SURVEY ON CIRCULAR FEATURES DETECTION TECHNIQUES

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ABSTRACT

Hough transform and Rotational pixel swapping are two methods basically used for detection of circular features in images. This survey paper focuses on the techniques used to detect circular features in the images. It is studied from literature that rotational pixel swapping provides more stable detection for circular features than other techniques. Also that the circular features are important for analysis of remote sensing satellite images. The main feature of rotational pixel swapping is that it enhances the rotational symmetric patterns. The nonrotational symmetric patterns are weakened or eliminated.

Keyword: - *Circular features,RPSW,Haugh tranform,rotation,pattern detection*

1. Introduction

Recent advances in remote sensing technique provided huge number of images which contains various circular features. There are numerous circular features such as impact craters, volcanoes, geological domes and manmade structures symbols present in the terrestrial images [1]. Many methods have been proposed to detect these circular features. But these methods are able to detect only those circular features which are more dominant. There should be some method which can detect circular features from the images in which dominant noncircular features must get eliminated and nondominant circular features must get detected. Also the simple circles as well as more complex circular features such as incomplete ring structures or several concentric rings are to be detected.

Rotational pixel swapping is the method which uses rotational operation and multiplication operation to eliminate the noncircular part and detects the circular features [1].

Previous studies show that pattern-matched filtering technique or Hough transform are suitable for extraction of impact craters as well as geological features. When these techniques are to be applied to Earth-observation satellite images where noncircular features are more dominant these requires various pre-processing on original image before applying these techniques. Hough transform requires various mathematical morphology operators to detect circular features from these images and also calculation time required is more. So to optimize the computational time as well as to detect these circular features such as impact craters an automatic technique would help and these huge number of remote sensing images will be utilized.

The various techniques for detecting these circular features have been summarized in this paper. This paper is organized in following sections. First section presents various types of circular features. Techniques used to detect impact craters as they are one of the circular feature are presented in second section. Third section provides techniques to detect circles. Proposed system is explained in fourth section. Finally the paper is concluded with outlook to future wok.

1.1 TYPES OF CIRCULAR FEATURES

There are various types of circular features as follows:

a) Craters created by impact: It is an approximately circular depression in surface of planet. In [2][3][4][5] presented the methods used to detect these impact craters.

b) Circles, ellipses geological domes: These are also circular features present in the images. There are methods presented in [1], [6], [7] which are used to detect them.
c) Dominant circular impact craters: There are some images such as images of Mars, the Moon in which circular impact craters are dominant over noncircular geological features [1].
The techniques used to detect mentioned circular features are summarized as follows:

2. TECHNIQUES USED TO DETECT IMPACT CRATERS

1. In [2] R. Honda, Y. Iijima et.al presented the method in which images were grouped based on spatial frequency patterns. Images were grouped based on spatial frequency patterns.Crators were detected using optimized parameter set and noise reduction techniques.SOM (self organizing map) is used to exclude false candidates. It consists of clustering of images followed by manual extraction of features for representative image in each cluster. Candidate patterns are learnt. Unknown images are screened according to saved information. The limitation of the system is that it is not able to achieve sufficient detection rate which is required in scientific analysis
2. In [3**]** Cheng, Y. and Ansar presented the algorithm. This algorithm uses lighting source direction and edge convex properties. Edge convex properties consist of groups of intensity edges. Convex polygonal chain is formed by groups of edges and is extracted from image edge fragment set. Uses local convexity graph to encode neighboring image edges. It mainly focuses on edge detection and grouping. This method lacked in ability to adopt and differentiate imagining conditions.
3. The technique in [4] T. F.Stepinski1 et.al uses automatic approach of combination of image processing and machine learning. Image-based crater-detection approaches based on machine learning and those that exploit it.
4. S.Lon cari et.al [5] work, a DEM-based CDA has been used for systematic cataloguing of craters from topography reconstructed from optical images. This is an important contribution to the field of CDA -related research, because optical images use most of the lunar and planetary bodies in larger special resolution and quality than existing DEMs**.**Table I summarizes the above work.

