification of damping and nonlinearities. This will be challenging due to the system properties (nonlinear, multivariable, unstable, and resonant).

Estimated Frequency Response Function (black) and model (red)