

Audio Signal Compression using DCT and LPC Techniques

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Abstract—Audio compression is designed to reduce the transmission bandwidth requirement of digital audio streams and storage size of audio files. Audio compression has become one of the basic technologies of the multimedia age to achieve transparent coding of audio and speech signals at the lowest possible data rates. This paper presents a comparative analysis of audio signal compression using transformation techniques like discrete cosine transform and linear prediction coding. Performance measures like compression ratio, signal to noise ratio (SNR), peak signal to noise ratio (PSNR) and mean square error (MSE) etc are calculated for analysis.

Key words— Discrete Cosine Transform (DCT), linear prediction coding (LPC), compression ratio (CR), SNR, PSNR, MSE.

I. INTRODUCTION

In digital signal processing data compression involves encoding the information using fewer bits than the original representation. Compression reduces the usage of resources like storage space and transmission capacity. Audio Compression is a process of lessening the dynamic range between the loudest and quietest parts of an audio signal. This is done by boosting the quieter signals and attenuating the louder signals. Audio compression basically consists of two parts. The first part, called encoding, transforms the digital audio data (.WAV file) into a highly compressed form called bit stream. However, the second part, called decoding takes the bit stream and re-expands it to a WAV file[1].

Compression Types

There are mainly two types of compression techniques: Lossless Compression and Lossy Compression techniques. Lossless data compression algorithms allow exact reconstruction of original

data from the compressed data. Lossy compression techniques does not allow perfect reconstruction of data but offers good compression ratio values relative to the lossless compression techniques.

B. General Audio Compression Architecture

The most common characteristic of audio signals is the existence of redundant information between adjacent samples. Compression tries to remove this redundancy and makes the data de-correlated. Typical audio compression system contains three basic modules to accomplish audio compression. First, an appropriate transform is applied. Second, the produced transform coefficients are quantized to reduce the redundant information; here, the quantized data hold errors but should be insignificant[1]. Third, the quantized values are coded using packed codes; this encoding stage changes the format of quantized coefficients values using one of the suitable variable length coding technique.

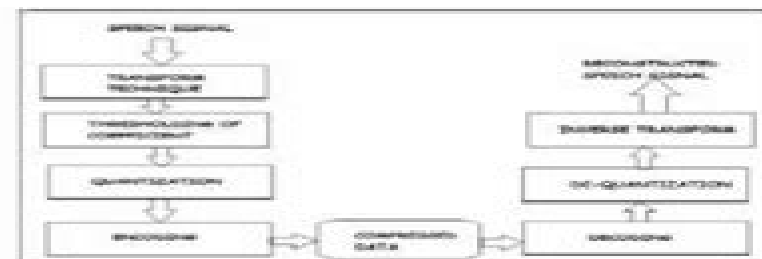


Fig1: General block diagram

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Digital Signal Processing with Examples in MATLAB Samuel D. Stearns, Donald R. Hush, 2016-04-19 Based on fundamental principles from mathematics linear systems and signal analysis digital signal processing DSP algorithms are useful for extracting information from signals collected all around us Combined with today's powerful computing capabilities they can be used in a wide range of application areas including engineering communication Digital Signal Processing Li Tan, Jean Jiang, 2013-01-21 Digital Signal Processing Second Edition enables electrical engineers and technicians in the fields of biomedical computer and electronics engineering to master the essential fundamentals of DSP principles and practice Many instructive worked examples are used to illustrate the material and the use of mathematics is minimized for easier grasp of concepts As such this title is also useful to undergraduates in electrical engineering and as a reference for science students and practicing engineers The book goes beyond DSP theory to show implementation of algorithms in hardware and software Additional topics covered include adaptive filtering with noise reduction and echo cancellations speech compression signal sampling digital filter realizations filter design multimedia applications over sampling etc More advanced topics are also covered such as adaptive filters speech compression such as PCM u law ADPCM and multi rate DSP and over sampling ADC New to this edition MATLAB projects dealing with practical applications added throughout the book New chapter chapter 13 covering sub band coding and wavelet transforms methods that have become popular in the DSP field New applications included in many chapters including applications of DFT to seismic signals electrocardiography data and vibration signals All real time C programs revised for the TMS320C6713 DSK Covers DSP principles with emphasis on communications and control applications Chapter objectives worked examples and end of chapter exercises aid the reader in grasping key concepts and solving related problems Website with MATLAB programs for simulation and C programs for real time DSP **Digital Signal Processing** EduGorilla Prep Experts, 2024-07-25 EduGorilla Publication is a trusted name in the education sector committed to empowering learners with high quality study materials and resources Specializing in competitive exams and academic support EduGorilla provides comprehensive and well structured content tailored to meet the needs of students across various streams and levels Analysis of the MPEG-1 Layer III (MP3) Algorithm using MATLAB Andreas Spanias, Jayaraman Thiagarajan, 2022-05-31 The MPEG 1 Layer III MP3 algorithm is one of the most successful audio formats for consumer audio storage and for transfer and playback of music on digital audio players The MP3 compression standard along with the AAC Advanced Audio Coding algorithm are associated with the most successful music players of the last decade This book describes the fundamentals and the MATLAB implementation details of the MP3 algorithm Several of the tedious processes in MP3 are supported by demonstrations using MATLAB software The book presents the theoretical concepts and algorithms used in the MP3 standard The implementation details and simulations with MATLAB complement the theoretical principles The extensive list of references enables the reader to perform a more detailed study on specific

