ПРИКАЗИ
ОБЗОРЫ
REVIEWS

Review of ther book entitled Discrete Communication Systems by Stevan Berber, Oxford University Press, 2021

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Abstract:

The book contains the theory of discrete communication systems that are presented in the form of block schematics defined by mathematical operators. For the sake of comparison, the theory of digital communication systems is added to understand better the relations between the two theories. Two generic schemes of the systems are designed that are used to develop specific discrete and digital systems as their special cases. The complementary chapters of the book contain the theory of the continuous-time and discrete-time processing of the deterministic and stochastic signal that is necessary for understanding the main chapters presenting communication systems.

Key words: discrete communication system, digital communication system, discrete modulation, digital modulation, theory of information and coding, discrete-time signal processing, continuous-time signal processing deterministic signals, random signals.

Book title: Discrete Communication Systems
Book author: Stevan Berber, The University of Auckland, Auckland, New Zealand, Senior member of IEEE, s.berber@auckland.ac.nz.
Place of publication: New York, USA
Publisher: Oxford University Press
Copyright date: Stevan Berber, 2021

Number of pages in the book: 928 pages, plus index.
Number of pages in the supplementary material:
Solutions to the Problems 356 pages, Projects 204 pages.

Purpose and the main features of the book

This book primarily presents the theoretical base of discrete communication systems with a reference to digital communication systems. The contents of the book solely address problems in the design of a communication system that includes a transmitter, a transmission channel, and a receiver. The signals processed in the system are presented in two domains of time, the continuous-time domain and the discrete-time domain, as well as in two corresponding domains of frequency, the Fourier series and transforms for continuous-time and discrete-time signals. A system operating in the continuous-time domain is named *the digital system*, while a system operating in the discrete-time domain is named *a discrete system*. The theory of discrete systems is the focus of this book because of the existing theory of digital communication systems; however, it is not sufficient to work on the design and implementation of the communication system transceiver blocks in modern DSP technology. The purpose of the book is not to explain all existing modulation techniques, but to make a firm foundation of communications systems operating in the discrete-time domain covering the basic discrete modulation methods.

The writing of this book is additionally motivated by modern trends in the design of communication systems on the FPGA and DSP platforms. These trends were heavily supported by advances in the theory of discrete-time signal processing. These trends will continue in the future supported by the everlasting increase in the processing ability of digital technology allowing the development of sophisticated communication algorithms we could not dream of in the past. For these reasons, it is necessary to know how to use the discrete-time signal processing theory and how to apply it in the design of modern communication devices. Even more important is to make available the theory of discrete-time communication systems to researchers, practicing engineers, and designers of communications devices in the industry. Practically all modern communication devices such as wireless and cable modems, TV modems, consumer entertainment systems, satellite modems, and similar, are based on the use of digital processing technology and the principles of the discrete-time signal processing theory.

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The distinguishing features of the book are:

1. This is the first book that presents the essential theory and practice of discrete communication systems design. In contrast to already published books, the operation of the discrete communication systems is expressed in terms of the theory of discrete-time stochastic processes and related to the existing theory of digital communication systems.

2. Based on the presented orthogonality principles, a generic structure of a communication system, based on correlation demodulation and optimum detection, is developed and presented in the form of mathematical operators.

3. Due to the random nature of the signals processed, the theory of continuous-time and discrete-time stochastic signal processing is extensively and consequently applied to present the signals at the inputs and outputs of the transceiver blocks and to develop the general system named the generic system.

4. Based on the generic system, the traditionally defined phase shift keying (PSK), frequency shift keying (FSK), quadrature amplitude modulation (QAM), orthogonal frequency division multiplexing (OFDM), and code division multiple access (CDMA) systems are deduced as its special cases.

5.Having in mind the controversial nature of the continuous-time white Gaussian noise process having infinite power, a separate chapter is dedicated to noise discretization by introducing the notions of noise entropy and the truncated Gaussian density function.

