Preface

Overview

The realm of embedded systems is quite large and is predominantly carried out around the general purpose processor and microcontrollers. The use of field programmable gate array (FPGA) in microprocessor-based embedded systems is often for glue logic or for off-loading the processor from tasks that require fast updates. The motivation for writing this text is to present a single source of information that can be used to understand how a FPGA and the Hardware Description Language (HDL) can be used in the design of embedded digital systems.

Digital design methodology has undergone several changes over the past three decades. The use of FPGA and HDL for implementing digital logic has become widespread in the last decade. The use of FPGA in embedded systems is still in its nascent stage. The majority of the embedded applications are divided between an 8-bit microcontroller implementation and a 32-bit processor-based real time operating system (RTOS) implementation. This text provides a starting point for the design of embedded system using FPGA and HDL. To give the text a common thread of thought from the application point of view, a design example of a hypothetical industrial robot controller is taken up. Different chapters of the text provide the necessary background on FPGA and HDL along with its use in designing an industrial robot controller.

Coverage

The first FPGA, introduced in 1985, consisted of 2000 gates. Since then, gate density has grown to tens of millions of gates. With increasing density of FPGAs, varied hardware resources have become a standard feature of contemporary FPGA-based devices. The text includes simulation of digital logic using Verilog HDL, synthesis of HDL code for a given FPGA device and processor-based FPGA devices. The focus of the HDL chapter is to emphasise the synthesizable area of Verilog constructs and to provide a basis to understand the application examples that follow in subsequent chapters. A chapter is devoted to the understanding of hardware–software partitioning in a FPGA device. Proprietary 8-bit and a 32-bit soft processors are discussed along with interfacing methodology using system-on-

chip interconnections. Basic technique for serial data communication, signal conditioning, motor control and hardware prototyping is covered using FPGA and HDL.

How to Use This Book

Moore's law has kept the semiconductor business in a constant state of flux. It is very difficult to write a book that uses FPGA and continues to be relevant despite ongoing technological changes. The author has presented basic concepts and techniques for using FPGA and hence should not change quickly. Since this book covers vast areas of HDL and FPGAs, some sections are brief and sketchy. For this the author recommends that the reader supplement the contents of each chapter with additional available literature. The chapter on HDL coding and simulation should be supplemented by standard textbooks on HDL coding and simulation. The FPGA resources and synthesis topic should be supplemented by EDA tools provided by different FPGA vendors and FPGA device datasheets. The contents on FPGA embedded processors can be supplemented by application notes on interfacing processors to custom codes and datasheets of soft processors.

FPGA Device and Tools Used

For purposes of illustration and consistency, Xilinx ISE™ software and SPARTAN™3E FPGA have been used throughout the book. Though the exemplars are specific to this device, the concepts can be applied to FPGA devices available from other FPGA vendors.

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