aspects of the algorithm and gain exposure to advancements in perceptual coding Table of Contents Introduction Analysis Subband Filter Bank Psychoacoustic Model II MDCT Bit Allocation Quantization and Coding Decoder **Digital Signal Processing with Matlab Examples, Volume 2** Jose Maria Giron-Sierra,2016-12-02 This is the second volume in a trilogy on modern Signal Processing The three books provide a concise exposition of signal processing topics and a guide to support individual practical exploration based on MATLAB programs This second book focuses on recent developments in response to the demands of new digital technologies It is divided into two parts the first part includes four chapters on the decomposition and recovery of signals with special emphasis on images In turn the second part includes three chapters and addresses important data based actions such as adaptive filtering experimental modeling and classification *DSP for MATLAB and LabVIEW: Fundamentals of discrete frequency transforms* Forester W. Isen,2008 The entire series consists of four volumes that collectively cover basic digital signal processing in a practical and accessible manner but which nonetheless include all essential foundation mathematics As the series title implies the scripts of which there are more than 200 described in the text and supplied in code form available via the internet at <http://www.morganclaypool.com/page/isen> will run on both MATLAB and LabVIEW The text for all volumes contains many examples and many useful computational scripts augmented by demonstration scripts and LabVIEW Virtual Instruments VIs that can be run to illustrate various signal processing concepts graphically on the user's computer screen **MATLAB for Engineers** Karel Perutka,2011-10-13 The book presents several approaches in the key areas of practice for which the MATLAB software package was used Topics covered include applications for Motors Power systems Robots Vehicles The rapid development of technology impacts all areas Authors of the book chapters who are experts in their field present interesting solutions of their work The book will familiarize the readers with the solutions and enable the readers to enlarge them by their own research It will be of great interest to control and electrical engineers and students in the fields of research the book covers *Starting Digital Signal Processing in Telecommunication Engineering* Tomasz P. Zieliński,2021-01-29 This hands on laboratory driven textbook helps readers understand principles of digital signal processing DSP and basics of software based digital communication particularly software defined networks SDN and software defined radio SDR In the book only the most important concepts are presented Each book chapter is an introduction to computer laboratory and is accompanied by complete laboratory exercises and ready to go Matlab programs with figures and comments available at the book webpage and running also in GNU Octave 5.2 with free software packages showing all or most details of relevant algorithms Students are tasked to understand programs modify them and apply presented concepts to recorded real RF signal or simulated received signals with modelled transmission condition and hardware imperfections Teaching is done by showing examples and their modifications to different real world telecommunication like applications The book consists of three parts introduction to DSP spectral analysis and digital filtering introduction to DSP advanced topics multi rate adaptive model based and multimedia

speech audio video signal analysis and processing and introduction to software defined modern telecommunication systems SDR technology analog and digital modulations single and multi carrier systems channel estimation and correction as well as synchronization issues Many real signals are processed in the book in the first part mainly speech and audio while in the second part mainly RF recordings taken from RTL SDR USB stick and ADALM PLUTO module for example captured IQ data of VOR avionics signal classical FM radio with RDS digital DAB DAB radio and 4G LTE digital telephony Additionally modelling and simulation of some transmission scenarios are tested in software in the book in particular TETRA ADSL and 5G signals Provides an introduction to digital signal processing and software based digital communication Presents a transition from digital signal processing to software defined telecommunication Features a suite of pedagogical materials including a laboratory test bed and computer exercises experiments **Multimedia Signals and Systems** Mrinal Kr.

