Developing servo drive and simulation software using Simulink code generation
Agenda

Introduction

Adoption of automatic code generation at ANCA Motion

Engineering education initiative:

- Servo drive and motor simulator with a web based interface
- Synchronous motor Hardware in the Loop (HIL)
ANCA Motion designs and manufacture flexible control systems, specialising in high precision solutions for CNC machines
Introduction – Typical CNC Machine
Servo drives enable position, velocity and torque control of permanent magnet synchronous motors.

Various current ratings

Usually multiple drives are used in an individual CNC machine.
Evolving requirements – Servo Drive

Faster and more accurate motor control

Increasing variety of applications each with different needs

How to keep up with increased demands and have robust code?

How to handle the increasing number of test scenarios?
Before code generation

- Model key phenomena
- Develop Controller
- Test
- Is the model accurate enough?
  - Y
  - N
- Manually translate to C
- Prototype
- Implementation issue?
  - Y
  - N
- Deploy

Translation step is an extra source of error
Using Code Generation

- Encourages development of more accurate models
- More testing in simulation
- Shorten test-develop-debug cycle
- Automates translation step

Diagram:

1. Develop plant model
2. Develop Controller
3. Automatic translation to C
4. Test
   - Pass
   - Fail
5. Prototype
   - Fail
6. Deploy
   - Y: Is the model accurate enough?
   - N: Pass
   - Fail
Software in the Loop (SIL)

Detailed plant model and code generation have allowed us to create an automated Software in the Loop (SIL) test system.

Integrated with our Continuous Integration (CI) server and run nightly.
ANCA Motion - Code generation advantages

Automates translation step, reducing development time and a potential source of errors.

Easier to achieve code consistency between developers.

SIL testing has reduced the need for physical hardware.

With SIL, errors can be detected earlier in the development cycle.
Student Project – Web based servo sim

Create a servo drive and synchronous motor simulator with a web interface
Web based servo sim – Simulink & ASP

Controller

Model

Plant Model DLL

Simulink Coder

ASP.NET MVC

View
Web based servo sim
Student Project – Motor HIL

Create a synchronous motor simulator that can replace physical motors when testing servo drive hardware.

The simulator will run on a Texas Instruments (TI) C2000 based microcontroller.
Motor HIL System overview

- PWM
- Position
- Current

C2000

- Switch Model
  - Voltage
  - Motor Model
- Encoder Model
  - Position
- Rotor Dynamics
- DAC
  - Current
- Winding Dynamics
Motor HIL System - Simulink

The custom motor simulator was written entirely in Simulink.

Embedded coder was used to generate C code from Simulink and call the TI toolchain to compile and deploy onto the target.

TI target support package used to configure and control hardware.
Motor HIL System - Results

Encoder signals CW and CCW rotation 5 rad/s

Duty cycle measurement

Source: Li, D., Li, W., Wei, Y., Zhang, L. (2016). Servo Drive Hardware in the Loop Test System
Conclusion

Automatic code generation automates translation step removing potential source of errors.

SIL allows errors to be captured earlier.

Enables greater focus on algorithms as opposed to implementation concerns.