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Studying the Properties of Water Plans in Satellite Images by Adopting Curvelet Transformation

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ABSTRACT

Features extraction and Texture analysis are viewed as significant activities in image processing field for different PC applications. In this paper a proposed method for analyzing and extracting the features of water plans images based on Curvelet transform (by decomposing the image into its components then adopting the segmentation algorithms on that components), which offers precisely the edges because it deals with the winding information in all directions. Apply segmentation techniques to get information in region of interest, as it is fragmented or split the image into several sections. Studying the features of texture of water plans in satellite images of northern Mosul (Mosul dam).

Proposed algorithm segmentation need been used to extricate area for premium (water plans) from. images, which contain limitation accuracy for edges, to be studied. The algorithm produces a set of segments, which are stored in the cells array, for extracting features of the textures using a co-occurrence matrix .

The texture features of the image, based on the proposed approach, such as Contrast, Correlation, Energy and Homogeneity, gave an accurate representation of texture class.

Introduction

Remote sensing images can be used in the several applications. The main utilization of remotely detected information is to make an order diagram of explicit or important highlights or classifications of land spread sorts in a scene [1].

It is considered, clearly defined is one of the main components of each scene, which plays an important role in the spatial distribution of the flow of surface water and determine the external processes (erosion, accumulation and corrosion etc.). Terrain information is necessary for modeling and understanding many physical processes [2].

Every pixel of image data detected from a separation speaks to a model in a specific spot of the planet. These images have an enormous number of purposes that contain meteorology, mapping and military insight. Satellite pictures can be one of the accompanying: water vapor, infrared and unmistakable light as appeared in Figure (1). image is the most straightforward approach to acquire geographic data. [3]

Interpretation and understanding of satellite symbolism is a technique for acquiring data about objects and the scene. It is a particular procedure of considering the geographical land reality dependent on the recognition, distinguishing proof and spatial limitation of individual items and territory shapes caught in elevated photos and satellite picture records. Translating the picture means decoding its multifaceted substance from the perspective of the reason which the over viewed learning serves [5].

The information that we are searching for in the pictures are encoded in different shades and surfaces. The translation of computerized images is essentially conceivable in two different ways, more often than not alluded to as visual elucidation and PC understanding. The user is available in both sub-forms yet in every one they have an alternate assignment. Visual elucidation is a less controllable procedure, in which there are numerous variables. [6]

Image1 (Mosul Dam)

Image2 (Tanzanian capital) [4]

Figure1: Satellite Image

Related Work

In (2019), Ahmed .S and others, was used curvelet transform to disassembled a traffic signs images and get coefficients.[7],in (2017), Khalil I. Alsaif and Esraa Hussein,was used curvelete Transform to detected kidney stones.[8] In (2013) A. Djimeli, D. Tchiotsop et.al was concerned with refine edge model dependent on Curvelet coefficients investigation. Results demonstrate that when the decomposition scale increases, their method brings out details on edges.[9] In (2013) Yan Zhang n, TaoLi et.al presented a way to deal with analysis and division of tire laser stereography image by joining curevelet transform and Canny edge identification to distinguish deserts in tire surface. So this technique would bring about a remade image progressively advantageous for edge detection and the time multifaceted nature is decreased.[10]

In (2010) a researcher was used curvelet transform to estimate the optical flow and founded it much better than most other methods in that area.[11]

Curvelet Transform (CT):

The curvelet transform is a multiscale directional tansform, which permits a practically ideal non versatile scanty portrayal of items with edges. It has produced expanding enthusiasm for the network of connected arithmetic and sign handling over the previous years. [12]

The curvelet transform has two noteworthy ages. Original utilize an unpredictable advances which incorporate the ridgelet transform of radon transform of a image. Second era disregards the utilization of ridgelet transform, the reiteration decreased which prompts expanded speed. [13]