Table I: Techniques for impact crater detection

Paper	year	Technique used	Pros and Cons
R. Honda, Y. Iijima, and O. Konishi, "Mining of topographic feature from heterogeneous imagery and its application to lunar craters,"	2002	Images grouped according to spatial frequency pattern	The detection rate achieved in this study is not sufficient in comparison with the requirements for scientific analysis
Cheng, Y. and Ansar," Landmark Based Position Estimation for Pinpoint Landing on Mars."	2005	Edge Detection and grouping	Achieved sub-pixel accuracy but lacked in adaptive ability to differentiate the imaging condition
S. Lon caric, et.al Automatic detection of lunar craters based on topography reconstruction from Chandrayaan-1 M3 imagery	2011	DEM based CDA used for systematic cataloguing of craters from topography reconstructed from optical images	Based on DEMs of still higher resolution obtained from other spacecraft images.
T. F. Stepinski et al "Detecting Impact Craters in Planetary Images Using Machine Learning" Dept. of Geography, Univ. of Cincinnati, OH 45221, USA	2009	Uses automatic approach of combination of image processing and machine learning	Methods rely exclusively on pattern recognition techniques to identify crater rims with circular or elliptical features in an image
G. Salamuni ccara et al., "Test-field for evaluation of laboratory craters using a crater shape-based interpolation crater detection algorithm and comparison with Martian and Lunar impact craters,"	2012	CDA already has internal knowledge about craters shapes, which can be utilized in order to achieve a higher quality of evaluation	Scientific investigation of real impact craters using laboratory craters as proxies is possible

3. TECHNIQUES USED TO DETECT CIRCLE

1. Kaushik Chattopadhyay et.al [6] proposed the algorithm called as Ant system algorithm. The method uses a new and efficient scheme to detect circles in grayscale digital images in which edges are detected. The main memory is used to store only the co-ordinates of edge pixels. It can be used to detect circles as well as ellipses. The system lacks with respect to distortion due to digitization. It requires considerable time if the number if the number of nodes and branches are more.
2. Fatoumata Dembele[7]provides an algorithm than can be used to find any shape within an image. Classification of objects in image is accordingly to parameters used to describe the shapes. This is achieved using the Hough Transform. Circular Hough transform used to detect circles.
3. The method based on sampling given by Lianyuan Jiang et.al [8] is used to detect circle. In edge image three points will be randomly sampled and the fourth point is sampled within the margin of inscribed squares and vertical circumscribed of the circle determined by three previously sampled points. Threshold value is used to reduce the processing time.Table II summarizes the above techniques

Table II: Techniques to detect circle

Paper	year	Technique used	Pros and Cons
Kaushik Chattopadhyay et.al ""An Efficient Circle Detection Scheme in Digital Images Using Ant System Algorithm" ,Proceedings of the 2008 IEEE Sponsored Conference on Computational Intelligence, Control and Computer Vision in Robotics and Automation, Rourkela, India	2008	Finds the closed loops in the image and test it for circle, Uses incidence matrix	Time efficient for the system where branches and nodes are less in number but increases with increase in them
Fatoumata Dembele,"Object Detection using Circular Hough Transform"	2010	Classify the objects accordingly to parameters needed to describe the shape, Uses template matching	Performance depend on results from the edge detector
Lianyuan jiang et. al "Fast randomised algorithm for circle detection by efficient sampling "Journal of Theoretical and Applied Information Technology 20th February 2013. Vol. 48 No.2	2013	It is based on sampling technique	Strong robustness and low demand for memory.

4. PROPOSED METHOD

Proposed system first extracts RSP as circle and concentric ring patterns belongs to RSP.It uses multiplication operation between original image and rotated image to enhance rotational symmetric patterns and to eliminate noise, nonratational symmetric patterns [1]

The contribution of the work is given as follows:

- The method deployed from [1] consists of use of rotational operation on original image as preprocess. There is use of binary images for extraction of circular features.
- The system under experimentation first detect centres of these features using method deployed in [1].Then the circular features are detected using Hough transform.
- After detecting circular features their sizes are estimated by considering the limited area around the circle.

- The system under experimentation can be able to detect simple circles, imperfect circles, concentric rings etc.

The flowchart for the system is given as follows:

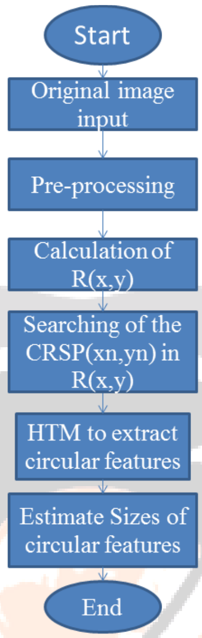

Fig.1:Flowchart of the proposed system

a) Multiplication of binary image and rotated images

This step is used to exclude all noncircular features from the input image. For this input image is converted in to binary image. Then multiplication of binary image and each rotated image is done. The output of this step is image in which RSPs i.e. circular features are enhanced and nonrotational symmetric patterns are weakened.

b) Calculation of R(x, y)

To search for centre of RSP in targeted image rotational symmetricalness function is used. The value of R is calculated using following equation:

$$R(x,y) = \sum_{i} \sum_{j} \prod_{K} B_{x,y,\varphi=k\cdot\Delta\varphi}(i,j)$$

where (x,y) is the rotation center for the calculation of the rotated image $B_{x,y,\varphi}$, k is from 0 to N , $\Delta\varphi$ is incremental angle of rotation and N is total number of rotated images[1].

c) Searching for centre of RSPs

This R is calculated for each pixel and relatively higher value of R is considered as the centre of RSP[1].

d) HTM to extract circular features

The centres obtained from RPSW are given to CHT.The Circle Hough Transform is designed to find a circle characterized by a centre point(x0, y0) and a radius r.It uses the equation of circle.

$$r^2 = (x - a)^2 + (y - b)^2$$

Here a and b represent the coordinates for the centre, and r is the radius of the circle.

