MATLAB Manual for Fundamentals of Spherical Array Processing

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1 Introduction

The book Fundamentals of Spherical Array Processing provides fundamental theory and methods for processing of signals from spherical microphone arrays. This manual aims to provide a MATLAB support to the theory and methods presented in the book. Like the book, the nature of the manual is tutorial, with the MATLAB code and embedded descriptions aiming to provide the reader with the understanding of how the methods may be coded into MATLAB, also providing a starting point to develop own applications. All MATLAB functions that have been used to generate the examples and produce the figures in the book are provided with this manual.

2 Overview

The files are organized in three directories. `fig` includes all files used to generate the book figures, arranged into chapters; `plot` directory includes several functions used for plotting; and `math` directory includes all mathematical functions. Table 1 details all figure files, Table 2 details all plotting functions, and Table 3 details all mathematical functions.

3 MATLAB code

All files are zipped into `SphericalArrayProcessingManual.zip`.

MATLAB files	Figures (and table)
fig/ch1/fig_example_function.m	1.2, 1.3, 1.4
fig/ch1/fig_sh_balloon.m	1.5, 1.6, 1.7, 1.8
fig/ch1/fig_xyz_coordinates.m	1.5, 1.6, 1.7, 1.8, 1.15
fig/ch1/fig_spherical_grid.m	1.9
fig/ch1/fig_Pnm.m	1.10
fig/ch1/fig_Pn.m	1.11
fig/ch1/fig_sinc_and_cap.m	1.12, 1.13, 1.14
fig/ch1/fig_rotation.m	1.15
fig/ch2/fig_radial_functions_1.m	2.1, 2.2, 2.3, 2.4, 2.9
fig/ch2/fig_planewave_freefield_xy.m	2.5
fig/ch2/fig_radial_functions_2.m	2.6, 2.10
fig/ch2/fig_planewave_freefield_sphere.m	2.7
fig/ch2/fig_planewave_rigid_xy.m	2.11
fig/ch2/fig_planewave_rigid_sphere.m	2.12
fig/ch3/fig_sampling_schemes.m	3.1, 3.2, 3.4, 3.5
fig/ch3/fig_platonic_solids.m	3.3
fig/ch3/fig_aliasing_matrix.m	3.6
fig/ch3/fig_aliasing_example.m	3.7, 3.8
fig/ch4/fig_array_design_examples.m	4.1, 4.3
fig/ch4/fig_array_radial_functions.m	4.2, 4.5, 4.6
fig/ch4/fig_cardioid_directivity.m	4.4
fig/ch4/fig_array_condition_numbers.m	4.7, 4.8, 4.9, 4.10, 4.11
fig/ch5/fig_onmi_and_directional.m	5.4
fig/ch5/fig_WNG_example.m	5.5
fig/ch5/fig_beamforming_example.m	5.6, 5.7, 5.8
fig/ch6/fig_hypercardioid_beampatterns.m	6.1
fig/ch6/fig_WNG_open_and_rigid.m	6.2
fig/ch6/fig_WNG_and_DI_example.m	6.3
fig/ch6/fig_supercardioid_beampatterns.m	6.4
fig/ch6/fig_Chebyshev_polynomial.m	6.5, 6.6
fig/ch6/fig_DolphChebyshev_beampatterns.m	6.7, 6.8
fig/ch6/fig_multiple_objective_beampatterns.m	6.9, 6,10
fig/ch6/fig_mixed_objectives_designs.m	Table 6.2
fig/ch7/fig_MVDR_beampatterns_1.m	7.1, 7.2
fig/ch7/fig_MVDR_beampatterns_2.m	7.3, 7.4
fig/ch7/fig_LCMV_beampatterns_1.m	7.5, 7.6, 7.7
fig/ch7/fig_LCMV_beampatterns_2.m	7.8, 7.9, 7.10, 7.11

Table 1: MATLAB files and figures generated (with one table), separated into chapters.

MATLAB files	Descriptions
plot/plot_aliasing.m	Plots the aliasing matrix.
plot/plot_balloon.m	Generates a balloon plot of a function.
plot/plot_contour.m	Generates a contour plot of a function.
plot/plot_sampling.m	Generates balloon and contour plots of a sampling scheme.
plot/plot_sphere.m	Generates a plot of a function on a sphere.

Table 2: MATLAB plot files and their short description.

MATLAB files	Descriptions
math/besselhs.m	Spherical Hankel function of the first kind.
math/besselhsd.m	First derivative of the spherical Hankel function of the first kind.
math/besseljs.m	Spherical Bessel function of the first kind.
math/besseljsd.m	First derivative of the spherical Bessel function of the first kind.
math/Bn.m	Radial functions for a plane wave around a sphere.
math/BnMat.m	Radial functions for a plane wave around a sphere, in a matrix form.
math/c2s.m	Converts spherical to Cartesian coordinates.
math/chebyshev_coefficients.m	Coefficients of Chebyshev polynomials.
math/derivative_ph.m	Derivative along ϕ of a spherical harmonics steering vector.
math/derivative_th.m	Derivative along θ of a spherical harmonics steering vector.
math/DolphPACT.m	Matrix product **PACT** for the design of a Dolph-Chebyshev beam pattern.
math/equiangle_sampling.m	Equal-angle distribution of samples on a sphere.
math/gaussian_sampling.m	Gaussian distribution of samples on a sphere.
math/legendre_coefficients.m	Legendre polynomial coefficients.
math/platonic_solid.m	Platonic solids, by Kevin Moerman.
math/s2c.m	Converts spherical to Cartesian coordinates.
math/sh2.m	Spherical harmonics matrix.
math/uniform_sampling.m	Uniform distribution of samples on a sphere.
math/wignerD.m	Wigner-D matrix.

Table 3: MATLAB math files, in alphabetical order, and their short description.