Chapter 1
Model-Based Control Design

INTRODUCTION

Control applications are widespread and are still expanding into emerging areas. In aviation, control is used for guidance, navigation and control (GNC), for engine control, and for vehicle power and environmental control (temperature and pressure). In automotive, control is used for powertrain, suspension, traction, braking and steering. Control is widely applied in process industries: refineries, pulp and paper, and chemical processing. Control is also used in manufacturing machines, appliances, robotics, power generation and transmission, and transportation such as elevators, locomotives. More and more control is implemented in control application software on embedded control systems. Embedded control product development focus is shifting from hardware development to control software development. With ever increasing system complexity, control software development consumes more and more budget and time of product development projects, and the quality of the control software is becoming increasingly important to a product success in the market place.

Model-based control design is adopted by more and more companies and industries for developing embedded control systems. It applies systems engineering principles with the aid of modeling to control system development, ensuring the final product meeting customer needs and requirements through a rigorous design and testing process. In this chapter, we first give a brief introduction of systems engineering, then we talk about why we want to use

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models and model-based design in embedded control system development. With new technologies and tasks introduced by model-based design, proper design and testing tools are required to efficiently implement a model-based design. Popular tools used in model-based design process are discussed, focusing on their usages. At the end, a model-based control design process is presented, with detailed description of each of it steps. This process can be applied directly to develop an embedded control system or it can be customized by the user to suit his/her project needs under realistic product development constraints.

SYSTEM ENGINEERING

Nowadays, more and more products with embedded control system appear in the markets and enter people's daily life. Aircraft can fly on autopilot and avoid collision; smart collision avoidance systems in automotive alert drivers to nearby vehicles and even take emergency evasive action. Control system implementation is moving from hardware to embedded software due to the enormous growth of the processing power of embedded microprocessor. For instance, today's modern cars contain dozens of microprocessors that may run 100millions lines of code for the purpose of delivering hundreds of functions to drivers and passengers. More often it is the software, rather than electronics, that makes a product stand out and determines the market winners. The inherent flexibility of software offers lots of opportunities to develop additional control functions, enabling manufacturers to create innovative products to meet customer expectations. By enabling seemingly boundless product functionality, software has taken center stage in all kinds of products, enabling many new kinds of interconnections between parts of the product and between the product and it environment. More connections create exponential increases in system complexity. This new development trend creates additional challenges for controls engineers.

There are many challenges for embedded control systems development. Expertise in multiple technical fields is needed, including electronics and software engineering. As software driven functionalities become the focal point, you have to get your hardware and software teams to work together really well. There are others issues controls engineers are facing today. More and more development teams are located in different places around the world; effectively managing distributed teams to ensure efficient, accurate and cooperative results becomes an issue. As customer demand for new control

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