The work all through in two measurements, for example with spatial variable x, with a frequency domain variable, and with r and polar coordinates in the frequency domain. Begin with a couple of windows W(r) and V (t), which we will call the "radial window" and "angular window", separately. These are smooth, nonnegative and genuine esteemed, with W taking positive real arguments and supported on r∈(1/2,2) and V taking real contentions and bolstered on t∈[-1,1]. These windows will consistently comply with the tolerability conditions as in equations (1_a) and (1_b):

$$\sum_{j=\infty}^{\infty} w^2(2^j r) = 1\,, \qquad r \in \left(\frac{3}{4},\frac{3}{2}\right) \ldots (1_a)$$

$$\sum_{j=\infty}^{\infty} V^2(t-1) = 1\,, \qquad t \in \left(-\frac{1}{2},\frac{1}{2}\right) \ldots (1_b)$$

Then, for every $j \geq j_0$, introducing the frequency window U_j defined in the Fourier domain by

$$U_j(r,\theta) = 2^{\frac{3j}{4}} W(2^{-j}r) V\left(\frac{2\lfloor j/2 \rfloor \theta}{2\pi}\right) \ldots (2)$$

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where $\lfloor j/2 \rfloor$ is the integer part of j/2. Thus the boost of U_j is a polar "wedge" delimit by the support of W and V, the radial and angular windows, applied with scale-dependent window widths in each direction. To acquire real-valued curvelets, work with the symmetrized version namely,

$$U_j(r,\theta) + U_j(r,\theta+\pi)$$

Delimit the waveform $\varphi_j(x)$ by all means of its Fourier transform. is a "mother" curvelet in the sense that every curvelets at scale 2^{-j} are get by rotations and translations of φ_j .

The equispaced sequence of rotation angles $\theta_t = 2\pi.2^{\lfloor j/2 \rfloor}.l$, with $l = 0,1,\ldots$ such that $0 \leq \theta_t < 2\pi$,and the sequence of translation parameters $k = (k1,k2) \in z^2$. With these notations, defining curvelets (as function of $x = (x1,x2)$) at scale 2^{-j}, orientation θ_t and position $x_k^{(j,l)} = R_{\theta_t}^{-1}\left(k_1.2^{-j}, k_2.2^{-\frac{j}{2}}\right)$ by

$$\varphi_{j,l,k}(x) = \varphi_j\left(R_{\theta_l}(x - x_k^{(j,l)})\right) \qquad \ldots.(3)$$

where R_θ is the rotation by θ radians and R_θ^{-1} its inverse (also its transpose).

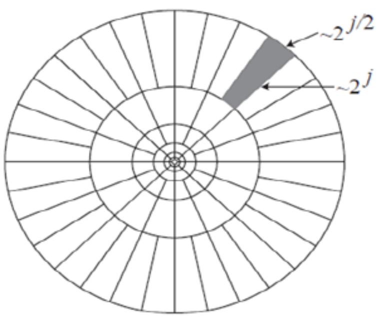

Figure 2: Curvelet tiling of space and frequency [14]

Curvelet transform is another augmentation of wavelet transform which plans to manage fascinating wonders happening along curved edges in 2D images[15]. It is a high-dimensional speculation of the wavelet transform intended to depict images at various scales and various directions (angles). It is seen as a multiscale pyramid with casing components ordered by area, scale, and direction parameters with needle-formed components at fine scales. Curvelets have time-frequency limitation properties of wavelets yet additionally demonstrates a high level of directionality and anisotropy, and its singularities can be all around approximated with not very many coefficients.[16]

Gray Level Co-occurrence Matrix (GLCM)

GLCM is the applied mathematics techniques of analyzing the textures that contain the spatial relationship between the pixels.

GLCM is made from a gray-scale image. The GLCM involve information about how regularly a pixel with gray-level value i happens either on a level horizontally, vertically, or diagonally to adjoining pixels with the value j. Where i and j are the gray level values in an image.

