Wallis Normalization Image
Enhancement Tactical Support
System (TESS (3)) Documentation

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Abstract

The Wallis Normalization Image Enhancement (WNIE) software module is a general purpose digital processing function that normalizes the pixel values for a given input image. The process permits the user to accept default values or input the desired mean and standard deviation required for the output image. The function creates a new image that raises the contrast in low contrast regions and lowers the contrast in those sections that are too high. This allows the user to view the entire image with one enhancement that brings out the majority of features, whether they be sea surface temperature gradients in an infrared ocean image or sea ice features (floes, leads, etc.) in a visible or infrared polar image. The speed and flexibility of the wallis filter is a powerful tool the operator can implement to increase the image content readily extracted.

Acknowledgments

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FOR THE
WALLIS NORMALIZATION IMAGE ENHANCEMENT

1.0 SCOPE

1.1 Identification

The Computer Software Configuration Item (CSCI), identified as the Wallis Normalization Image Enhancement (WNIE) Version 1.0, is a software module targeted for implementation on the MASSCOMP to normalize a display image. The WNIE software will provide the analyst with enhanced means to visually locate sea surface temperature gradients and sea ice features.

1.2 CSCI Overview

WNIE, based on the Wallis normalization algorithm, performs a space variant contrast stretch to normalize a display image.

1.3 Document Overview

This Software Requirements Specification (SRS) establishes the requirements for the CSCI identified as the WNIE software.

2.0 APPLICABLE DOCUMENTS

The following document of the exact issue shown forms a part of this specification to the extent specified herein. In the event of conflict between the document referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.


3.0 ENGINEERING REQUIREMENTS

3.1 CSCI External Interface Requirements

The following items constitute the external menu interface required for the WNIE.

list - lists all menu options to the users terminal
init - initialize input parameters, desiredMean, desiredDev, window, maxGain, alpha, sampleInc, and lineInc, to default values
setp  -  allows the user to set input parameters, desiredMean, desiredDev, window, maxGain, alpha, sampleInc, and lineInc

run  -  enter the input and output file names and execute the Wallis Normalization algorithm

disp  -  display the input or output file

clr  -  clear the display screen

disp  -  end the program

3.2 CSCI Capability Requirements

The WNIE shall perform a space variant contrast stretch to normalize the input display image using the Wallis algorithm. The computational algorithm has the following form:

\[ X'(S,L) = \sqrt{\frac{DSVAR}{VAR+EPS}} \ast [X(S,L) - MEAN] + \alpha \ast \text{desiredMean} + (1-\alpha) \ast \text{MEAN} \]

where:

- \( S \) = Samples coordinate.
- \( L \) = Line coordinate.
- \( X'(S,L) \) = Normalized pixel intensity at coordinates \( S,L \).
- \( X(S,L) \) = Original pixel intensity at coordinates \( S,L \).
- \( \text{MEAN} \) = Local mean.
- \( \text{VAR} \) = Localized variance (localized standard deviation**2) (local neighborhood defined by WINDOW parameter).
- \( \text{desiredMean} \) = Desired mean.
- \( \text{DSVAR} \) = Desired variance (standard deviation**2).
- \( \text{EPS} \) = \( \frac{1}{\text{MAXGAIN}} \) - to restrict the maximum gain.
- \( \alpha \) = Factor to govern mean value shifting (between 0 and 1)
3.3 CSCI Internal Interfaces

Data Definitions

Input Image - 8 bit byte binary image file.

Input Parameters - User supplied input to control the normalization process.

Output Image - 8 bit binary byte image file.

Process Definitions

Wallis Transformation - creates a normalized output image by applying the Wallis Normalization algorithm to the input image.

3.4 CSCI Data Element Requirements

Input image (inImage) - ASCII character string, no default.

Output image (outImage) - ASCII character string, no default.

Desired mean (desiredMean) - Real, default = 128.0, 0.0 ≤ desiredMean ≤ 255.0.

Desired deviation (desiredDev) - Real, default = 76.8, 1.0 ≤ desiredDev ≤ 255.0

Window (window) - Integer, default = 41, window > 3.

Maximum gain (maxGain) - Real, default = 6.0, 0.0 ≤ maxGain ≤ 255.0.

Alpha (alpha) - Real, default = 0.8, 0.0 ≤ alpha.