Mandal,2012-12-06 Multimedia Signals and Systems is primarily a technical introductory level multimedia textbook including problems examples and MATLAB codes It will be a stepping stone for readers who want to research in audio processing image and video processing and data compression This book will also be useful to readers who are carrying out research and development in systems areas such as television engineering and storage media Anyone who seeks to learn the core multimedia signal processing techniques and systems will need Multimedia Signals and Systems There are many chapters that are generic in nature and provide key concepts of multimedia systems to technical as well as non technical persons There are also several chapters that provide a mathematical analytical framework for basic multimedia signal processing The readers are expected to have some prior knowledge about discrete signals and systems such as Fourier transform and digital filters However a brief review of these theories is provided Additional material for this book including several MATLAB codes along with a few test data samples e g audio image and video may be downloaded from <http://extras.springer.com> **Digital**

Signal Processing Thomas Holton,2021-02-18 Combining clear explanations of elementary principles advanced topics and applications with step by step mathematical derivations this textbook provides a comprehensive yet accessible introduction to digital signal processing All the key topics are covered including discrete time Fourier transform z transform discrete Fourier transform and FFT A D conversion and FIR and IIR filtering algorithms as well as more advanced topics such as multirate systems the discrete cosine transform and spectral signal processing Over 600 full color illustrations 200 fully worked examples hundreds of end of chapter homework problems and detailed computational examples of DSP algorithms implemented in MATLAB and C aid understanding and help put knowledge into practice A wealth of supplementary material accompanies the book online including interactive programs for instructors a full set of solutions and MATLAB laboratory exercises making this the ideal text for senior undergraduate and graduate courses on digital signal processing

Data-Driven Science and Engineering Steven L. Brunton,J. Nathan Kutz,2022-05-05 A textbook covering data science and machine learning methods for modelling and control in engineering and science with Python and MATLAB

Introduction to Audio Analysis Theodoros Giannakopoulos, Aggelos Pikrakis, 2014-02-15 *Introduction to Audio Analysis* serves as a standalone introduction to audio analysis providing theoretical background to many state of the art techniques It covers the essential theory necessary to develop audio engineering applications but also uses programming techniques notably MATLAB to take a more applied approach to the topic Basic theory and reproducible experiments are combined to demonstrate theoretical concepts from a practical point of view and provide a solid foundation in the field of audio analysis Audio feature extraction audio classification audio segmentation and music information retrieval are all addressed in detail along with material on basic audio processing and frequency domain representations and filtering Throughout the text reproducible MATLAB examples are accompanied by theoretical descriptions illustrating how concepts and equations can be applied to the development of audio analysis systems and components A blend of reproducible MATLAB code and essential theory provides enable the reader to delve into the world of audio signals and develop real world audio applications in various domains Practical approach to signal processing The first book to focus on audio analysis from a signal processing perspective demonstrating practical implementation alongside theoretical concepts Bridge the gap between theory and practice The authors demonstrate how to apply equations to real life code examples and resources giving you the technical skills to develop real world applications Library of MATLAB code The book is accompanied by a well documented library of MATLAB functions and reproducible experiments

Communication Systems Principles Using MATLAB John W. Leis, 2018-10-16 Discover the basic telecommunications systems principles in an accessible learn by doing format *Communication Systems Principles Using MATLAB* covers a variety of systems principles in telecommunications in an accessible format without the need to master a large body of theory The text puts the focus on topics such as radio and wireless modulation reception and transmission wired networks and fiber optic communications The book also explores packet networks and TCP IP as well as digital source and channel coding and the fundamentals of data encryption Since MATLAB is widely used by telecommunications engineers it was chosen as the vehicle to demonstrate many of the basic ideas with code examples presented in every chapter The text addresses digital communications with coverage of packet switched networks Many fundamental concepts such as routing via shortest path are introduced with simple and concrete examples The treatment of advanced telecommunications topics extends to OFDM for wireless modulation and public key exchange algorithms for data encryption Throughout the book the author puts the emphasis on understanding rather than memorization The text also Includes many useful take home skills that can be honed while studying each aspect of telecommunications Offers a coding and experimentation approach with many real world examples provided Gives information on the underlying theory in order to better understand conceptual developments Suggests a valuable learn by doing approach to the topic Written for students of telecommunications engineering *Communication Systems Principles Using MATLAB* is the hands on resource for mastering the basic concepts of telecommunications in a learn by doing format

Digital Signal Processing and Applications with the C6713 and C6416 DSK Rulph Chassaing, 2004-12-20 This book is a tutorial on digital techniques for waveform generation digital filters and digital signal processing tools and techniques The typical chapter begins with some theoretical material followed by working examples and experiments using the TMS320C6713 based DSP Starter Kit DSK The C6713 DSK is TI's newest signal processor based on the C6x processor replacing the C6711 DSK