The parametric representation of this circle is

x = a + r*cos (ø)

y = b + r*sin (ø)

Setting a range (maximum and minimum) prior to running the application. For each edge point, a circle is drawn with that point as origin and radius r.

e) Estimating sizes of circular features

Sizes for each circular feature can be calculated by considering the limited area around the centre of circular features.

4. CONCLUSIONS

The proposed system uses the rotational pixel swapping method used to detect centres of the circular features. This method searches CRSPs in a target image. These centres are used by Hough transform to extract circular features. Then the sizes of the circular features are to be estimated by a hybrid approach deploying rotational pixel swapping and Hough transform. It is observed that RPSW and HTM provide more stable extraction of circular features than any other methods.

5. REFERENCES

[1] Satoru Yamamoto, Tsuneo Matsunaga,"Rotational Pixel Swap-ping Method for Detection of Circular Features in Binary Images"IEEE Trans.Geoscience and Remote Sensing, VOL. 53,NO. 2 2015

[2] R. Honda, Y. Iijima, and O. Konishi, "Mining of topographic feature from heterogeneous imagery and its application to lunar craters," in Progress in Discovery Science, Final Report of the Japanese Discovery Science Project, vol. 2281. Berlin, Germany:Springer-Verlag, 2002,pp. 395-407

[3] Cheng, Y. and Ansar,"Landmark Based Position Estimation for Pinpoint Landing on Mars." In Proceedings of the 2005 IEEE International Conference on Robotics and Automation (ICRA),pages 4470-4475, Barcelona, Spain

[4] T. F. Stepinski1, Wei Ding,2 R. Vilalta "Detecting Impact Craters in Planetary Images Using Machine Learning" Dept. of Geography, Univ. of Cincinnati, OH 45221, USA. 2Dept. of Computer Science, Univ. Of Massachusetts Boston, 100 Morrissey Blvd. Boston, MA 02125-339, USA. 3Dept. of ComputerScience, University of Houston, 4800 Calhoun Rd., Houston, TX 77204, USA.

[5] S. Lon caric, G. Salamuniccara, A. Grumpe, and C. Whler, "Automatic detection of lunar craters based on topography reconstruction from Chandrayaan-1 M3 imagery", presented at the Lunar Planetary Science Conference, The Woodlands, TX, USA, Mar.2011, Paper 1454

[6] Kaushik Chattopadhyay, Joydeep Basu, Amit Konar "An Ecient Circle Detection Scheme in Digital Images Using Ant System Algorithm" ,Proceedings of the 2008 IEEE Sponsored Conference on Computational Intelligence, Control and Computer Vision in Robotics and Automation,Rourkela, India

[7] Fatoumata Dembele,"Object Detection using Circular Hough Transform"

[8] Lianyuan Jiang et.al ,"Fast randomised algorithm for circle detection by efficient sampling" Vol. 48 No.2 Journal of Theoretical and Applied Information Technology,Feb. 2013

[9] J. H. Han, L. T. Koczy, and T. Poston, "Fuzzy Hough transform,Pattern Recognit." Lett., vol. 15, no. 7, pp. 649658, Jul. 1994

[10] G. Salamuni ccara et al., "Test-eld for evaluation of laboratory craters using a crater shape-based interpolation crater detection algorithm and comparison with Martian and Lunar impact craters,"Planet. Space Sci., vol. 71, no. 1, pp. 106-118, Oct. 2012.

[11] P. Pina, J. Saraiva, and T. Barata, "Automatic recognition of aeolian ripples on Mars," presented at the Lunar Planetary Science Conference, The Woodlands, TX, USA, Mar. 2004, Paper 1621.

[12] Zhangquan Shen, Jiaguo Qi, and Ke Wang,"Modication of Pixel swapping Algorithm with Initialization from a Sub-pixel/pixel Spatial Attraction Model"Photogrammetric Engineering and Remote Sens ing Vol. 75, No. 5, May 2009, pp. 557567.

[13] Yong Xu, and Bo Huang,"A SpatioTemporal Pixel-Swapping Algorithm for Subpixel Land Cover Mapping "IEEE Trans. Geoscince and Remote Sensing, June 2013.