Sample Increment (sampleInc) - Integer, default = 3, sampleInc ≥ 1.
Line Increment (lineInc) - Integer, default = 3, lineInc > 1.

3.5 Adaptation Requirements
Not applicable.

3.6 Sizing And Timing Requirements
WNIE will normalize a byte file in two minutes or less when using the default input values.

3.7 Safety Requirements
Not applicable.

3.8 Security Requirements
Not applicable.

3.9 Design Constraints
Not applicable.

3.10 Software Quality Factors
Not applicable.

3.11 Human Performance
The values for the samples (x) direction increment and the line (y) direction increment must be selected with care. A large increment value for either direction will allow the WNIE 1.0 to run faster, but with less accurate results. A small increment value for either direction will produce more accurate results, but the time to run the WNIE 1.0 will increase tremendously. The suggested increment for the x and y direction is three (3).

3.12 Requirements Traceability
Not applicable.

4.0 QUALIFICATION REQUIREMENTS
Not applicable.

5.0 PREPARATION FOR DELIVERY
Not applicable.
6.0 NOTES

Abbreviations and Acronyms:

CSCI - Computer Software Configuration Item
SRS - Software Requirements Specification
WNIE - Wallis Normalization Image Enhancement
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SOFTWARE DESIGN DOCUMENT
FOR THE
WALLIS NORMALIZATION IMAGE ENHANCEMENT

1.0 SCOPE

1.1 Identification

The Computer Software Configuration Item (CSCI), identified as the Wallis Normalization Image Enhancement (WNIE) Version 1.0, is a software module targeted for implementation on the MASSCOMP to normalize a display image. High contrast areas are toned down while low contrast regions are brightened by redistributing the pixel count value histogram. The WNIE software provides the analyst with a means to enhance sea surface temperature gradients and sea ice features across the entire image, even when illumination or temperatures change markedly across the sensor swath.

1.2 System Overview

WNIE, based on the Wallis Normalization algorithm, performs a space variant contrast stretch to normalize a display image.

1.3 Document Overview

This Software Design Document (SDD) describes the software design details of the WNIE software.

2.0 REFERENCED DOCUMENTS


3.0 PRELIMINARY DESIGN

3.1 CSCI Overview

WNIE will normalize a display image by using the Wallis Normalization algorithm to perform a space variant contrast stretch on the input image. This image enhancement provides the analyst with a means to enhance sea surface temperature gradients and sea ice features.

The following items constitute the external menu interface required for the WNIE software:

- list - lists all program options to the user's terminal
- init - initialize input parameters, desiredMean


desiredDev, window, maxGain, alpha, sampleInc, and lineInc, to default values

setp - allows the user to set input the parameters desired\text{mean}, desiredDev, window, maxGain, alpha, sampleInc, and lineInc

run - enter the input and output image file names and execute the Wallis Normalization algorithm

disp - display the input or output file

clr - clear the display screen

der - end the program

3.1.1  CSCI Architecture

The WNIE is composed of two Computer Software Components (CSCs), WALLIS and DNORM. WALLIS is the interface CSC. WALLIS will receive and validate input, open the input and output images, calculate offsets, call DNORM, and close the input and output files. DNORM will read the input image, normalize the input image using the Wallis algorithm, and write the output image.

The following items constitute the WALLIS to DNORM interface:

Input image (inImage) - Source image to be normalized.

Output image (outImage) - Destination image (normalized).

Desired mean (desiredMean) - Desired mean.

Desired deviation (desiredDev) - Desired standard deviation.

Window (window) - Size of the square data window for computation of the local standard deviation (VAR) and local mean (MEAN). Window must be an odd integer larger than three.

Maximum gain (maxGain) - Maximum gain.

Alpha (alpha) - Factor to govern mean value shifting.

Sample Increment (sampleInc) - Increment in the samples (x) direction for the calculation of the local statistics.
Line Increment (lineInc) - Increment in the line (y) direction for the calculation of the local statistics.

Number Samples (numSamples) - The number of samples in the image in the horizontal dimension.

Number lines (numLines) - The number of lines in the image in the vertical dimension.

Number bands (numBands) - The number of spectral bands.

Offsets (offsets) - offsets to gain, variance, mean, bias.

3.1.2 System States And Modes

Not Applicable

3.1.3 Memory And Processing Time Allocation

Not Applicable

3.2 CSCI Design Description

3.2.1 Wallis (WALLIS)

WALLIS receives the following data items, which compose the external menu interface of WNIE software.

