RADAR Texture Algorithms

Created by: Nathan Jennings
nate@jenningsplanet.com
www.jenningsplanet.com

Updated on: 05.29.2010

Mean

$$Mean = \frac{\Sigma x_{ij}}{n}$$

Sum(X_{ij}) – the sum of the pixels within a given "window" (e.g. 3x3) size.
n – number of pixels within the "window" (i.e. 9 for a 3x3 window)

Computes Mean value of a moving window. This algorithm is more of a filter than a texture measure. The mean can be used in RADAR processing to "smooth" the speckle that is inherent in raw RADAR data. This algorithm was created for the author to learn and trouble shoot the other texture measures:

1. Variance
2. Skewness
3. Kurtosis

The mean value of the moving window is used in all of the texture algorithms listed. This alforithm simply computes the mean of the moving window and writes it out to an image.

Variance

$$Variance = \frac{\Sigma (x_{ij} - M)^2}{n - 1}$$

Sum(X_{ij} – M)^2 – sum of the squares of the difference between a pixel and the mean of a "window."
M – Mean from above
n – number of pixels within a window.

Computes Variance Statistical Measure how "variable" a distribution curve is.
A large variance indicates that pixels within a local neighborhood are different from one another. A small variance indicate that pixels are similar to one another and may have a normal distribution.

The resulting variance image can help in determining some land cover types or assit to "segment" the image into areas with distinct texture patterns.

Skewness

$$\text{Skewness} = \frac{\sum (X_{ij} - M)^3}{(n-1)(V)^{3/2}}$$

X_{ij} – pixel value
M – Mean (from above)
V – Variance (from above)
n – number of pixels in the “window”

Computes Skewness Statistical Measure how "shifted" a distribution curve is. A large positive skewness indicates a "shift" to the right of the mean (i.e. the right side of the distribution has a longer tail than the left side). A large negative value indicates a shift to the left of the mean (i.e. the left side of the distribution has a longer tail than the right). The resulting skewness values can be positive or negative.

From an image processing "texture" point of view large (positive or negative) skewness values indicates a trend in the local neighborhood of brightness values. A broad area of negative values can indicate that the original brightness values tend to be small, but similar. A broad area of positive values can indicate that the original brightness values tend to be larger, but similar. The resulting skewness image can help in determining some land cover types or assit to "segment" the image into areas with distinct texture patterns.

Kurtosis

$$Kurtosis = \frac{\Sigma(x_{ij} - M)^4}{(n-1)(V)^2}$$

X_{ij} – pixel value
M – Mean (from above)
V – Variance (from above)
n – number of pixels in the “window”

Computes Kurtosis Statistical Measure how "peaked" or "flat" a distribution curve is. A high peak about the mean that falls off rapidly and has "heavy" tails indicate high kurtosis.

From an image processing "texture" point of view large kurtosis values indicates that many pixel values are near the mean within a local neighborhood (e.g. 3x3, 5x5, 7x7 area) and a smaller number of pixels are further away from the mean (i.e. are towards the tails of the distribution curve). One can say that most of the pixels in a local area are "similar" to one another, but do have some pixels that are very different. The resulting kurtosis image can help in determining some land cover types or assit to "segment" the image into areas with distinct texture patterns.

The algorithm functions be be found here:

Work Cited

Iron, J. R., and G. W. Petersen. 1981. Texture Transforms of Remote Sensing Data. Remote Sensing of Environment 11:359-370.