6. The book is self-sufficient because it uses a unified notation and terminology, both in the main ten chapters explaining communications systems theory and in nine complementary chapters dealing with the continuous and discrete-time signal processing for both deterministic and stochastic signals. Therefore, readers do not need to go to various books on signal processing and struggle with their different notations to understand them in the context of the operation of communication systems.

7. The unified notation and unified terminology allow clear distinction of deterministic signals from stochastic ones, power signals from energy signals, as well as discrete-time signals and processes from continuous-time signals and processes.

8. For the sake of explanation and clarity, the theory of digital communication systems is presented to a certain extent and related to the main theory of discrete communication systems.

9. The text of the book is accompanied by solutions to about 300 problems and five Projects.

Content of the book

The book contains two parts, as it can be seen in Fig. 1.

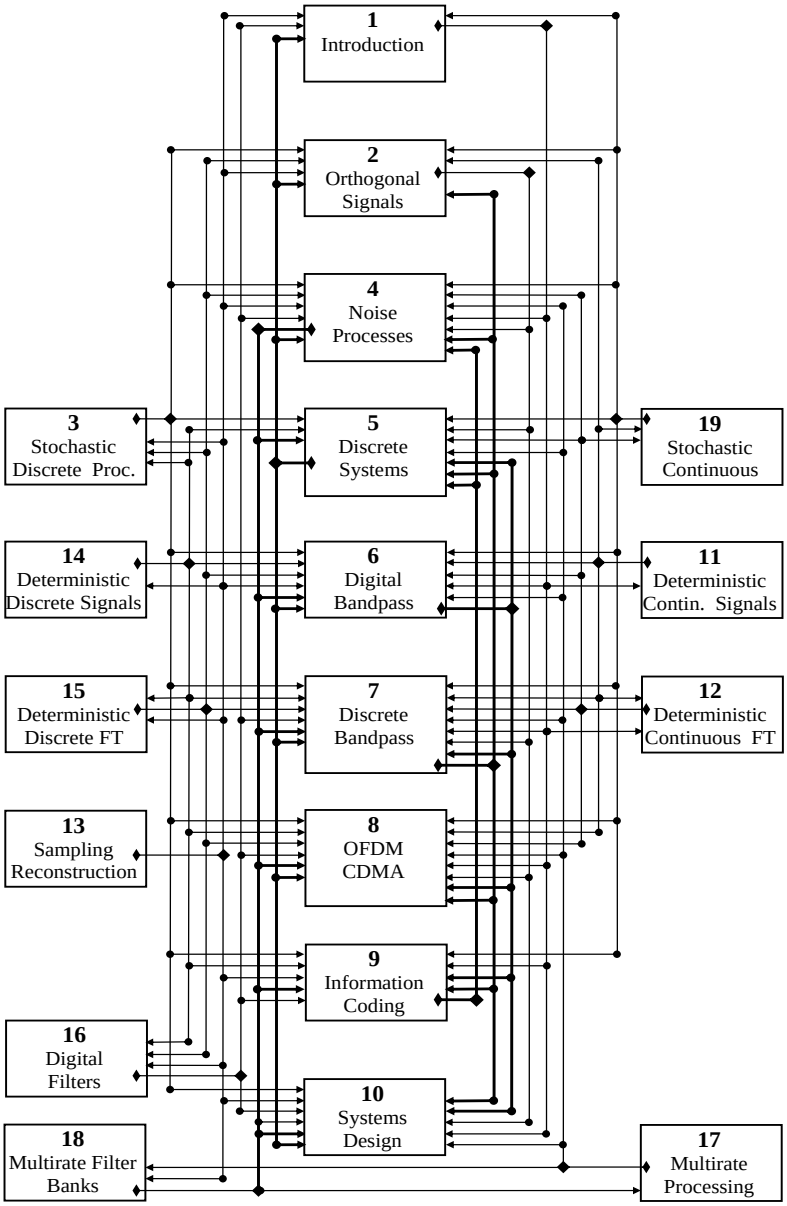

Figure 1 – Book structure and the relations between chapters
Рис. 1 – Структура книги и взаимосвязь между главами.
Слика 1 – Структура књиге и концепција поглавља

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The First Part has ten main chapters and presents an essential theory of discrete and digital communication systems, the operation of their building blocks, and in the first place the operation of modulators and demodulators/detectors. Due to the importance of the theory of discrete and continuous-time signal processing, for both deterministic and random signals, nine chapters containing this theory are incorporated into the Second Part of the book containing nine complementary chapters.