- list - lists all menu options to the user's terminal
- init - initialize input parameters, desiredMean, desiredDev, window, maxGain, alpha, sampleInc, and lineInc, to default values
- setp - allows the user to set input parameters, desiredMean, desiredDev, window, maxGain, alpha, sampleInc, and lineInc
- run - enter the input and output file names and execute the Wallis Normalization algorithm
- disp - display the input or output file
- clr - clear the display screen
- end - end the program

WALLIS is executed from the command line with the data items of the external interface. WALLIS validates input items, opens the input and output image files, and calls DNORM with the data items of the internal interface (see Section 3.1.1). When DNORM returns, WALLIS closes the input and output image files and
exits. The structure flow for WALLIS is shown in Figure 1.

3.2.2 Normalization (DNORM)

DNORM normalizes the input image by performing the Wallis algorithm as described in Section 4.2.2.

DNORM is called from WALLIS with the data items of the internal interface (see Section 3.1.1).

DNORM divides the input image into WINDOW sized subsets, calculates the local mean and variance for each window, and calculates the bias and gain needed for each window to normalize the output image to the desired mean and variance. DNORM applies the bias and gain to each point in the input file and writes the result to the output file. The structure flow for DNORM is shown in Figure 2.

4.0 DETAILED DESIGN

4.1 Wallis (WALLIS)

The WALLIS module the interface and control functions for the WNIE software.

4.1.1 WALLIS Design Specification

WALLIS receives and validates the data items of the external interface, opens the input image file and output image files, initialize data, allocates memory, and calls DNORM. When DNORM returns, WALLIS closes the input image file and the output image file, and exits.

4.1.2 WALLIS Design

The following is the pseudo code for the WALLIS module of the WNIE software.

WALLIS

INPUT

INIMAGE - SOURCE IMAGE TO BE NORMALIZED
OUTIMAGE - DESTINATION IMAGE (NORMALIZED)
DESIREDMEAN - DESIRED MEAN
DESIREDDEV - DESIRED STANDARD DEVIATION
WINDOW - SIZE OF THE SQUARE DATA WINDOW FOR COMPUTATION OF THE LOCAL STANDARD DEVIATION (VAR) AND LOCAL MEAN (MEAN)
MAXGAIN - MAXIMUM GAIN
ALPHA - FACTOR TO GOVERN MEAN VALUE SHIFTING
SAMPLEINC - INCREMENT IN THE SAMPLES (X)
DIRECTION FOR THE CALCULATION OF THE LOCAL STATISTICS

LINEINC - INCREMENT IN THE LINE (Y)

COMMENT - WINDOW MUST BE AN ODD NUMBER GREATER THAN 3

VALIDATE WINDOW

OPEN INPUT IMAGE
READ Numsamples FROM INPUT IMAGE
READ NUMLINES FROM INPUT IMAGE
READ NUMBANDS FROM INPUT IMAGE

OPEN OUTPUT IMAGE

CALCULATE OFFSET (MEANOF, VAROFF, GAINOF, BIASOF)

CALL DNorm

INPUT
INIMAGE - SOURCE IMAGE TO BE NORMALIZED
OUTIMAGE - DESTINATION IMAGE (NORMALIZED)
DESIREDMEAN - DESIRED MEAN
DESIREDDEV - DESIRED STANDARD DEVIATION
WINDOW - SIZE OF THE SQUARE DATA WINDOW FOR COMPUTATION OF THE LOCAL STANDARD DEVIATION (VAR) AND LOCAL MEAN (MEAN)

MAXGAIN - MAXIMUM GAIN
ALPHA - FACTOR TO GOVERN MEAN VALUE SHIFTING
SAMPLEINC - INCREMENT IN THE SAMPLES (X) DIRECTION FOR THE CALCULATION OF THE LOCAL STATISTICS
LINEINC - INCREMENT IN THE LINE (Y) DIRECTION FOR THE CALCULATION OF THE LOCAL STATISTICS
NUMSAMPLES - THE NUMBER OF SAMPLES IN THE IMAGE IN THE HORIZONTAL DIMENSION
NUMLINES - THE NUMBER OF LINES IN THE IMAGE IN THE VERTICAL DIMENSION
NUMBANDS - THE NUMBER OF SPECTRAL BANDS
OFFSETS - OFFSETS TO GAIN, VARIANCE, MEAN, BIAS

CLOSE INPUT IMAGE
CLOSE OUTPUT IMAGE

END WALLIS
4.2 Normalization (DNORM)

The DNORM module performs the normalization function of the WNIE.

