Practical Programming Tutorial of Two Dimensional Discrete Fourier Transform (DFT) Based on MATLAB® for Both 2D Signals and Images

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Abstract

The two-dimensional (2-D) Discrete Fourier Transform (DFT) and Inverse Discrete Fourier Transform (IDFT) represent mathematical models for 2-D signals (such as digital images and digital videos) in the frequency and spatial domains, respectively. Digital Image Processing (DIP) has been implemented globally over the past two decades. Thus, 2-D Discrete Fourier Transform (2-D DFT) is essential in terms of representing mathematical models and analyzing 2-D signals and systems. In light of its importance, this article presents a tutorial for 2-D DFT utilizing MATLAB® for both 2-D signals and images. The analysis of the discrete signals are based on both spatial and frequency domains. The theoretical basic of 2-D DFT is presented, followed by a tutorial based on synthetic and real examples using MATLAB®.

Keywords: 2-D Discrete Fourier Transform (DFT), 2-D Inverse Discrete Fourier Transform (IDFT), Digital Image Processing (DIP).
Bibliography

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Introduction

One-dimensional DFT (1-D DFT) and 2-D DFT have a great deal of similarity at the conceptual level. However, there are also considerable differences between these two types of signals, especially in terms of the amount of data involved in typical applications. Consequently, this impacts the computational efficiency of the signal processing algorithm for 2-D signals and images.

However, 2-D DFT and 2-D IDFT are essential approaches for converting between the spatial and frequency domains (and vice versa) of 2-D signal processing in many applications such as:

- Digital Image Processing (DIP).
- Image Enhancement.
- Image Smoothing such as Idea Lowpass Filter, Butterworth Lowpass Filter, and Gaussian Lowpass Filter.