**For this section we used contourlet toolbox V2** (at the end of this document, the content of this toolbox described)

**In this document, the main files related to watermarking in contourlet domain using 2D-GARCH models are introduced**

1. **Watermarking in contourlet domain**
   1. **Insert watermark in contourlet domain:**

**Used in section 5-2-2 of book**

function [X,yy,wD,zD,s8]=watermark\_insert\_garch(X,wdr,pfilt,dfilt);

* Inputs:
  + X:input image
  + Wdr: watermark to document ratio
  + pfilt, dfilt: filters for contourlet transform
* Important Outputs:
* yy:watermarked image,
* wD: inserted watermark

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* 1. **watermark detector in a contourlet subband based on using 2D-GARCH model**

**Used in section 5-2-2 of book**

function H=detector\_garch\_2D(y,w);

* Inputs:
  + Y: contourlet subband
  + W:watermark
* Important Outputs:
* H : is 1 if watermark detect and 0 if watermark not detect

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* 1. **watermark detector in a contourlet subband based on using 2D-GARCH-GG model**

**used in section 5-4-1 of book**

watermark detector in a contourlet subband based on using 2D-GARCH-GG model

H=detector\_garch\_generalized\_Gaussian\_2D(y,w);

* Inputs:
  + Y: contourlet subband
  + W:watermark
* Important Outputs:
* H : is 1 if watermark detect and 0 if watermark not detect

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Auxiliary files

* **watermark detector in a wavelet subband based on using Gaussian distribution (for comparison)n**

function H=detector\_gaussian\_2D(y,w);

* Inputs:
  + Y: wavelet subband
  + W:watermark
* Important Outputs:
* H : is 1 if watermark detect and 0 if watermark not detect

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* **watermark detector in a wavelet subband based on using Generalized Gaussian distribution (for comparison)**

H=detector\_generalized\_Gaussian\_2D(y,w);

* Inputs:
  + Y: wavelet subband
  + W:watermark
* Important Outputs:
* H : is 1 if watermark detect and 0 if watermark not detect

**Note: Other files are related to different test reported in the book for example computing ROC and …**

**Contourlet toolbox files:**

%Contourlet Toolbox (Version 2.0)

%

%Demos

% DECDEMO Demonstrates contourlet decomposition and reconstruction

% NLADEMO Demo for contourlet nonlinear approximation.

% NLADEMO2 Nonlinear approximation demo using only the finest scale

% DENOISEDEMO Denoise demo

%

%Main functions: Contourlets pyramidal directional filter bank

% PDFBDEC Pyramidal Directional Filter Bank (or Contourlet) Decomposition

% PDFBREC Pyramid Directional Filterbank Reconstruction

%

%Retrieve filters by names

% PFILTERS Generate filters for the Laplacian pyramid

% DFILTERS Generate directional 2D filters

% LDFILTER Generate filter for the ladder structure

%

%Utility functions of the contourlet transform

% SHOWPDFB Show contourlet or PDFB coefficients.

% PDFB2VEC Convert the output of the PDFB into a vector form

% VEC2PDFB Convert the vector form to the output structure of the PDFB

% PDFB\_TR Retain the most significant coefficients at certain subbands

% PDFB\_NEST Estimate the noise standard deviation in the PDFB domain

%

%Laplacian pyramid

% LPDEC Laplacian Pyramid Decomposition

% LPDEC Laplacian Pyramid Reconstruction

%

%Wavelet filter bank

% WFB2DEC 2-D Wavelet Filter Bank Decomposition

% WFB2REC 2-D Wavelet Filter Bank Decomposition

%

%Directional filter bank

% DFBDEC Directional Filterbank Decomposition

% DFBREC Directional Filterbank Reconstruction

% DFBDEC\_L Directional Filterbank Decomposition using Ladder Structure

% DFBREC\_L Directional Filterbank Reconstruction using Ladder Structure

% DFBIMAGE Produce an image from the result subbands of DFB

%

%Two-channel 2D filter banks (used in the DFB)

% FBDEC Two-channel 2D Filterbank Decomposition

% FBDEC\_L Two-channel 2D Filterbank Decomposition using Ladder Structure

% FBREC Two-channel 2D Filterbank Reconstruction

% FBREC\_L Two-channel 2D Filterbank Reconstruction using Ladder Structure

%

%Multidimensional filtering (used in building block filter banks)

% SEFILTER2 2D seperable filtering with extension handling

% EFILTER2 2D Filtering with edge handling (via extension)

% EXTEND2 2D extension

%Multidimensional sampling (used in building block filter banks)

% PDOWN Parallelogram Downsampling

% PUP Parallelogram Upsampling

% QDOWN Quincunx Downsampling

% QUP Quincunx Upsampling

% QUPZ Quincunx Upsampling (with zero-pad and matrix extending)

% DUP Diagonal Upsampling

% RESAMP Resampling in 2D filterbank

% RESAMPZ Resampling of matrix

% RESAMPC Mex file used in RESAMP

%

%Polyphase decomposition (used in the ladder structure implementation)

% QPDEC Quincunx Polyphase Decomposition

% QPREC Quincunx Polyphase Reconstruction

% PPDEC Parallelogram Polyphase Decomposition

% PPREC Parallelogram Polyphase Reconstruction

%

%Support functions to avoid visual distortion (used in DFB)

% BACKSAMP Backsampling the subband images of the directional filter bank

% REBACKSAMP Re-backsampling the subband images of the DFB

%

%Support functions for generating filters

% FFILTERS Fan filters from diamond shape filters

% LD2QUIN Quincunx filters from the ladder network structure

% MCTRANS McClellan transformation

% MODULATE2 2D modulation

%

%Other support functions

% COMPUTESCALE Comupute display scale for PDFB coefficients

% SMTHBORDER Smooth the borders of a signal or image

% SNR Compute the signal-to-noise ratio