The main chapters are in the middle of the diagram (1 to 10, including Chapter 3 on the left). The complementary chapters, containing the theory of signal sampling and reconstruction, and the necessary theory in deterministic discrete-time signal processing, are on the left-hand side (13, 14, and 15). The chapters containing the theory of continuous-time signal processing are on the right-hand side (11, 12, and 19). Chapters 16 to 18, at the bottom of Fig. 1, contain the essential theory of digital filters and multi-rate signal processing that is relevant for nearly all chapters of the book and for Chapters 7 and 10. The chapters are interconnected by the input arrow and output diamond lines.

Description of chapters in the main part

Chapter 1 introduces the subject of the book, defines the main terms in communication systems, and presents the main objectives for writing this book.

Chapter 2 is dedicated to the principle of discrete-time signals orthogonalization. Understanding this chapter is a prerequisite to understanding Chapters 4 to 10.

Chapter 3 contains the theory of discrete-time stochastic processes, which is a prerequisite for the chapters related to the theory of discrete communication systems exposed in Chapters 4 to 10.

Chapter 4 addressed the issues related to the theory of noise in communication systems. Adding the entropy and truncated density functions to already used autocorrelation and power spectral density functions allowed mathematical modeling of the discrete noise generators and regenerators. This chapter is in close relation to Chapters 3, 19, 13, 16, 17, and Project 3.

Chapter 5 is a vital part of this book presenting the generic communication system operating in the discrete-time domain, which is based on the implementation of orthogonal modulators, correlation demodulators, and optimum detectors, following the definition of signal synthesizers and analyzers in Chapter 2.

The generic discrete system is shown in Fig. 2, to be used to deduce the practical systems as its special cases.

Chapter 6 presents mathematical models of the traditional baseband and bandpass digital communication systems based on the BPSK, QPSK, FSK, and QAM modulation methods.

Chapter 7 presents the operation of a discrete system that processes pure discrete-time signals.

The vital characteristics of the system and its blocks are expressed in terms of amplitude spectral density, autocorrelation functions, power and energy spectral densities, and bit error probability.

This chapter presents mathematical models of the discrete baseband and bandpass communication systems based on the BPSK and QPSK, FSK, and QAM modulation methods, which are deduced from the generic system structure presented in Chapter 5, which confirms the basic idea of this book that the practical communication systems are special cases of the generic system. An example of a derived BPSK system is shown in Fig. 3 operating at the intermediate frequency.

Chapter 8 presents modern multiuser and multicarrier CDMA and OFDM systems, and Project 4 demonstrates the procedure of mathematical modeling, simulation, and design of a CDMA system in FPGA technology.

Chapter 9 presents the fundamentals of information theory, including the theory of iterative and turbo channel coding that is demonstrated in Project 5.

Chapter 10 presents some practical aspects of discrete communication systems design in digital technology, primarily in DSP and FPGA.