The properties or highlights separated from standardized symmetrical GLCM are appeared in table(1)

Table (1) GLCM properties

properties	formula
'Contrast'	$\sum_{i,j} \lvert i-j \rvert^2 p(i,j)$
'Correlation'	$\sum_{i,j} \frac{(i-\mu i)(j-\mu j)p(i,j)}{\sigma_i \sigma_j}$
'Energy'	$\sum_{i,j} p(i,j)^2$
'Homogeneity'	$\sum_{i,j} \frac{p(i,j)}{1+\lvert i-j \rvert}$

Proposed Algorithm:

The essential thought of the proposed algorithm relies upon the way that the image has many unique attributes. These qualities vary from image to image depending on the color space of the object and the space of the tissue. In this paper the tissue properties obtained from the analysis of water plans images can be used to improve the performance of the classification and knowledge of the water parts in aerial images in future research.

In this research, an algorithm was proposed to extract the properties of the water plans. The algorithm included acquisition aerial images and then performing preliminary treatment by extracting certain parts of the images to be used in the research (These parts were 128×128, 256×256, 512×512), and then apply a linear low pass filter to whole parts in order to remove noise from them, then apply histogram equalization to redistribute the image points evenly within the range 0-256, Then image decomposition using Curvelet transform has been adopted due to its ability to handle the curves contained in the water plans images in order to facilitate the handling of the images, this transform decompose the image to its coefficients. Finally, the GLCM Matlab function was applied to extract the properties from the images (Contrast, Energy, Homogeneity, Correlation coefficient), These properties were stored in a database to be adopted and to get benefiting from it for future research. Figure (3) shows the block diagram of the proposed algorithm.

RESULTS AND DISCUSSION

In the trials, the proposed procedure has been executed to a set of water bodies in satellite images of 128×128, 256×256 and 512×512 sizes. The procedure has been implemented in MATLAB, to get the fast discrete curvelet coefficients.

The accompanying outcomes describe the proposed algorithm for two real of water bodies images:

1. Table(2) indicates estimations of Gray Level Co-Occurrence matrixes (GLCM), the measurable features for contrast, correlation, energy and homogeneity were determined from enhancement water bodies images after applying histogram equalization operations with different sizes of segmented images. Results represent Properties for Image 1 and image 2 : Contrast, Correlation, Energy, homogeneity with sizes (128×128, 256×256, 512×512)
2. Figures (4), and (5) represent Energy properties of image1and image2 respectively, with different sizes of (128×128, 256×256, 512×512). Figures (6) and (7) demonstrate the consequence of applying the proposed calculation on two real of water bodies images contrast properties of image1and image2 respectively, with sizes (128×128, 256×256, 512×512). Figures (8), and (9) represent Correlation properties of image1and image2 respectively, with sizes (128×128, 256×256, 512×512). Figures (10), and (11) represent Homogeneity properties of image1and image2 respectively, with sizes (128×128, 256×256, 512×512). After applying histogram equalization on segmented images, the subsequent image has then issue of more brightness than the original image due to histogram equalizationthe particles give off an impression of being somewhat more brilliant than their unique one. image improvement strategies can be performed on the first image.
3. Energy, contrast and homogeneity, were directly proportional with size of the image, which is clear seen in figures (4,5,6,7,10,11).
4. Contrast and correlation seems to be a good indicator image quality.

