Department of Electrical Engineering and Computer Science

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EECE 333 Fundamentals of Signals and Systems

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Final Project Abstract

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Objective: Investigation of DFT and FFT Algorithm for Signal Processing using MATLAB

Abstract:

The Discrete Fourier Transform (DFT) is a fundamental digital signal processing (DSP) technique widely used to analyze the frequency content of discrete-time signals. Due to the high computational cost of directly evaluating the DFT for large datasets, the Fast Fourier Transform (FFT) algorithm is commonly used to compute the DFT efficiently. This project investigates the mathematical properties of the DFT and explores how the FFT algorithm enables practical computation of the DFT in signal processing applications. MATLAB will serve as the primary platform for implementing algorithms, visualizing results, and applying these techniques to real-world signals in audio processing, image processing, and data analysis.

Introduction:

The main objective of this project is to explore the structure and behavior of the DFT, both analytically and computationally, and to study the FFT as a fast algorithm for its efficient computation. MATLAB will be used to generate signals, compute their DFTs, and apply FFT-based methods in different signal-processing domains.

Methodology:

The project will proceed through the following steps:

1. **Theory and Fundamentals:**
   Study the mathematical basis of the DFT and its properties such as linearity, periodicity, and symmetry.
2. **MATLAB Implementation:**
   Use MATLAB to generate various discrete signals and compute their DFT. Analyze how these transforms represent the frequency components of the signals.
3. **FFT Algorithm:**
   Implement or utilize the FFT algorithm in MATLAB to compute DFTs efficiently. Study how the FFT leverages symmetries in the DFT to reduce computation time.
4. **Application Areas:**
   - **Audio Processing:** Use FFT to analyze audio signals and extract frequency content.
   - **Image Processing:** Apply 2D FFT for frequency filtering of images.

- **Data Analysis:** Use spectral analysis techniques on time-series data to reveal underlying patterns.

Deliverables:

1. **MATLAB Code:**
   - Scripts for signal generation and DFT computation
   - FFT-based DFT implementation
   - Case studies in signal analysis
2. **Final Report:**
   - Explanation of DFT and FFT theory
   - Analysis of DFT properties and structure
   - Application of DFT/FFT in various signal processing scenarios

Conclusion:

This project will provide a deeper understanding of the Discrete Fourier Transform and how the FFT algorithm enables its practical application in modern signal processing. We aim to gain theoretical insight and practical skills relevant to audio, image, and data analysis using MATLAB by analyzing and processing real-world signals.