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Összefoglaló

Ide jön a ½-1 oldalas magyar nyelvű összefoglaló, melynek szövege a Diplomaterv Portálra külön is feltöltésre kerül.

Abstract

Ide jön a ½-1 oldalas angol nyelvű összefoglaló, amelynek szövege a Diplomaterv Portálra külön is feltöltésre kerül.

# Introduction

The main goal of my Hardware-in-The-Loop system is to make the development of an electric drive control unit easier. The control unit provides the control signals to the gate driver unit and regulates certain motor parameters. Measured parameters, which make the regulation possible, are fed back to the control unit. If you want to test the regulation algorithm, you can use non-real-time tests on a PC platform.

If you want to test the control unit itself

It is possible to make one without using a HIL system, but it is much more difficult and expensive to test the control system. Therefore, it is used widely in the industry for advanced development.

# Presentation of the drive system

The motor in drive system in the HIL model is ~~based~~ on asynchronous machines. The model contains a grid model, a 3-phase rectifier model, a DC link model, a 3-phase two-level inverter model and an asynchronous machine model.

# The fundamentals of real-time modelling

## Mathematical tools

The model operates in discrete time. I use backward Euler-method for integrations.

For example, the Euler equation of the inductivity model, as it comes from the differential equation of the inductivity:

Examining a sample time interval:

Converting the equation using the backward Euler method:

Ami hiányzik

Fix pontos számábrázolás, mik vele a gondok ( túlcsordulás, pontosság, műveletek költsége ( összeadás, szorzás, osztás)...)

Euler nél mi a jelentősége a TS nek ( lehetne ábra Newton módszerről ( derivált \* t + előző minta, ezen ábrán meg lehet mutatni a ha nagya lépés köz

Említsük runga-kutta ( elsőredű, másodrendű, mi a kapcsolata eulerrel -> miért használjuk az euler ezek helyett )

## Technical environment

For the implementation, I use the Zedboard (type!!). The board has an ARM processor, which communicates with the PC. The model implements on the Zedboard FPGA. -

# Creation of the system elements real-time models

## Grid model

The Grid model has three phases. Each phase consist a voltage generator and a grid inductivity. The model calculates the grid phase voltages as its output.

## Rectifier

The rectifier model contains 6 diodes, 2 for each phase. Its input is the 3 phase voltages from the grid model and the rectified current from the DC link. I use logic operations to compute the output voltage. Its output is the rectified voltage.

## DC link

The DC link model contains a choke inductivity and a DC capacitor. The models use the formerly presented Euler method. The DC link’s input is the rectified voltage from the rectifier and the DC current from the inverter model. Its outputs are the DC voltage and the rectified current.

## Inverter

The inverter contains three brigde branches, each of them having a 2 transistor-diode pairs. Its input is the DC voltage from the DC link, the transistor gate signals from the control system, and the three phase currents from the motor model. It uses logic operations to determine its ouputs. Its outputs are the three phase inverted voltages, the DC current, and the short-circuit signal.

## Asynchronous machine

The asynchronous machine model uses a reduced parameter equivalent circuit. The reduction is necessary, because it doesn’t require to model the rotor leakage inuctance, which makes the modelling much easier. It operates in x-y coordinates, and performes d-q transfomations in the end. Its inputs are the three phase voltages and the load torque. Its outputs are the three phase currents, the rotor angular speed and rotor position, and every electrical parameter in either x-y or d-q coordinates, which can be used for testing.

# hajtásrendszer valós idejű modellje

# Design of the FPGA environment

The FPGA does not support floating-point variables, so I used fixed-point variables in my models. The FPGA has digital outputs, and I used sigma-delta conversions for the model outputs.

# 7. Verification

I used the Matlab Simpower System toolbox for the model verification. To verify the implemented model, I made an RC filter to have analog output signals, and measured them to see if the model fits the requirements.

Irodalomjegyzék

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Függelék