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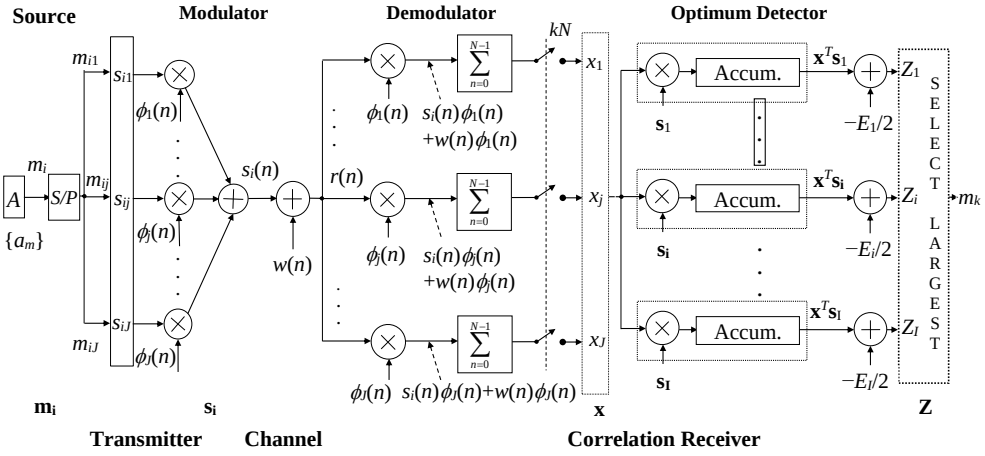

Figure 2 – Generic discrete communication system operating in the discrete-time domain
Рис. 2 – Обобщенная дискретная система связи, работающая в дискретном времени
Слика 2 – Генерички дискретни комуникациони систем који ради у домену дискретног времена

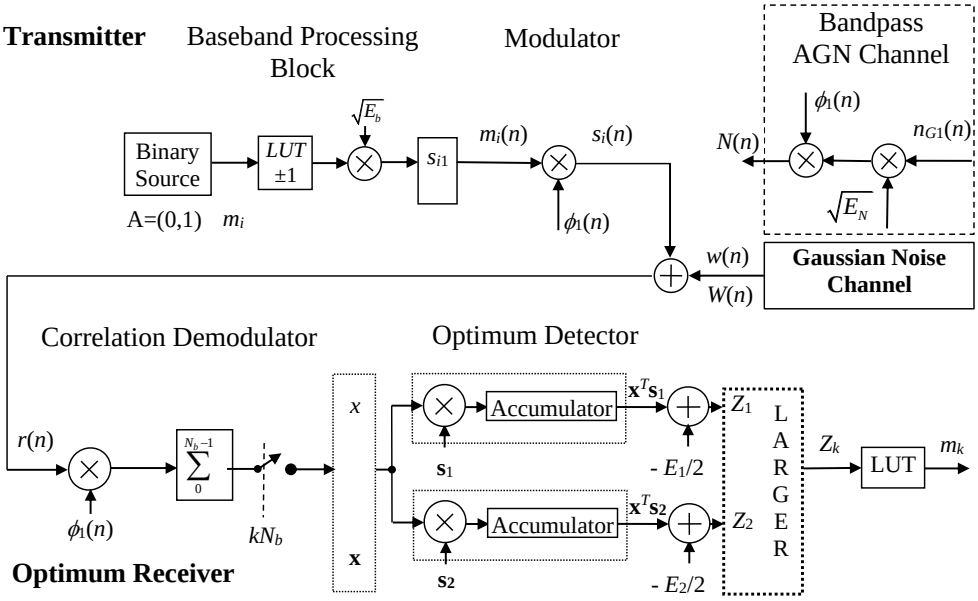

Figure 3 – Discrete BPSK, an example of a special case of the generic discrete system
Рис. 3 – Дискретный BPSK, пример частного случая обобщенной дискретной системы
Слика 3 – Дискретни BPSK, пример посебног случаја генеричког дискретног система

Description of chapters in the complementary part

Complementary Chapters 11 to 19 are added for three reasons. Firstly, they contain the basic theory of continuous-time and discrete-time signal processing that is essential for the understanding of mathematical models and operations of the digital and discrete transceivers, where the theory of deterministic and stochastic signal processing is used. Secondly, the unified notation and terminology in all 19 chapters simplify the understanding of their content. Thirdly, presenting the signal processing and communication systems theory with a unified notation makes this book self-sufficient, allowing readers to avoid wasting time and getting confused by reading various books with different notations. Even though a reader can be very familiar with the signal processing theory contained in the complementary chapters, it is advisable to read them before starting to work on the main 10 chapters.

