MethodsX 2 (2015) 219–231

Contents lists available at ScienceDirect

MethodsX

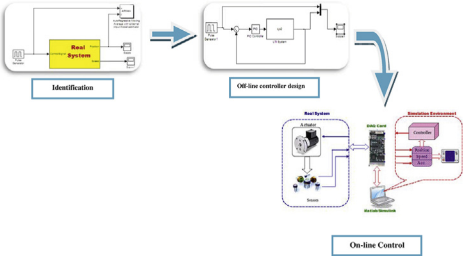
journal homepage: www.elsevier.com/locate/mex

A methodology for identification and control of electro-mechanical actuators

Tarek A. Tutunji [a], Ashraf Saleem [b,*]

[a] Department of Mechatronics Engineering, Philadelphia University, Jordan
[b] Department of Electrical and Computer Engineering, Sultan Qaboos University, Oman

GRAPHICAL ABSTRACT



ABSTRACT

Mechatronic systems are fully-integrated engineering systems that are composed of mechanical, electronic, and computer control sub-systems. These integrated systems use electro-mechanical actuators to cause the required motion. Therefore, the design of appropriate controllers for these actuators are an essential step in mechatronic system design. In this paper, a three-stage methodology for real-time identification and control of electro-mechanical actuator plants is presented, tested, and validated. First, identification models are constructed from experimental data to approximate the plants' response. Second, the identified model is used in a simulation environment for the purpose of designing a suitable controller. Finally, the designed controller is applied and tested on the real plant through Hardware-in-the-Loop (HIL) environment. The described three-stage methodology provides the following practical contributions:

- Establishes an easy-to-follow methodology for controller design of electro-mechanical actuators.
- Combines off-line and on-line controller design for practical performance.
- Modifies the HIL concept by using physical plants with computer control (rather than virtual plants with physical controllers).

* Corresponding author. Tel.: +968 91198985.
E-mail address: asaleem@squ.edu.om (A. Saleem).

http://dx.doi.org/10.1016/j.mex.2015.04.001

Simulated and experimental results for two case studies, induction motor and vehicle drive system, are presented in order to validate the proposed methodology. These results showed that electromechanical actuators can be identified and controlled using an easy-to-duplicate and flexible procedure.

A R T I C L E I N F O
Keywords: System identification, Hardware-in-the-Loop, Electro-mechanical actuators, Mechatronics
Article history: Received 17 January 2015; Accepted 9 April 2015; Available online 25 April 2015

Method details

The aim of the proposed methodology is to choose and apply appropriate controllers to general electro-mechanical actuators. It is assumed that the plant model is not known in advance. The idea is to approximate the plant model by identifying the transfer function using real-time data. This implies the use of computer acquisition arrangement connected directly to the plant. Then, the plant is disconnected and controllers are applied to the identified model in a simulation environment. This provides the flexibility of trying different control methods to the model without causing damage or downtime for plant. Once the controller is designed and tuned in a pure simulation environment, the plant is then re-connected to the computer acquisition arrangement where the computer is used as the controller. These steps are shown in Fig. 1. The advantages of the proposed methodology are: optimizing time resources and minimizing the cost as a result of online identification and offline controller design. The three steps are described in next.

Stage one: identification

Identification is the process of building a dynamical mathematical model using measured data in a real-time environment [1]. The mathematical model built is the estimated transfer function of the identified system. In this stage, the actuator is connected to the computer through data acquisition

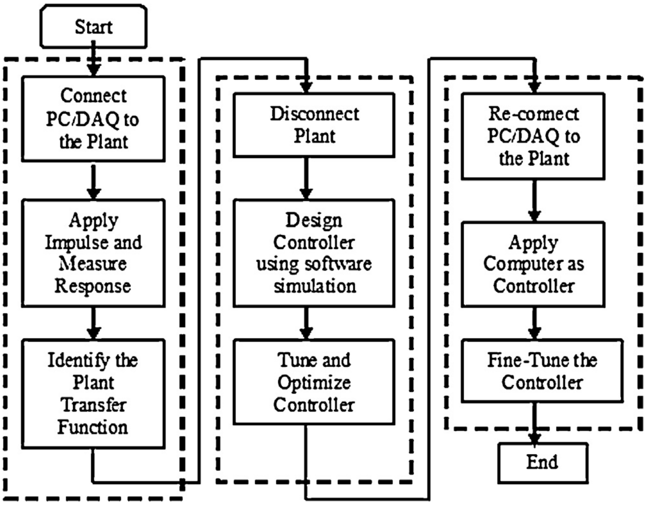


Fig. 1. The proposed three-stage methodology.