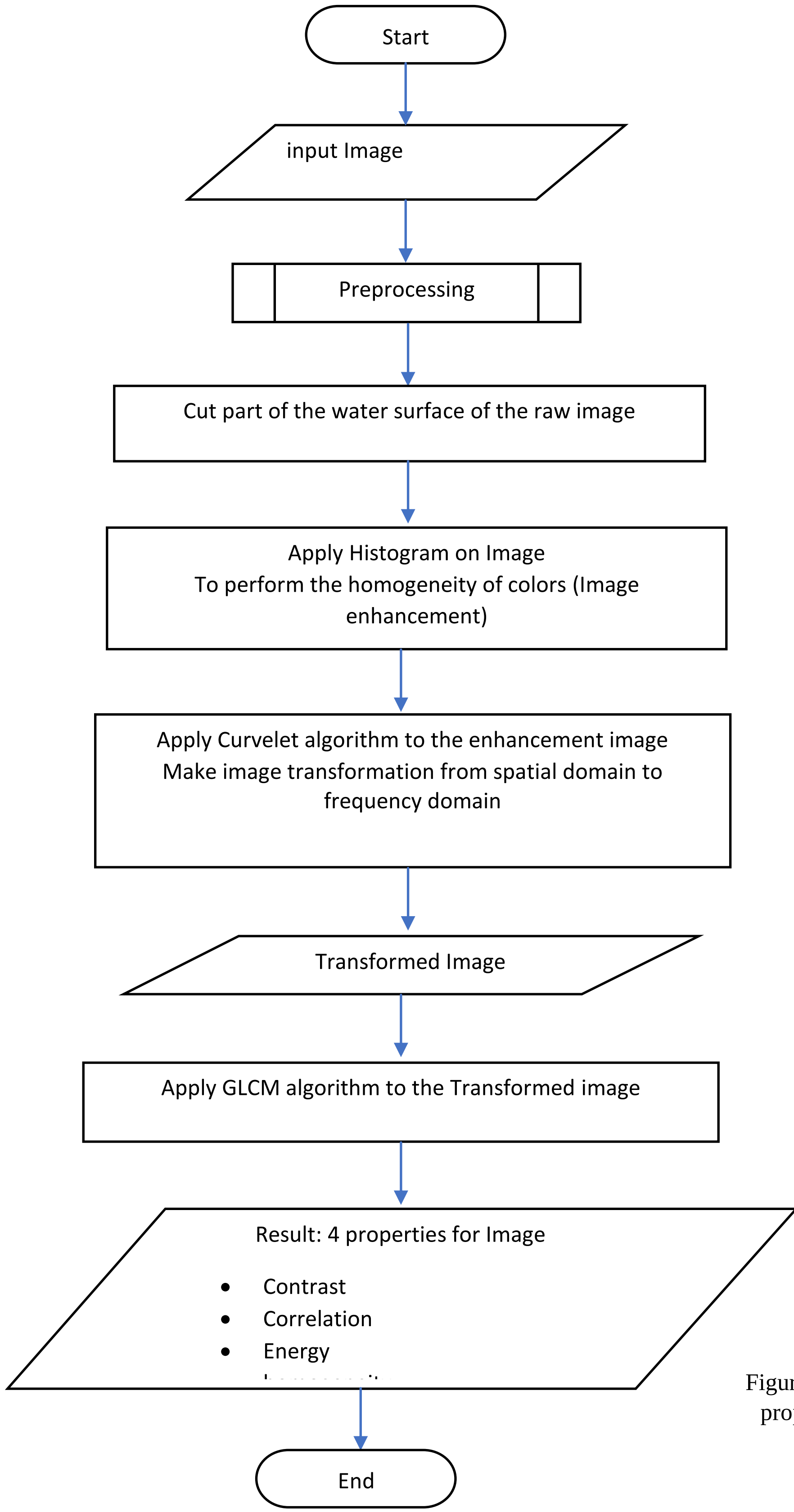

Figure (3) Chart of the proposed algorithm

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Table(2) Results represent Properties for Image 1 and image 2 : Contrast, Correlation, Energy, homogeneity with sizes (128×128, 256×256, 512×512)

Image and size	Contrast	Correlation	Energy	Homogeneity
Image1 128×128	5.1647	0.18	0.0072	0.2364
Image1 256×256	5.69625	0.017	0.0086	0.2444
Image1 512×512	7.23597	0.0441	0.01049	0.2712
Image2 128×128	4.309	0	0.0039	0.21
Image2 256×256	5.213	0.1104	0.0046	0.2351
Image2 512×512	5.698	0.0789	0.0051	0.264

Conclusion

Based on the results obtained from the experimental application of proposed algorithm, the following conclusions were obtained:

- The process of dropping the low-frequency of curvelet coefficients is not affected by the level of analysis or the number of angles adopted at decomposition.
- The characteristics of Contrast, Correlation, Energy, and Homogeneity clearly show differences between samples of images.