Digital Signal Compression William A. Pearlman, Amir Said, 2011-10-27 Provides clear and easily understandable coverage of the fundamental concepts and coding methods whilst retaining technical depth and rigor

Music Emotion Recognition Yi-Hsuan Yang, Homer H. Chen, 2011-02-22 Providing a complete review of existing work in music emotion developed in psychology and engineering Music Emotion Recognition explains how to account for the subjective nature of emotion perception in the development of automatic music emotion recognition MER systems Among the first publications dedicated to automatic MER it begins with a comprehensive introduction to the essential aspects of MER including background key techniques and applications This ground breaking reference examines emotion from a dimensional perspective It defines emotions in music as points in a 2D plane in terms of two of the most fundamental emotion dimensions according to psychologists valence and arousal The authors present a computational framework that generalizes emotion recognition from the categorical domain to real valued 2D space They also introduce novel emotion based music retrieval and organization methods Describe a ranking base emotion annotation and model training method Present methods that integrate information extracted from lyrics chord sequence and genre metadata for improved accuracy Consider an emotion based music retrieval system that is particularly useful for mobile devices The book details techniques for addressing the issues related to the ambiguity and granularity of emotion description heavy cognitive load of emotion annotation subjectivity of emotion perception and the semantic gap between low level audio signal and high level emotion perception Complete with more than 360 useful references 12 example MATLAB codes and a listing of key abbreviations and acronyms this cutting edge guide supplies the technical understanding and tools needed to develop your own automatic MER system based on the automatic recognition model

Speech and Audio Processing Ian Vince McLoughlin, 2016-07-21 With this comprehensive and accessible introduction to the field you will gain all the skills and knowledge needed to work with current and future audio speech and hearing processing technologies Topics covered include mobile telephony human computer interfacing through speech medical applications of speech and hearing technology electronic music audio compression and reproduction big data audio systems and the analysis of sounds in the environment All of this is supported by numerous practical illustrations exercises and hands on MATLAB examples on topics as diverse as psychoacoustics including some auditory illusions voice changers speech compression signal analysis and visualisation stereo processing low frequency ultrasonic scanning and machine learning techniques for big data With its pragmatic and application driven focus and concise explanations this is an essential resource for anyone who wants to rapidly gain a practical understanding of speech and audio

processing and technology **Natural Computing for Unsupervised Learning** Xiangtao Li, Ka-Chun Wong, 2018-10-31
This book highlights recent research advances in unsupervised learning using natural computing techniques such as artificial neural networks evolutionary algorithms swarm intelligence artificial immune systems artificial life quantum computing DNA computing and others The book also includes information on the use of natural computing techniques for unsupervised learning tasks It features several trending topics such as big data scalability wireless network analysis engineering optimization social media and complex network analytics It shows how these applications have triggered a number of new natural computing techniques to improve the performance of unsupervised learning methods With this book the readers can easily capture new advances in this area with systematic understanding of the scope in depth Readers can rapidly explore new methods and new applications at the junction between natural computing and unsupervised learning Includes advances on unsupervised learning using natural computing techniques Reports on topics in emerging areas such as evolutionary multi objective unsupervised learning Features natural computing techniques such as evolutionary multi objective algorithms and many objective swarm intelligence algorithms **Linear Algebra, Signal Processing, and Wavelets - A Unified Approach** Øyvind Ryan, 2019-03-05 This book offers a user friendly hands on and systematic introduction to applied and computational harmonic analysis to Fourier analysis signal processing and wavelets and to their interplay and applications The approach is novel and the book can be used in undergraduate courses for example following a first course in linear algebra but is also suitable for use in graduate level courses The book will benefit anyone with a basic background in linear algebra It defines fundamental concepts in signal processing and wavelet theory assuming only a familiarity with elementary linear algebra No background in signal processing is needed Additionally the book demonstrates in detail why linear algebra is often the best way to go Those with only a signal processing background are also introduced to the world of linear algebra although a full course is recommended The book comes in two versions one based on MATLAB and one on Python demonstrating the feasibility and applications of both approaches Most of the MATLAB code is available interactively The applications mainly involve sound and images The book also includes a rich set of exercises many of which are of a computational nature **Conference Record of the Thirty-Seventh Asilomar Conference on Signals, Systems & Computers, November 9-12, 2003, Pacific Grove, California** Michael B. Matthews, 2003

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