4.2.1 DNORM Design Specification

DNORM normalizes the input image by performing a space variant contrast stretch based on the Wallis Normalization algorithm. DNORM divides the input image into WINDOW sized subsets, calculates the local mean and variance for each window, and calculates the bias and gain needed for each window to normalize the output image to the desired mean and variance. DNORM applies the bias and gain to each point in the input file and writes the result to the output file.

4.2.2 DNORM Design

DNORM performs a space variant contrast stretch to normalize the input display image using the Wallis algorithm. The computational algorithm has the following form:

\[ X'(S,L) = \sqrt{\frac{DSVAR}{VAR+EPS}} \times [X(S,L)-MEAN] + \alpha \times \text{desiredMean} + (1-\alpha) \times \text{MEAN} \]

where:
- \( S \): Sample (x) coordinate.
- \( L \): Line (y) coordinate.
- \( X'(S,L) \): normalized pixel intensity at coordinates \( S,L \).
- \( X(S,L) \): original pixel intensity at coordinates \( S,L \).
- \( \text{MEAN} \): local mean.
- \( \text{VAR} \): localized variance (localized standard deviation**2 (local neighborhood defined by WINDOW parameter)).
- \( \text{desiredMean} \): desired mean.
- \( \text{DSVAR} \): desired variance (standard deviation**2).
- \( \text{MAXGAIN} \): Maximum allowable gain.
- \( \text{EPS} \): \((1/\text{MAXGAIN})\) - to restrict the maximum gain.
- \( \alpha \): factor to govern mean value shifting (between 0 and 1)

The following is the pseudo code for the DNORM module of the WNIE software:

```
DNORM
 INPUT
     INIMAGE  - SOURCE IMAGE TO BE NORMALIZED
     OUTIMAGE - DESTINATION IMAGE (NORMALIZED)
     DESIREDMEAN - DESIRED MEAN
```
DESIREDEV - DESIRED STANDARD DEVIATION
WINDOW - SIZE OF THE SQUARE DATA WINDOW FOR COMPUTATION OF THE LOCAL STANDARD DEVIATION (VAR) AND LOCAL MEAN (MEAN)
MAXGAIN - MAXIMUM GAIN
ALPHA - FACTOR TO GOVERN MEAN VALUE SHIFTING
SAMPLEINC - INCREMENT IN THE SAMPLES (X) DIRECTION FOR THE CALCULATION OF THE LOCAL STATISTICS
LINEINC - INCREMENT IN THE LINE (Y) DIRECTION FOR THE CALCULATION OF THE LOCAL STATISTICS
NUMSAMPLES - THE NUMBER OF SAMPLES IN THE IMAGE IN THE HORIZONTAL DIMENSION
NUMLINES - THE NUMBER OF LINES IN THE IMAGE IN THE VERTICAL DIMENSION
NUMBANDS - THE NUMBER OF SPECTRAL BANDS
OFFSETS - OFFSETS TO GAIN, VARIANCE, MEAN, BIAS

FOR EACH X DIRECTION WINDOW BEGIN
  FOR EVERY LINEINC LINE IN X WINDOW BEGIN
    READ X WINDOW FROM INPUT FILE
    FOR EACH Y DIRECTION WINDOW BEGIN
      FOR EVERY SAMPLEINC OF Y BEGIN
        CALCULATE LOCAL MEAN
        CALCULATE LOCAL VARIANCE
      END FOR EVERY SAMPLEINC OF Y
    END FOR EACH Y DIRECTION WINDOW
  END FOR EVERY LINEINC LINE IN X WINDOW

FOR EACH Y WINDOW BEGIN
  CALCULATE GAIN FROM LOCAL VARIANCE
  CALCULATE BIAS FROM LOCAL MEAN
END FOR EACH Y WINDOW

FOR EACH Y WINDOW BEGIN
  CALCULATE GAIN INTERPOLATION MATRIX
  CALCULATE BIAS INTERPOLATION MATRIX
END FOR EACH Y WINDOW

