Dynamic Identification of YuMi ABB Collaborative Robot

Meryem TAGHBALOUT, Jean-François ANTOINE and Gabriel ABBA

Université de Lorraine, Arts et Métiers ParisTech, LCFC, F-57000 Metz, France
École doctorale: IAEM.
Contact author : meryem.taghbalout@gmail.com

We would like to thank the Robotix Academy, contract number N°002-4-09-001 for funding this work as a part of the project funded by INTERREG V-A Grande Région program.

Context

The objective is to handle and assemble flexible parts using the ABB IRB 14000 "YUMI" two-armed collaborative robot. The flexible parts can be cables, wires or fibres.
Applications :

- Soldering flexible cables to a connector
- Stripping of wires or cables with one or more braided wires

Objectives

- Modeling and identification of the robot model and parameters.
- Development of control laws in position and force.
- Changing the control via the Ethernet connection.
- Development of trajectory planning algorithms.
- Collaboration between the two arms and improvement of the production quality and overall efficiency.

Analyses, Method

Dynamic identification model

The dynamic model of the robot is a non-linear model that can be linearized with respect to the identifiable parameters: $\Gamma_{\text{mdi}} = \text{IDM}(q, \dot{q}, \ddot{q}) . \chi$

- Where $q, \dot{q}, \ddot{q}, \Gamma_{\text{mdi}}$, are respectively the vectors of the positions, velocities, accelerations and joint torques, χ the vector of the identifiable dynamic parameters (inertial and friction) of robot.

Identification method

IDIM_LS identification method makes possible estimating the parameters using the inverse dynamic model and least square, knowing the torque and the articular positions (Fig 1).

- The identified parameters have unrealistic values, which do not correspond to the physical significance of the parameter[1].

Precision of estimated parameters

Using classical method with statistical properties, we calculate the precision of the identified parameters. The calculation method was detailed in the work done by [2].

The number of inertial parameters were reduced from 77 to 57 using SYMORO+ software.

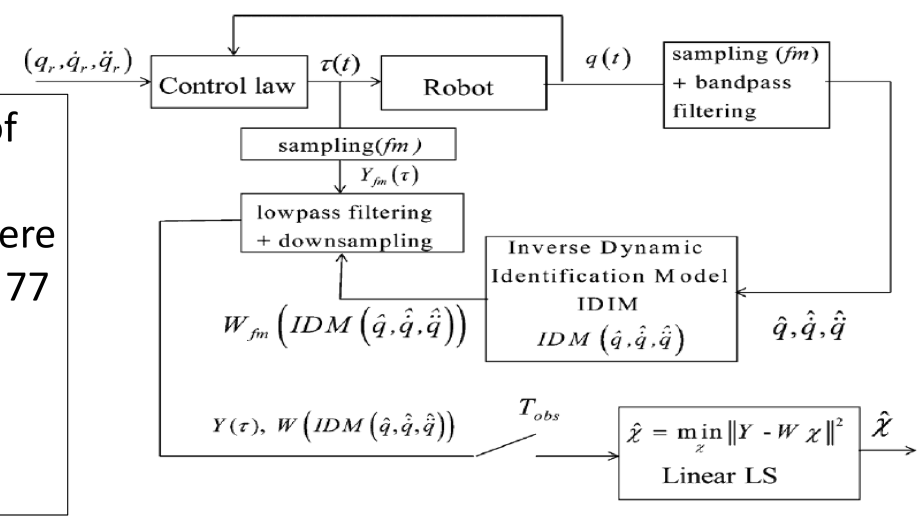

Fig. 1 Principle of IDIM_LS identification method .

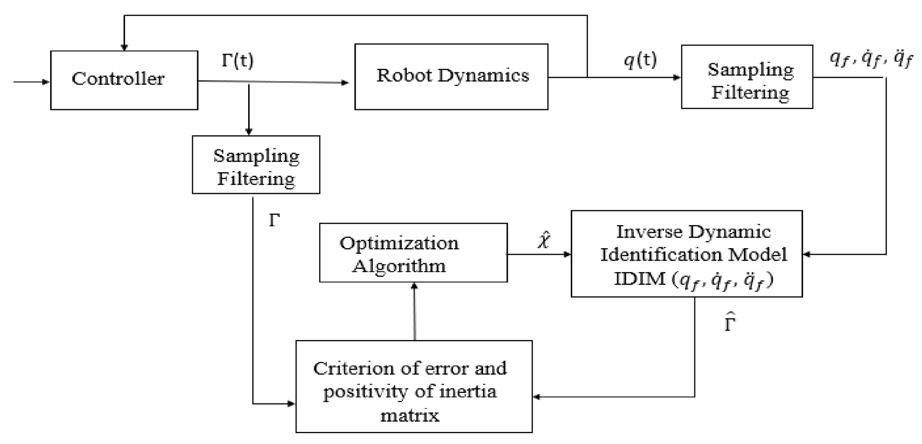

Fig. 2 Identification method with parameter optimization algorithm.

Results

Optimization

A numerical optimization based on an estimation of the parameters by minimizing different criteria was carried out (Fig 2).

