Preface

A sensor is a universal and one of the most ubiquitous components being used in the simplest to the most complex application of any industry, including automotive, communications, computers, consumer electronics, medical, aerospace, etc. There is almost not one industry where a sensor is not used.

Semiconductor and integrated sensor design are heavily driven by technology scaling. Rapid advances in microelectronics and nano-technologies have brought new challenges to the digital, smart, intelligent sensors and sensor systems design.

Digital sensors and systems appeared from a necessity to input results of measurement into a computer. Traditionally, the design task of such sensors and sensor systems was solved by converting an analog quantity (voltage or current) into a digital code by an analog-to-digital converter (ADC). Most books about digital sensors and sensor systems design focus on such classical approach. However, at the *nm* technology level, the design of analog and mixed-signal circuit becomes essentially more difficult and expensive. Only a few books, book chapters, articles and papers, written mainly by the author, consider a technology driven and coming alternative to the ADC – a frequency (time)-to-digital conversion, well suited for technology scaling.

Because digital, smart, intelligent sensors and sensor systems design based on the frequency (time)-to-digital conversion has not been adequately covered in the literature before, this book aims to fill a significant gap and presents new knowledge in this emerging area of modern sensors.

Research and development results, described in this book, are relevant to the author's international research activities in the frame of European FP6 Marie Curie Chairs Excellence (EXC) project MEXT-CT-2005-023991 Smart Sensors Systems Design (SMARTSES), and International Frequency Sensor Association (IFSA) activities.

Who Should Read this Book ?

This book will greatly benefit undergraduate and at PhD students, engineers, scientists and researchers in both industry and academia. It is especially suited as a reference guide for practicians, working for Original Equipment Manufacturers (OEM) electronics market (electronics/hardware), sensor industry, and using commercial-off-the-shelf components, as well as anyone facing new challenges in technologies, and those involved in the design and creation of new digital sensors and sensor systems, including smart and/or intelligent sensors for physical or chemical, electrical or non-electrical quantities. The goal of this book is to help the practicians achieve the best metrological and technical performances at low cost, and significantly to reduce time-to-market. It should be also be useful for students, lectures and professors to provide a solid background of the novel concepts and design approach because of till now such topics have been covered adequately only in a few European and American universities.

How this Book is Organized ?

This book has been organized into 19 Chapters and one Appendix.

Chapter 1. Starting with detailed modern sensor market analyze the Chapter 1 discusses main technological challenges and two possible digital sensors and sensor systems design approaches.

Chapters 2 and 3 covers detailed information about novel integrated circuits – Universal Frequency-to-Digital Converters (UFDC-1, UFDC-1M-16) and its development board; Universal Sensors and Transducers Interface (USTI) and its future modifications - USTI-EXT for extended, high operational temperature range up to +150 ^{0}C, and USTI-WSN for wireless sensor network applications.

Chapter 4 devoted to the Frequency-to-Digital Converter (FDCP) integrated circuit with parallel, high speed interface.

Chapters 5–12 describes appropriate digital sensors, transducers and sensor systems designs: optoelectronic, temperature, pressure, humidity, acceleration, magnetic, rotational speed, chemical and biosensors. Each chapter starts from appropriate sensor market analyze and state-of-the-art review, contains practical examples, and followed by lists of references with dozens titles. These chapters can be used separately.

Chapter 13–15 deals with a direct interfacing of resistive, capacitive and resistive bridge sensing elements.

Chapter 16 describes the data acquisition systems design for both: quasi-digital and analog sensors. This chapter also discusses multifunctional and multiparametric sensors, transducers and sensor systems.

Chapter 17 devoted to intelligent sensors and sensor systems design including extension of IEEE 1451 standard for quasi-digital sensors and transducers.

Chapter 18 covers other quasi-digital sensors and transducers based designs, and applications, including wireless sensor networks.

Chapter 19 describes System-on-Chip (SoC), System-in-Package (SiP) designs based on MEMS sensors and outlines the future perspectives and modern trends.

Appendix contains useful information about engineering technique how to estimate a resulting, total error of designed sensor system in practice. An example and practical consideration are given.

How to Use this Book ?

If you are familiar with the UFDC-1, UFDC-1M-16 and USTI integrated circuits, you can pass the Chapter 2 and 3 and read appropriate chapters devoted to particular digital sensors and sensor systems designs. Each chapter in this book can be used independently and contains its own detailed list of references. For additional and up-dated information, the appropriate sensor web sections at Sensors Web Portal launched by the author are recommended to use at http://www.sensorsportal.com/HTML/Sensor.htm