FOR EACH LINE ACROSS X WINDOW BEGIN
READ INPUT IMAGE BY NUMSAMPLES INCREMENTS

FOR EACH Y WINDOW
BEGIN
CALCULATE GAIN FOR WINDOW TO ACHIEVE DESIRED
DEVIATION
CALCULATE BIAS FOR WINDOW TO ACHIEVE DESIRED MEAN

FOR EACH INPUT POINT
BEGIN
CALCULATE NORMALIZED POINT VALUE \( x' = \text{GAIN} \times x + \text{BIAS} \)
END FOR EACH INPUT POINT
END FOR EACH Y WINDOW

WRITE NORMALIZED POINT VALUES TO OUTPUT IMAGE

END FOR EACH LINE ACROSS X WINDOW

END FOR EACH X DIRECTION WINDOW

5.0 CSCI DATA

Number Samples (numSamples) is the number of samples in the input image in the horizontal dimension. numSamples is an integer, calculated in WALLIS from the input image. numSamples is used in DNORM to traverse the input image.

Number lines (numLines) is the number of lines in the input image in the vertical dimension. numLines is an integer, calculated in WALLIS from the input image. numLines is used in DNORM to traverse the input image.

Number bands (numBands) is the number of spectral bands in the input image. numBands is an integer, calculated in WALLIS from the input image. numBands is used in DNORM to traverse the input image.

Offsets (offsets) are the offsets to the gain, variance, mean, and bias in the input image. offsets are integers, calculated in WALLIS from the input image. offsets are used in DNORM to find the gain, variance, mean, and bias of the input image.

6.0 CSCI DATA FILES

6.1 Data File To CSC/CSU Cross Reference

Input image - WALLIS, DNORM
Output image - WALLIS, DNORM

6.2 Input image (inImage)
inImage is the input image file. It is a 8-bit binary, random access file. inImage contains a single record that describes the nonnormalized image.

6.3 Output Image (outImage)

outImage is the output image file. It is a 8-bit binary, random access file. outImage contains a single record that describes the normalized image.

7.0 REQUIREMENTS TRACEABILITY

Not Applicable

8.0 NOTES

Abbreviations and Acronyms:

CSC - Computer Software Component
CSCI - Computer Software Configuration Item
CSU - Computer Software Unit
SDD - Software Design Document
SRS - Software Requirements Specification
WNIE - Wallis Normalization Image Enhancement

9.0 APPENDICES

Appendix A contains the flow charts for the WNIE software modules, WALLIS and DNORM.
Appendix A

WNIE Flow Charts
For each X direction window

Last X direction window?

No

Read input image

For each Y direction window

Last Y direction window?

Yes

Calculate local mean

Calculate local variance

For each Y direction window

Last Y direction window?

No

Calculate gain matrix

Calculate bias matrix
SOFTWARE TEST DESCRIPTION

For The

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SOFTWARE TEST DESCRIPTION
FOR THE
WALLIS NORMALIZATION IMAGE ENHANCEMENT

1.0 SCOPE

1.1 Identification

The Computer Software Configuration Item (CSCI), identified as
the Wallis Normalization Image Enhancement (WNIE) Version 1.0,
is a software module targeted for implementation on the MASSCOMP to
normalize a display image. The WNIE software provides the
analyst with a means to visually enhance sea surface temperature
gradients and sea ice features.

1.2 System Overview

WNIE Version 1.0, based on the Wallis normalization algorithm,
performs a space variant contrast stretch to normalize a display
image.

1.3 Document Overview

The purpose of this Software Test Description (STD) is to
provide a test case and the test procedure necessary to perform
formal qualification testing of the WNIE Version 1.0.

2.0 REFERENCED DOCUMENTS

"Software Requirement Specification (SRS) for the Wallis
Normalization Image Enhancement (WNIE)", Sverdrup Technology,

"Software Design Document (SDD) for the Wallis Normalization
Image Enhancement (WNIE)", Sverdrup Technology, Inc., September

3.0 FORMAL QUALIFICATION TEST PREPARATIONS

Not applicable.

4.0 FORMAL QUALIFICATION TEST DESCRIPTIONS

The WNIE Software Test (WST) will validate the input parameters
and produce a normalize output image from an input image. The
following section describes the WST using an input test image
containing ice and water.

4.1 Water And Ice Test Case (WAITC)

The WAITC will read an input image, iceimage.dat, consisting of
areas of ice and water, and normalize the image to produce an
output image, normimag.dat. In iceimage.dat, the ice areas are high brightness and contrast, and the water areas are low brightness and contrast. In normimag.dat, the brightness and contrast of the ice and water will be lowered and raised respectively, to provide a more viewable image.

