Examples

If you want to insert a 2D (M x N) wave, plane0, into plane number 0 of an (M x N x 3) wave, rgbWave:

```
ImageTransform /P=0/D=plane0 setPlane rgbWave
```

If your source wave is 100 rows by 100 columns and you want to create a montage of this image use:

```
ImageTransform /W/N={200,200} padImage srcWaveName
```

Hue and Saturation Segmentation Example

```
Function hueSatSegment(hslW,lowH,highH,lowS,highS)
    Wave hslW
    Variable lowH,highH,lowS,highS

    Make/D/O/N=(2,3) conditionW
    conditionW={{lowH,highH},{lowS,highS},{NaN,NaN}}
    ImageTransform/D=conditionW matchPlanes hslW
    KillWaves/Z conditionW
End
```

Voronoi Tesselation Example

```
Make/O/N=(33,3) ddd=gnoise(4)
ImageTransform voronoi ddd
Display ddd[][1] vs ddd[][0]
ModifyGraph mode=3,marker=19,msize=1,rgb=(0,0,65535)
AppendToGraph M_VoronoiEdges[][1] vs M_VoronoiEdges[][0]
SetAxis left -15,15
SetAxis bottom -5,10
```

See Also

Chapter III-11, **Image Processing**, for many examples. In particular see: **Color Transforms** on page III-352, **Handling Color** on page III-379, and **General Utilities: ImageTransform Operation** on page III-381. The **MatrixOp** operation.

References

Born, Max, and Emil Wolf, *Principles of Optics*, 7th ed., Cambridge University Press, 1999.

Details about the rgb2i123 transform:

Gevers, T., and A.W.M. Smeulders, Color Based Object Recognition, *Pattern Recognition*, *32*, 453-464, 1999.

ImageUnwrapPhase

ImageUnwrapPhase [*flags*][**qualityWave=*qWave*,**] **srcwave=*waveName***

The ImageUnwrapPhase operation unwraps the 2D phase in srcWave and stores the result in the wave M_UnwrappedPhase in the current data folder. srcWave must be a real valued wave of single or double precision. Phase is measured in cycles (units of 2π).

Parameters

qualityWave=*qWave*	Specifies a wave, *qWave*, containing numbers that rate the quality of the phase stored in the pixels. *qWave* is 2D wave of the same dimensions as srcWave that can be any real data type and values can have an arbitrary scale. If used with /M=1 the quality values determine the order of phase unwrapping subject to branch cuts, with higher quality unwrapped first. If used with /M=2 the unwrapping is guided by the quality values only. This wave must not contain any NaNs or INFs.
srcwave=*waveName*	Specifies a real-valued SP or DP wave that may contain NaNs or INFs but is otherwise assumed to contain the phase modulo 1.

Flags

/E	Eliminate dipoles. Only applies to Goldstein's method (/M=1). Dipoles are a pair of a positive and negative residues that are side by side. They are eliminated from the unwrapping process by replacing them with a branch cut. The variable V_numResidues contains the number of residues remaining after removal of the dipoles.

/L	Saves the lookup table(LUT) used in the analysis with /M=1. This information may be useful in analyzing your results. The LUT is saved as a 2D unsigned byte wave M_PhaseLUT in the current data folder. Each entry consists of 8-bit fields:

bit=0:	Positive residue.
bit=1:	Negative residue.
bit=2:	Branch cut.
bit=3:	Image boundary exclusion.

Other bits are reserved and subject to change. See **Setting Bit Parameters** on page IV-12 for details about bit settings.

/M=*method*	Determines the method for computing the unwrapped phase:

method =0:	Modified Itoh's algorithm, which assumes that there are no residues in the phase. The phase is unwrapped in a contiguous way subject only to the ROI or singularities in the data (e.g., NaNs or INFs). You will get wrong results for the unwrapped phase if you use this method and your data contains residues.
method=1:	Modified Goldstein's algorithm. Creates the variables V_numResidues and V_numRegions. Optional *qWave* can determine order of unwrapping around the branch cuts.
method=2:	Uses a quality map to decide the unwrapping path priority. The quality map is a 2D wave that has the same dimensions as the source wave but could have an arbitrary data type. The phase is unwrapped starting from the largest value in the quality map.

/MAX=*len*	Specifies the maximum length of a branch cut. Only applicable to Goldstein's method (/M=1). By default this is set to the largest of rows or columns.
/Q	Suppresses messages to the history.
/R=*roiWave*	Specifies a region of interest (ROI). The ROI is defined by a wave of type unsigned byte (/B/U) that has the same number of rows and columns as *waveName*. The ROI itself is defined by entries or pixels in the *roiWave* with value of 1. Pixels outside the ROI should be set to zero. The ROI does not have to be contiguous but it is best if you choose a convex ROI in order to make sure that any branch cuts computed by the algorithm lie completely inside the ROI domain.
/REST = *threshold*	Sets the threshold value for evaluating a residue. The residue is evaluated by the equivalent of a closed path integral. If the path integral value exceeds the threshold value, the top-left corner of the quad is taken to be a positive residue. If the path integral is less than -*threshold*, it is a negative residue.

Details

Phase unwrapping in two dimensions is difficult because the result of the operation needs to be such that any path integral over a closed contour will vanish. In many practical situations, certain points in the plane have the property that a path integral around them is not zero. These nonzero points are residues. We use the definition that when a counterclockwise path integral leads to a positive value the residue is called a positive residue.

ImageUnwrapPhase uses the modified Itoh's method by default. Phase is unwrapped with an offset equal to the first element that is allowed by the ROI starting at (0,0) and scanning by rows. If there are no residues or if you unwrap the phase using Itoh's algorithm, then the phase is unwrapped only subject to the optional ROI using a seed-fill type algorithm that unwraps by growing a region outward from the seed pixel. Each time that the region growing is terminated by boundaries (external or due to the ROI), the algorithm returns to the row scanning to find a new starting point.

If there are residues and you choose Goldstein's method, the residues are first mapped into a lookup table (LUT) and branch-cuts are determined between residues and boundaries. It is also possible to remove some residues (dipoles) using the /E flag. Phase is then unwrapped in regions bounded by branch cuts using a seed-fill type algorithm that does not cross branch cuts. With a quality wave, the algorithm follows the same seed-fill approach except that it gives priority to pixels with high quality level. The phase on the branch cuts themselves is subsequently calculated.