Target audience of the book

The book is intended for undergraduate and graduate students doing courses in communication systems, and also for practicing engineers working on the design of transceivers in discrete communication systems. A one-semester senior-level course, for students who have had prior exposure to classical communication systems covering passband and baseband signal transmission, can use the material in Chapters 1 to 6, as well as the material in Chapter 9 supported with related complementary Chapters 11 to 15, Chapter 19 and Projects 1, 2 or 3. In a first-year postgraduate level course, the first six chapters provide students with a good review of the digital and discrete communication systems theory and the main lecturing will cover Chapters 2 to 5 and Chapters 7 to 10 that present the discrete communications systems and their design, and related Projects 1 to 5. The background theory for this course is contained in complementary Chapters 13 to 18.

For practicing engineers, who are experienced in the theory of digital communication systems, the material covered in Chapters 2 to 5 and Chapters 7 to 10 supported by complementary Chapters 13 to 18 is a good base for understanding the vital concepts in discrete communication systems. All Projects are relevant for them, Projects 4 and 5 in particular.

Supplementary material

The book contains the Supplementary Material that is composed of two parts: Solutions to the Problems in the book, and Research Projects

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with offered solutions. To master the theory, key chapters contain sets of problems for students' exercises. The solutions to the problems are inside a separate book belonging to the Supplementary Material for readers. In addition to the solved problems, the book contains several real-world case studies in the form of Projects related to the advanced modeling and designs of modern communication systems based on digital and discrete-time signal processing and the application of modern technologies like DSP and FPGA. None of these Projects is a laboratory exercise but a self-contained piece of research work related to a particular book chapter, and as such can be a part of a one-semester project inside the course in discrete and digital communication systems.

Обзор книги «Дискретные системы связи»,
Автор: Стивен Бербер,
Издательство Оксфордского университета, 2021г.

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РУБРИКА ГРНТИ: 49.00.00 Связь
ВИД СТАТЬИ: обзор книги

Резюме:

В книге приведена теория дискретных систем связи, которые представлены в виде блочных схем, определяемых математическими операторами. Для того чтобы лучше понять и сравнить взаимосвязь между двумя теориями, приведена также теория цифровых систем связи. Были определены обобщенные схемы обеих систем, которые использовались для разработки отдельных дискретных и цифровых систем в качестве их специальных случаев. В некоторых главах представлена теория обработки детерминированных и стохастических сигналов непрерывного и дискретного времен, которая способствует пониманию основных глав, в которых описаны системы связи.

Ключевые слова: дискретные системы связи, цифровые системы связи, дискретная модуляция, цифровая модуляция, теория информации и кодирования, обработка сигналов дискретного времени, обработка сигналов непрерывного времени, детерминированные сигналы, случайные сигналы.

Приказ књиге Discrete communication systems,
аутор Стеван Бербер,
Oxford University Press, 2021

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ОБЛАСТ: телекомуникације
КАТЕГОРИЈА (ТИП) ЧЛАНКА: приказ књиге

Сажетак:

Ова књига садржи теорију дискретних телекомуникационих система који су приказани у облику блок шема дефинисаних помоћу математичких оператора. У циљу поређења система, додата је теорија дигиталних телекомуникационих система ради бољег разумевања односа наведених теорија. Дефинисане су генеричке шеме оба система које су коришћене да се развију појединачни дискретни и дигитални системи као њихови специјални случајеви. Комплементарна поглавља књиге садрже теорију обраде детерминистичких и стохастичких сигнала континуалног и дискретног времена која је неопходна за разумевање главних поглавља која приказују телекомуникационе системе.

Кључне речи: дискретни телекомуникациони системи, дигитални телекомуникациони системи, дискретна модулација, дигитална модулација, теорија информација и кодовања, обрада сигнала дискретног времена, обрада сигнала континуалног времена, детерминистички сигнали, случајни сигнали.

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