Preface

Embedded systems are a combination of hardware and software, which facilitates mass production and a host of applications, benefiting from economies of scale. Many embedded systems consist of small, computerized parts within a larger device that serves a more general purpose. Some applications of embedded system are in the automotive filed as control system and in the data acquisition for scientific and industrial fields (control system).

Modern industrial plants utilize robots for obtaining temperature controls, pressure controls, speed controls and position controls, and so on. Feedback control system is to be found in almost every aspect of our daily environment.

Data Acquisition Systems (DAQ) are now the main instruments for testing, measuring in automation field and so on, which is used widely in the research laboratory by scientists and engineers.

Data acquisition is a necessity, which is why data acquisition systems and software applications are essential tools in a variety of fields. For instance, research scientists rely on data acquisition tools for testing and measuring their laboratory-based projects. Therefore, as a data acquisition system designer, you must have in-depth understanding of each part of the systems and programmes you create.

The complexity of new physics experiments and industrial processes require more complex DAQ with the following characteristics:

- Capable of managing large amounts of data.
- High-speed connection.
- Digital recording.
- Full reconfigure possibility.

Signals that are hard to characterize and analyse with real-time display are evaluated in terms of the following parameters:

- High frequency.
- Large dynamic range.
- Gradual changes.

Data acquisition software is typically available in a text-based user interface (TUI) that comprises an ASCII configuration file and a graphic user interface (GUI), which are generally available with any web browser. Both interfaces enable data acquisition system management and customization, do not need to recompile the sources. This means even inexperienced programmers can have full acquisition control.

Well-designed data acquisition and control software should be able to quickly recover from instrumentation failures and power outages without losing any data. Data acquisition software must provide a high-level language for algorithm design. Moreover, it requires data archiving capability for verifying data integrity.

You have many data acquisition software options. An example is programmable software that uses a language such as C. Other software and data acquisition software packages enable you to design the custom instrumentation suited for specific applications (e.g., National Instruments's LabVIEW and MathWorks's MATLAB).

A data acquisition system's complexity tends to increase with the number of physical properties it must measure. Resolution and accuracy requirements also affect a system's complexity. To eliminate cabling and provide for more modularity, you can combine data acquisition capabilities and signal conditioning in one device.

Recent developments in the field of fiber-optic communications have shown longer data acquisition transmission distances can cause errors. Electrical isolation is also an important topic. The goal is to eliminate ground loops (common problems with single-ended measurements) in terms of accuracy and protection from voltage spikes.

Recently, some new technological developments have proven to be beneficial to the overall efficacy of data acquisition applications. For instance, in USB flash drive successfully makes the data acquisition and storage simpler and more efficient than ever (think "plug and play") and wireless improves the speed of data transmission and security.

In future, consumers' demand for mobile computing systems will only increase, and this will require tablet computers to feature improved data acquisition and storage capabilities. Having the ability to transmit, receive and store larger amounts of data with tablets will become increasingly important to consumers as time goes on. There are three main things to consider when creating a data acquisition-related application for a tablet. Hardware connectivity: Tablets have few control options (e.g., Wi-Fi and Bluetooth). Program language support: Many tablets support Android apps created in Java. Device driver availability: Device drivers permit a high-level mode to easily and reliably execute a data acquisition board's functionality. C and LabVIEW are not supported by Android or Apple's iOS. USB, a common DAQ bus, is available in a set of tablets. In the other case, an adapter is required. Among these examples, moving a possible data acquisition system to a tablet requires extra attention.

For all of the aforementioned reasons that embedded system will figure prominently in the evolution of acquisition system technology makes them ideal for custom data acquisition systems and control system.

The limited function required of embedded systems allows them to be designed for the most efficient performance.

Such embedded computing and information technologies have become, at the same time, an enabler for future manufacturing enterprises as well as a transformer of organizations and markets.

Digital embedded security is no more an option but a necessity as it is critical for more transactions happening over embedded devices as front ends. Due to constrained resources on systems, embedded systems have challenges in implementation on full-fledged security systems; therefore, the concept of "embedded security" offers a new differentiator for embedded product marketing.

The main idea of this book is to describe the theory of the embedded system with the realization of a versatile project (hardware and software) for application as high-speed data acquisition and programmable control system.

Starting from the review of analogue and digital electronics, the book aims to provide the reader into a competent and independent practitioner in the field of embedded systems by providing several skills, in both hardware and software development.

On the hardware side, the book will focus on among microcontroller design, techniques of embedded design, high-speed data acquisition (DAQ) and control system. This culminates in the study and application of a Real-Time Operating System (Open Source), representing the most important way that an embedded system can be programmed. It is presented as a useful tool for embedded designers. Every concept has been made to present the many complex concepts in a way that is easy to understand and which makes them readily usable. Embedded Linux (both the free and licensed versions) remains an attractive choice for a range of development teams and its use is poised to see a manifold increase.

In the chapter of microcontroller design, techniques of design of FPGA will also be presented. FPGA designs combine multiple components into a single package that reduces component count, board size and manufacturing complexity. Processors, memory, custom logic and many of the peripherals in a typical embedded project can be found in the FPGA. Today's FPGA architecture has grown into billions of logic blocks (equivalent to gates), and with programmable interconnection flexibility designers can easily create hardware functions that exactly match the needs of a specific embedded application.

Moreover, embedded development system and PCB techniques will be presented. An embedded system is identified as the electronic device designed for a particular function.

The design of embedded system makes use of compilers, assembler, debugger and a whole range of suites for the development of both software and hardware.

PCB layout is one of the last steps but the most critical in the design process. High-speed circuit performance is heavily dependent on layout. A high-performance design can be rendered useless due to a poor or sloppy layout.

For a long time, embedded devices were mostly operating as stand-alone systems. However, with the advent of wireless connectivity, like Bluetooth, Zigbee, RFID, the scenario has changed. The recent trends in wireless for use in embedded systems are in the areas of system-on-chip (SoC) architecture, reduced power consumption and application of short-range protocols.

In future, security in the embedded devices will be a critical issue. The security requirements of the connected embedded devices are distinct according to their limited memory, constrained middleware and low computing power. Today, power consumption is still a key issue in the design of the embedded systems that directly affects the battery life, which the technology has not been able to match the advancements in the hardware that drives these systems in recent years.

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