Future Work

- The properties that obtained in this paper can be used as inputs on a fuzzy system or used in the genetic algorithm that discrimination certain patterns in order to detect some foreign tissue within those sections. Or enter it into a tree resolution to classify images.
- Adopt the algorithm as a diagnostic system so that it can be applied to images of different parts of the body to make satisfactory diagnoses.

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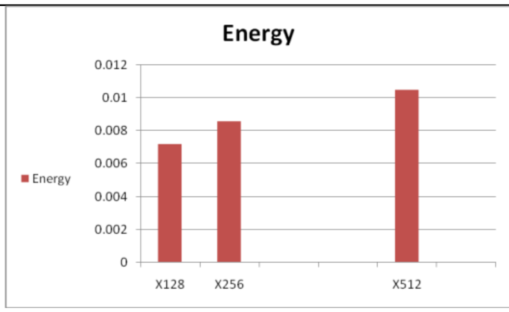

Figure (4) Energy properties of image1 with sizes (128×128, 256×256, 512×512)

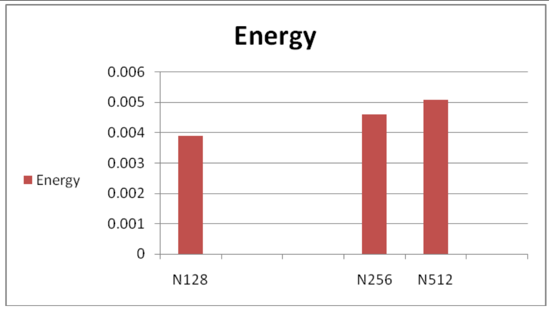

Figure (5) Energy properties of image2 with sizes (128×128, 256×256, 512×512)

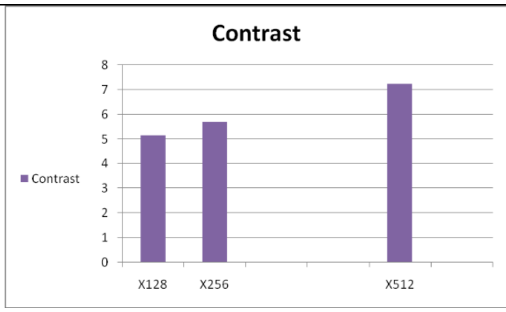

Figure (6) Contrast properties of image1 with sizes (128×128, 256×256, 512×512)

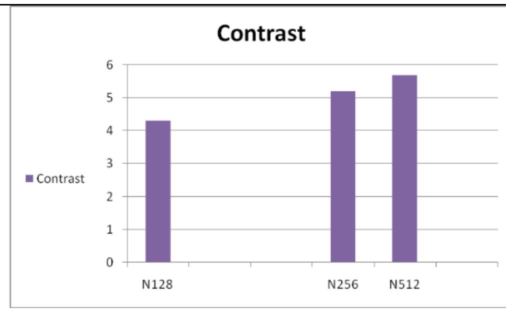

Figure (7) Contrast properties of image2 with sizes (128×128, 256×256, 512×512)

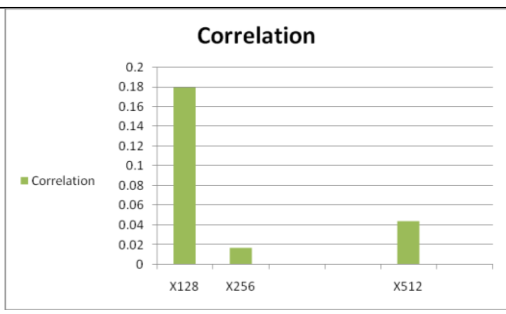

Figure (8) Correlation properties of image1 with sizes (128×128, 256×256, 512×512)

