Preface

For the past few years there was a requirement for a complete book volume which presents the fundamental techniques of signal conditioning along with their state of art applications both in the domain of continuous wave communication, single and two dimensional signal processing. In September 2010, just after the successful publication of my book "Digital communication—Principles and System Modelling" from Springer, the senior editor of Springer's "Signals and Communication Technology" series Dr. Christoph Baumann discussed about that requirement with me. He proposed me to write a book to meet the requirement. He opined that the present book along with the aforementioned book in digital communication can be an impressive two-volume archive for understanding the flavor of the subjects like communication, signal processing and image processing and their interdependencies. With this thought and motivation we both have prepared the draft table of content for the present book. This sincere effort to fulfill the expectations of all the readers including undergraduate and post graduate students, teachers, illustrators, domain professionals and researchers, started just one year back.

The generic chapter on preview and introduction starts with discussing about the fundamental properties and operations in signals and systems. The entire content is intentionally segregated in two parts namely "Continuous wave communication and analog signal conditioning" and "Discrete signal conditioning: 1D and 2D". The 1st part comprises of the continuous time Fourier series and transform, and the basic analog modulations like amplitude, frequency and phase modulation. The 2nd part starts with basic operations in discrete time signals and systems and ends with detailed discussion on different transformations like DTFS, DTFT, DFT, FFT, ZT and DWT.

I found a common problem among the students of undergraduate and even post graduate levels of incomplete and insufficient understanding of the transformed domain interpretation of signals and systems, physically. Most of them consider the same as only some mathematical tools which increases there overheads only. The main reason of this perception is the lag of communication from the authors and teachers (with due respect to all of them) in terms of interconnections between the transformed domain realizations of signals and systems, interpretations and

approach in solving the real world problems. Moreover, the students try to look at each of the transformations as a separate tool. The first thing I tried in my approach is interpreting the transformed domain representation used for analysis of signals and systems, physically. I have shown the physical interpretations of all the transformed coefficients so that they can just be derived by some very simple *geometric pattern matching*. I hope this will reduce the overhead of the readers and help them to understand the foundation and applicability of the different transformations, as well.

In this book, different transformations like Continuous and Discrete Time Fourier Series and Transforms (CTFS, CTFT, DTFS, DTFT), Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Laplace Transform (LT), Z-transform, and Discrete Wavelet Transform (DWT) are presented in a collateral way like beads in a single necklace. As the research progressed, new transformations evolved from the existing one to meet the requirements, applicability and reduction of computational cost. In this book I have introduced each of the transformations in the same fashion, considering them as inherited or derived transform from the previous one or the fundamental one like Fourier series or transform. This approach denies the wrong idea of considering each of the transforms as lonely island. They all are closely interrelated and in this book their relationships are clearly projected by deriving one transform from another. The boundary conditions used in these inter-conversions will help the students to understand why one transformation is at all necessary to be introduced, what is its applicability and how does it help to solve a real time problems in an easier way. This will answer the very basic question, "Why should I study this?" in students' mind. Believe me the answer will not just be "It is in the syllables"; moreover it will be "This is an important and interesting knowledge for me which I can apply in my domain of interest." I hope this new approach will help the teachers also to deliver the knowledge in an elegant way.

In my student days I was very much interested to learn new things and validate my own interpretation from the real world. I think most of the students have this kind of tendency. Real researchers are hidden to be explored into them. When I started my career as a teacher in a degree engineering college, I tried to present the subject in my own way. The classes should not be a copy book one. After few years of teaching when I looked into my last few years, I found that I have delivered the same set subjects at least 20 times but each time I followed completely different approach. The teacher-student interaction is really a *value-zone*, according to me. Each time the teacher should enjoy discovering the new shade of the subject. Then only the students will also enjoy the *value-zone*. I have incorporated some derivations and physical interpretations of some fundamental theorems in non-conventional way. I have shown how a problem can be attacked from different end of knowledge pool. I am just trying to give one example of the approach using the statement, "Sampling results in periodic spectra". This statement can be mathematically derived from the frequency shifting property of Fourier transform in a conventional way. I have incorporated the physical interpretation of sampling in frequency domain using convolution also. The same idea will help the readers to understand the two fundamental transformations for discrete time (sampled) signals, namely DTFS and DTFT easily.

It is comparatively easier to understand the concept of frequency and phase in time domain representation of single dimensional signal than that of a spatial representation of a two dimensional image. It is really difficult to realize frequency and phase from a given image without understanding the concepts physically. I have tried to hit that area also. In the chapter of Discrete Fourier Transform (DFT) I have clearly described the concept of frequency in image, in Fourier Series chapter (Chap. 2) I have shown how from the phase congruency we can detect several features like edges and corners from an image, in the discussion of Discrete Wavelet Transform (DWT) in Chap. 10, I have shown how we can achieve good compression ratio ensuring quality preservation according to bit budget. The applications of signal conditioning including the understanding of different transformations are projected in the area of electrical signal processing, image enhancement and processing, speech analysis and synthesis. The readers' eyes of knowledge would definitely feel soothing by this wide spectrum of domain coverage.

The Chap. 11 comprises of one interesting application of the understanding of the entire subject. There I have introduce the concept of "perceptual redundancy". A new way of communication where the signal to noise ratio (SNR) is tried to be minimized so that the signal can be ensured to be unobserved by the intruders. Steganography is a technique of secret data hiding in multimedia. I have shown different real time application of steganography in all the multimedia covers (carriers) including text, image, audio, video and IP datagram.

Salient Features

1. The subject is introduced from the very basic understanding of signal and explored the entire gamut in an elegant way.
2. Several transformed domain representations and realizations like Fourier series and transform, Laplace and Z-transform, Wavelet transform are introduced and presented in a collateral way as the research progressed in time depending on requirements, applicability and reduction of computational cost.
3. All the transformations are considered as inherited or derived transform from the previous one or the fundamental one like Fourier series and Fourier transform.
4. The application areas included in this volume are rich and resemblance to the present trend of research.
5. A supplementary electronic material is included into this book in the form of CD and/ or online content (www.extras.springer.com) which includes a number of *codes* and *MATLAB*, with illuminating uncommon and common applications for better understanding of the subject.
6. Complete code for many state-of-art real life applications like wavelet based image compression (EZW) and data hiding (watermarking) in multimedia are included.

7. A GUI based Fourier Synthesis module (Version 1.1) is also supplied with the other supplementary electronic materials. Readers can play with the tool and observe the synthesized waveform by tuning the amplitudes of the *sine* and *cosine* Fourier coefficients.
8. Elegant worked out numerical problems are designed in such a way that, the readers can get the flavour of the subject and get attracted towards the future scopes of research and development in the domain of signal processing, communication, image processing and speech processing.
9. Unparallel tabular, flow chart based and pictorial methodology description is included for sustained impression of the proposed design/algorithms in mind.
10. Depending on the relationship and interdependencies between all the chapters, three distinct study flows are presented. It's now up to the readers to choose which study flow suits them according to their area/ domain of interest.

This volume is intended to fulfil the expectations of students as well as the teachers. I hope this book would not only be a favourite study material for the students but also can be a nice resource for teaching. In my career, I have been engaged in full time teaching, faculty upgradation training, served both government R & D, and hardcore public limited industry. Therefore I can feel the requirements of each and every sector closely. I expect detailed feedback from the readers of this book. My sincere efforts would be successful, if this volume meets the requirements and expectations of all the students, teachers, researchers, and professionals in the domain of communication, signal processing and image processing.

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