

The *owtrans2d* package

Managing 2-dimensional orthogonal wavelet transforms

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Part I

Documentation

Chapter 1

Using the 2d orthogonal wavelet transform (`owtrans2d`) package

1.1 loading the `&owtrans2d` package

As for any package, you must load the `owtrans2d` package for using 1d-wavelet transforms. This is done by the original startup file or directly by typing `package load owtrans2d` in the terminal.

1.2 The `&owtrans2` structure

1.2.1 Introduction

In LastWave, a 2d orthogonal wavelet transform is stored in a structure called a `owtrans2` structure and corresponds to the type `&owtrans2`. The resulting images as well as the original images are stored in a 2d array of images. The first index corresponds to the octave number and the second to the orientation. The image `[0,0]` corresponds to the analyzed image. The images `[oct,or]` corresponds to the result of the wavelet transform at octave `oct` (≥ 1) and with orientation `or`. The orientation `or` is one of 1,2 or 3. A 0 value corresponds to the projection on the smoothing space V_{oct} .

Let us note that the images `[0,1]`, `[0,2]`, \dots , `[0,9]` are not directly used by LastWave, they can be used as by the user as working images.

1.2.2 The main fields of `&owtrans2`

The main fields of the `owtrans2` structure are

- `noct` : the number of octaves used for the decomposition. An octave value of 1 means that the image is decomposed in 4 images (4 times smaller), an octave value of 2 means it is decomposed into 7 images (3 of them being 4 times smaller and 4 of them being 16 times smaller) and so on... Actually it decomposes the original image in $3noct+1$ images.
- `[oct,or]` : a 2d array of images as described in the previous section.

1.3 A simple example

We follow here the demo in the file `scripts/owtrans2/DemoOWtrans2d`. Loading the `owtrans2d` package creates 2 variables named `a2` and `b2` of type `&owtrans2`. It also creates 2 commands named `a2` and `b2` to set the current object respectively to `a2` or `b2`. This is useful in order to access the images in a simpler way. Indeed, in order to access the image [`<oct>`,`<or>`] of `a2`, one can either use the regular syntax

```
a2[<oct>,<or>]
```

or the abbreviated syntax

```
<oct><or>a2
```

or, in the case `a2` is the current object, the syntax

```
a2> <oct><or>
```

Let's work on `a2` :

```
(&owtrans2) a> a2
(&owtrans2) a2>
```

Since all the images we are going to work on are grey level images, we will set the current colormap to the the (256 levels) grey one :

```
(&owtrans2) a2> colormap current 'grey'
```

We want to perform the transformation on the *lenna* image which is in the directory `image/` of the original `scripts` directory. The original script directory is stored in the global variable `_scriptDir`. Thus

```
(&owtrans2) a2> iread 0 '$_scriptDir/image/lenna.char' -c
```

We will perform the wavelet transform using the `Daubechies_8` filter on 6 octaves :

```
(&owtrans2) a2> owt2f 'Daub8'
(&owtrans2) a2> owt2d 6
```

Then we can display the wavelet transform using the standard representation

```
(&owtrans2) a2> ow2disp
```

and then perform the reconstruction and store it in the “working” image 1 (i.e., `a2[0,1]`) and display it :

```
(&owtrans2) a2> owt2r 1  
(&owtrans2) a2> disp Reconstructed 1 -pos 310 50
```

The error between the reconstruction and the original image is displayed easily

```
(&owtrans2) a2> disp Error 1a2-0a2 -pos 570 50
```

and the min and max values along with the L2 norm of the error are obtained using the `istats` command

```
(&owtrans2) a2> istats print 1a2-0a2  
L2 norm : 0.01634945  
Mean : -4.7685928e-05  
Variance : 4.0787427e-09  
Skewness : -3.9920873e-14  
Kurtosis : 1.2782898e-17  
Minimum at 185x231 is -0.00028991699  
Maximum at 56x121 is 0.00012207031
```

1.4 Display and mouse interaction

To learn about display and mouse interaction, you should run the Demos of the `owtrans2d` package.

The script command `ow2disp` is described in the script file `scripts/owtrans2d/owtrans2d.pkg`. Trying to understand how it works is a very good programming exercise. It simply displays images using the standard representation of the 2d wavelet transform. As with the `disp` command, each image is displayed in a *View* (no `FramedView` is used) and you can use the mouse and the `z` key for performing zoom independantly on each image in the same way as you would do on an image displayed using the `disp` command.

Part II

Reference

Chapter 2

Package owtrans2d 2.1

Package allowing to perform 2d orthogonal wavelet decomposition/reconstruction.

*** Authors and Copyright : G.Davies, E.Bacry and J.Fraieu*

2.1 Defined types

2.1.1 Type `&owtrans2`

This type is the basic type for 2d orthogonal wavelet transforms.

- `&owtrans2 [oct,orient]`
it returns the image which corresponds to octave `<oct>` and orientation `<orient>`. The octave number `<oct>` ranges between `[1,noct]`. The orientation number `<orient>` is 1,2 or 3 (and 0 corresponds to the projection on `V_oct`). The image `[0,0]` corresponds to the analyzed image. The images `[0,1],[0,2],...,[0,9]` are working images that are not used by the wavelet transform algorithm.
- `&owtrans2.name [= <name>]`
Sets/Gets the name of a `owtrans2`
- `&owtrans2.noct [= <noct>]`
Gets the number of octave of a 2d orthogonal wavelet transform.
- `&owtrans2.wavelet [= <name>]`
Gets/Sets the analyzing wavelet used for the wavelet transform.

2.2 Commands related to the owtrans2d package

- `owt2d [<owtrans2>=objCur] <noct>`
Performs wavelet decomposition of the image (in 0) in `<owtrans2>` on `<noct>` octaves.
- `owt2f <waveletName>`
Sets the default wavelet that will be used for the next decomposition. It must be one among 'Haar', 'Daub4', 'Daub6', 'Daub8', 'Antonini', 'Villa', 'Adelson', 'Brislawn', 'Brislawn2', 'Villa1', 'Villa2', 'Villa3', 'Villa4', 'Villa5', 'Villa6', 'Odegard'

- **owt2r** [`<owtrans2>=objCur`] [`<image>=0`]

Performs wavelet reconstruction and stores the result in the `<image>` (default is original image).

2.3 Script Commands

- **ow2disp** (in file `LastWave_3_0/scripts/owtrans2d/owtrans2d.pkg`) [`<owtrans2>=objCur`] [`<smallestOctave>=1`]

This function displays an orthogonal 2d wavelet transform (i.e., a variable of type '&owtrans2') on a window. If no `<owtrans2>` is specified then the current object is used. By default, all the octaves of the decomposition are displayed. If `<smallestOctave>` is specified then it corresponds to the smallest octave being displayed. Let us note that you can use the mouse on each image of the display in order to perform zooms.

2.4 Demos

Here is a list of all the Demo files and for each of them all the corresponding Demo commands. To try a Demo command, you should first source the corresponding Demo file then run the command. (When sourcing the Demo file, LastWave tells you about all the commands included in this file).

The Demo files corresponding to this package are :

Demo file **DemoOWtrans2d**

- **DemoOWtrans2d** (in file `LastWave_3_0/scripts/owtrans2d/DemoOWtrans2d`)

Displays the original 'lenna' image its orthogonale wavelet decomposition and its reconstruction

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