Modular Virtual Commissioning - A learning factory approach focussing on modularity and integration of component models.

Master Thesis

In partial fulfillment of the requirements for the degree

"Master of Science in Engineering"

Master program:
Mechatronics & Smart Technologies
Management Center Innsbruck

Supervisor:
Benjamin Massow, B.Sc. M.Sc.

Author:
Dominique Mathäus Geiger
2010620012

Declaration in Lieu of Oath

„I hereby declare, under oath, that this master thesis has been my independent work and has not been aided with any prohibited means. I declare, to the best of my knowledge and belief, that all passages taken from published and unpublished sources or docments have been reproduced whether as original, slightlychanged or in thought, have been mentioned as such at the corresponding placesof the thesis, by citation, where the extend of the original quotes is indicated.“

_____   _____
        Place, Date   Signature

Abstract

In this master thesis a concept for component libraries is created consisting of CAD data, simulation models, example control code and documentation.

Virtual commissioning is becoming increasingly important in the engineering process of plants and machines. This is the result of time savings and thus reduced costs in product development.

The behavior modeling of the different components can be done in several different tools, mostly depending on the manufacturer. The CAD data can also be available in different file formats and are thus no exception. This variety of possibilities increases the complexity of the integration process enormously. However, in order for virtual commissioning to be as efficient as possible, the integration of the used components should be as simple as possible.

In order to solve this problem, an exemplary library structure is developed in this thesis, which consists of the behavior model, CAD data and code snippets with related documentation. The basis for this are freely available and common interfaces, like Functional Mock-up Interface (FMI) for the behavior model and Collada for kinematic CAD data. This ensures that the widest possible range of applications is achieved. The practical use of this library is further demonstrated in a practical application.

In the example shown, the behavior model is executed in a separate task of the *Beckhoff* PLC, ensuring real-time capability. Visualization is done directly in the CAD software *Autodesk Inventor* based on the current state of the behavioral model. The behavior model is generated in *Matlab Simulink* and integrated using *FMI*.

As shown, using the developed library, the process of virtual commissioning can be simplified without the need for additional expertise.

Keywords: Virtual Commissioning, PLC, Automation, Modularity, Development.

Contents

1. Introduction

1.1. Motivation

1.2. Aim of this Thesis

1.3. Structure of this Thesis

2. State of the Art in Virtual Commissioning

2.1. Visualization in PLC Software

2.2. Digital Twin in Modeling Software

2.3. Visualization using Physics Engine

2.4. Data Formats

2.4.1. Kinematic CAD

2.4.2. Behavior Models

2.4.3. Example Code

2.4.4. Documentation

2.4.5. Exchange Libraries

2.5. Version Control

3. Proposed Data Structure for universal Data Exchange

3.1. Structure

3.2. Advantages and Disadvantages

4. Exemplary Application using the proposed Data Structure

4.1. Introduction

4.2. Module Separation

4.3. Module Filling

4.4. Visualization

5. Results and Evaluation

6. Summary and Outlook

6.1. Summary

6.2. Outlook

Bibliography

List of Figures

List of Tables

List of Code

A. Example Appendix