Hardware-in-the-Loop Testing Using an Extension of PLC Programming Languages

(Master Thesis)

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Topic

When commissioning industrial plants, it is important to avoid system failures. The effects caused by such failures may be expensive or safety-critical. To avoid failures, testing is an essential part of software development for industrial controllers. Besides testing on software level, the last step before commissioning a controller should be a Hardware-in-the-Loop (HiL) simulation. In a HiL simulation the system-under-test (SUT) is connected to a HiL simulator simulating the behavior of the plant and checking the correctness of the SUT according to a test case specification. For the simulation of the plant's behavior a model of the plant must be specified.

State of the Art

Existing solutions offer different concepts for HiL simulation, while no concept seems to be dominating. There are solutions where the simulation is based on 3D models of the controlled plants or on individual graphical and textual programming languages. These solutions have in common that the used languages are not native to the domain of industrial programming. Thus, their successful usage necessitates the user to learn both a new concept and a new specification language.

Objective

The objective of this thesis is the design of a concept for HiL test case specification. This concept has to fulfill several requirements: the programming languages which are used for the creation of the HiL simulation must origin in the domain of PLC programming languages standardized in IEC 61131-3. The languages will be extended in order to enable HiL simulation. The motivation for using PLC programming languages is that the tester is not required to learn a new language in order to write HiL test case specifications. Furthermore, the test-concept should provide a split into a test procedure, responsible for stimulating the SUT, and a corresponding acceptance criterion, responsible for checking the SUT in regard to the specified plant's model.

Approach

First it is important to analyze which concepts for HiL simulation and which type of languages are currently in use in industry. Then it is to be analyzed how these languages can be adapted for our purpose. The concept is evaluated by creating use cases for a small model plant. For these use cases, HiL tests will be implemented using the newly designed concept. The results will be compared to the process of implementing HiL tests with specification languages used by HiL simulation tools currently available.

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