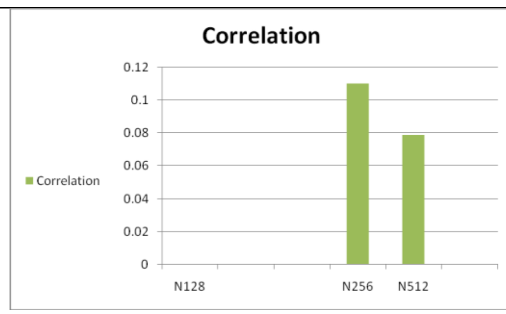

Figure (9) Correlation properties of image2 with sizes (128×128, 256×256, 512×512)

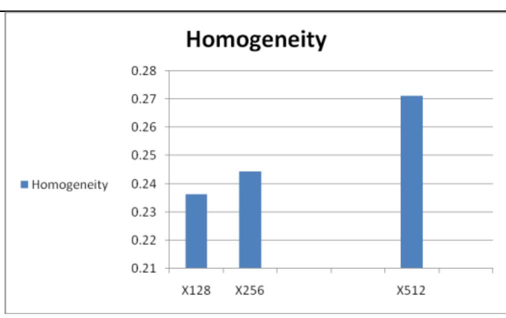

Figure (10) Homogeneity properties of image1 with sizes (128×128, 256×256, 512×512)

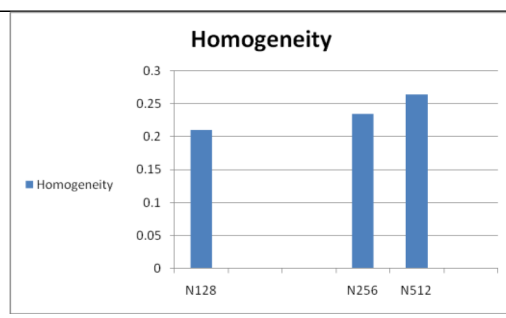

Figure (11) Homogeneity properties of image2 with sizes (128×128, 256×256, 512×512)

دراسة صفات المسطحات المائية في الصور الجوية باعتماد تحويلات الكيرفليت

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الملخص

يعد استخلاص الميزات وتحليل النسجة عمليات مهمة في مجال معالجة الصور لمختلف تطبيقات الكمبيوتر. في هذا البحث اقترحت طريقة لتحليل واستخراج (حيث يتم تفكيك الصورة الى معاملاتها ليتم تطبيق خوارزميات التقطيع على تلك المعاملات)، والتي تقدم بدقة ميزات صور المسطحات المائية بناءً على تحويل كيرفليت الحواف لأنها تتعامل مع معلومات اللف في جميع الاتجاهات. قمنا بتطبيق تقنيات التجزئة للحصول على معلومات في منطقة الاهتمام ، اذ قمنا بتجزئة الصورة إلى عدة اجزاء، ودراسة ملامح قوام المسطحات المائية في صور الأقمار الصناعية لشمال الموصل (سد الموصل).

تم استخدام خوارزمية التجزئة المقترحة لاستخراج منطقة الاهتمام (المسطح المائي) من الصور ، التي تحتوي على دقة لتحديد الحواف ، وذلك لغرض دراستها، اذ تنتج الخوارزمية مجموعة من الاجزاء ، التي يتم تخزينها في مصفوفة الخلايا ، لاستخراج ميزات القوام باستخدام مصفوفة التواجد المشترك.

أعطت ميزات نسيج الصورة المستخلصة (باعتماد الاسلوب القترح) مثل (التباين ، الارتباط ، الطاقة والتجانس) ، تمثيلًا دقيقًا لذلك النسيج.

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