4.1.1 Water And Ice Test Case Requirements Traceability

In WAITC, WNIE will perform a space variant contrast stretch to normalize the input image, iceimage.dat, using the Wallis Normalization algorithm.

4.1.2 Water And Ice Test Case Initialization

No initialization is needed for the WAITC.

4.1.3 Water And Ice Test Case Test Inputs

The following are the images and default parameter values to be used for WAITC.

- **Input image** = iceimage.dat - Source image to be normalized.
- **Output image** = normimag.dat - Destination image (normalized).
- **Desired mean** = 128.0 - Desired mean, 0.0 <= MEAN <= 255.0.
- **Desired deviation** = 76.8 - Desired standard deviation, 1.0 <= DEV <= 255.0.
- **Window** = 41 - Size of the square data window for computation of the local standard deviation (VAR) and local mean (MEAN). Window must be an odd INT and larger than three.
- **Maximum gain** = 6.0 - Maximum gain, 0.0 <= GAIN <= 255.0.
- **Alpha** = 0.8 - Factor to govern mean value shifting, 0.0 <= ALPHA.
- **Sample Increment** = 3 - Increment in the samples (x) direction for the calculation of the local statistics, 1 <= SAMPINC.
- **Line Increment** = 3 - Increment in the line (y) direction for the calculation of the local statistics, 1 <= LINEINC.
4.1.4 Water And Ice Test Case Expected Test Results

WAITC will produce a normalized image file named normimag.dat in the current directory.

4.1.5 Water And Ice Test Case Criteria For Evaluating Results

To evaluate the WAITC, the pixel values of the input image, iceimage.dat, and the output image, normimag.dat, must be examined. A section listing of the input image is contained in Appendix A, and a section listing of the expected output image is contained in Appendix B. The resulting output image generated by the test case WAITC should match the expected results in Appendix B.

4.1.6 Water And Ice Test Case Test Procedure

To execute WAITC, enter the following commands:

1. Invoke the program by entering the command "wallis".
2. Enter "init" to initialize program variables to the default values.
3. Enter "run" to execute the normalization.
4. Enter "iceimage.dat" as the input image.
5. Enter "normimag.dat" as the output image.
6. Enter "clr" to clear the graphic screen.
7. Enter "disp" to display a image.
8. Enter "normimag.dat" to display the output image.
9. Enter "clr end" to clear the graphic screen and end the program.

4.1.7 Water And Ice Test Case Assumptions and Constraints

It is assumed that this test will be performed on a MASSCOMP GA1000 running UNIX (RTU 4.0A or higher), using the supplied WNIE programs.
5.0 NOTES

Abbreviations and Acronyms:

CSCI - Computer Software Configuration Item
RTU - Real Time UNIX
SDD - Software Design Document
SRS - Software Requirements Specification
STD - Software Test Description
WAITC - Water And Ice Test Case
WNIE - Wallis Normalization Image Enhancement
WST - WNIE Software Test

6.0 APPENDICES

A sample of the input test image is contained in Appendix A. A sample of the output test image is contained in Appendix B.
Appendix A

Input Test Image
Input Test Image: iceimage.dat

Samples
248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263

<table>
<thead>
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<th>Lines</th>
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<th>250</th>
<th>251</th>
<th>252</th>
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<th>254</th>
<th>255</th>
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<th>262</th>
<th>263</th>
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Appendix B

Output Test Image
### Output Test Image: normimag.dat

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Abstract (Maximum 200 words).

The Wallis Normalization Image Enhancement (WNIE) software module is a general purpose digital processing function that normalizes the pixel values for a given input image. The process permits the user to accept default values or input the desired mean and standard deviation required for the output image. The function creates a new image that raises the contrast in low contrast regions and lowers the contrast in those sections that are too high. This allows the user to view the entire image with one enhancement that brings out the majority of features, whether they be sea surface temperature gradients in an infrared ocean image or sea ice features (floes, leads, etc.) in a visible or infrared polar image. The speed and flexibility of the Wallis filter is a powerful tool the operator can implement to increase the image content readily extracted.

Digital Image Analyses, Remote Sensing, Satellite Oceanography

Security Classification

Unclassified

Unclassified

Unclassified

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