Identifiable dynamic parameters

Friction and offset parameters were identified with good accuracy, ranging from 0.3 to 7%.

For Dynamic inertial parameters the accuracy is acceptable and varies between 0.68 and 18%.

The Normalized Root-Mean-Square Error values between the measured and estimated torques are between 1.37and 16.86%(Fig 3,4).

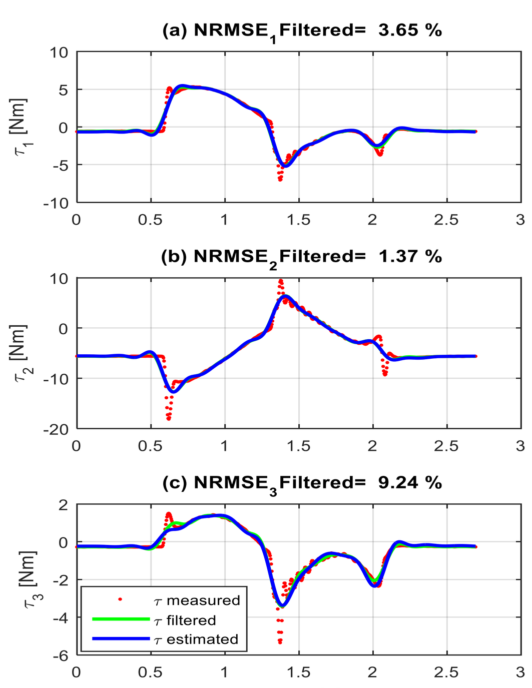

Fig. 3 Comparison of measured, filtered and estimated torques for joints 1 (a), 2 (b) and 3 (c)

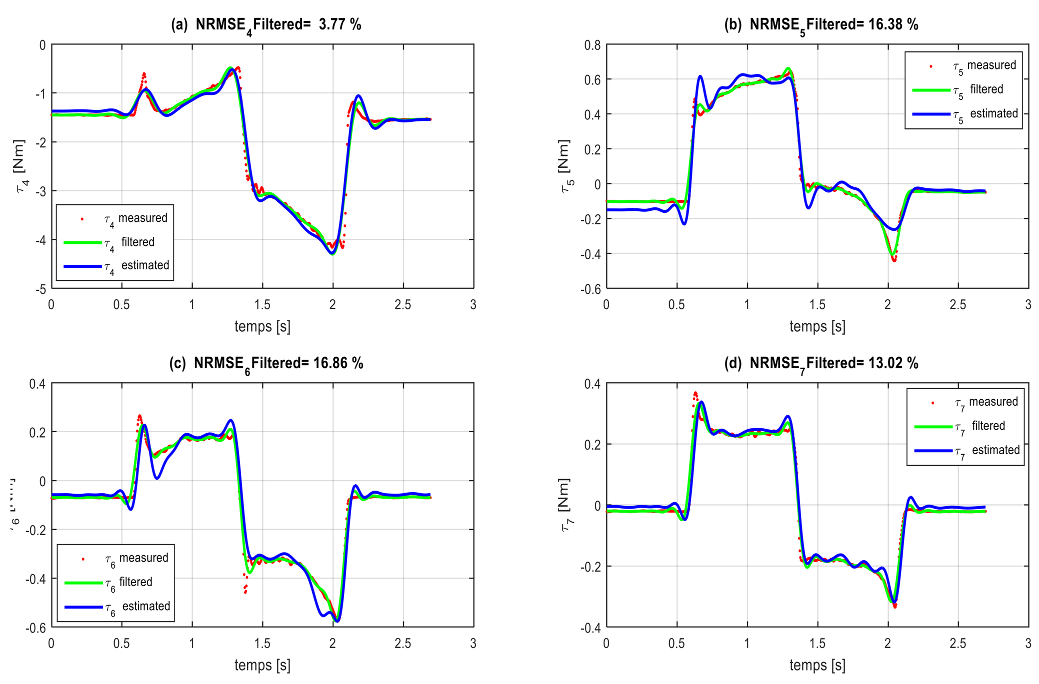

Fig. 4 Comparison of measured, filtered and estimated torques for joints 4 (a), 5 (b), 6 (c) and 7 (

Conclusion

To develop the control law, a robot simulator is needed. This poster presents some of the work done concerning:

- ✓ Identification of dynamic parameters
- ✓ identification the control law used by the manufacturer to control the robot motors
- ✓ Simulator validation
- ✓ Testing the connection and external control of the Yumi

Perspectives

- ✓ Development and implementation of robot control
- ✓ Conduct experimental tests for stripping and welding flexible cables.

References

[1] M. Taghbalout, J.F. Antoine and G. Abba, Experimental Dynamic Identification of a YuMi Collaborative Robot, Conference MIM 2019, August 28-30, 2019, Berlin Germany.

[2] I.C. Bogdan, and G. Abba, Identification of mechanical parameters at low velocities for a micropositioning stage using a velocity hysteresis model. IEEE Int conference on Robotics and Automation, 2012.