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# Detection of Domed Crater by Using Intensity Parameter

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***Abstract*** — Many image processing algorithms can apply in satellite imagery to identify or study topographical features. Most of the algorithms are considering features of the impact craters with circular shape not other structural patterns. Intensity projection at different angles is considered here for detecting topographical features so that craters in different styles can easily classify. The variations of the intensity are studied here by considering the shades of the image. Evaluation of intensity projection at different angles is used to detect object shape and shades. This will leads to detect domed crater easily.

***Keywords*** — **image intensity, DS9, domed craters, image processing.**

## I. INTRODUCTION

An important area for detection of the object can be done with the help of image processing algorithms. There are many algorithms are existing to study the planetary surface to detect or identify objects available in planetary body. Craters are forming in different shapes and size. Image processing algorithms can be used to detect craters. The satellite image normally contains crater in very small diameter, it will vary depending on the resolution of the image as well as topography of the planet.

To explore solar system, analysis of the satellite imagery is very important, it is a key role for missions to different planets. Because of the variability in shape, size and complexity new algorithms for better detection is essential. The detection and classification of topographic features on the huge amount of data can be done only with efficient image processing algorithms on satellite imagery. Intensity variations will easily extract the complexity of the crater shape.

## II. SURVEY ON CRATER DETECTION ALGORITHMS

Development of the efficient crater detection tool is the goal of the space science applied information system. Using Singular value decomposition method for detecting crater is giving 80% of probability detection rate and 12% false detection rate [1]. But this algorithm is just detecting crater and not focusing on the different characteristics of the structure or different types of crater. Most of the algorithms for crater detection are based on lunar image. But crater structures will vary depending on the planets.

Craters are spread over the planetary body, so these studies will help to find the age of the planet and comparative studies can be done with other planetary bodies. Algorithms are divided as supervised and unsupervised mode.

Unsupervised includes feature extraction and classification. Another algorithm focuses on edge segments and grey level co-occurrence matrix texture for classification and pattern matching method [2]. The crater detection with interpolation method mainly focuses on finding the depth/diameter ratio of the crater [3]. This algorithm is not focuses on different classification or other crater structure complexity.

Template matching method used in ridged plain to detect craters in Martian surface [4]. But the craters with diameter with greater than equal to 10 pixels are considered for detection. The true detection rate 86.57% and false detection rate 15.95% are obtained by using template matching method. But complexities of crater structure are not considered for this experiment.

A methodology to detect craters using mathematical morphology includes steps like: pre-processing, binarization, filtering, segmentation and detection [5]. In this case also the algorithm not deals with different pattern of the craters.

Detection rate with 69.8% achieved by focusing target edge segments, circle or ellipse for impact craters and then evaluated using a fitness function and template matching method. Here all type of craters is not specified [6].

Crater detection process in lunar by shadow removal, preprocessing, circular Hough transform and ridges detection includes edge extraction, morphological operations, crater detection and ridges detection [7]. The linear and non-linear feature extraction in lunar image is experimented.

Chemical combination in the planet surface is studied to detect craters or other topographical features. The crater could provide importance of outcrop characteristics and absolute mineral abundances in controlling the band strengths observed from orbit [8].

Another algorithm focuses on the elliptical shape of the craters and erosion of small to large size craters [9]. Intensity analysis is used here for detecting craters, but here also different structural pattern of the crater is not considered. The freshness and erosion of the craters are determined by using the intensity gradient information. Indication of the crater presence will determine the risk in landing.

## III. IMAGE INTENSITY OF CRATER IMAGE

Craters are forming in different size and shapes like center peak, nested, domed craters etc. The domed crater are circular or in elliptical in shape. The dome is present inside the crater circumference. Based on the intensity values available in the image, classify it into domed crater. Because of the presence of dome inside the crater, the intensity graph should vary according to the dome. The expected graph of the domed crater is shown in Figure – 1. The intensity values should be high or peak in the centre of the crater because of the presence of dome.

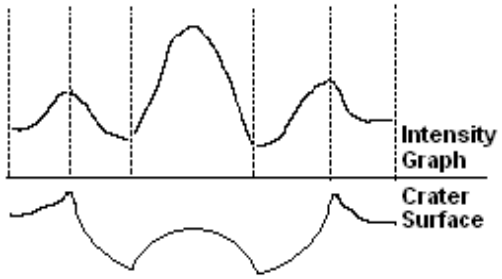


Figure – 1 Expected Intensity Graph of the Domed Crater

The expected graph contains three peaks of intensity, the first and last peak will give information about the circumference of the crater, and middle peak will information about the dome.

## IV. ANALYSIS OF CRATER IMAGE

The tool DS9 is used to developing intensity graph. For intensity projection, the line - region shape is used here, as shown in the Figure – 2.

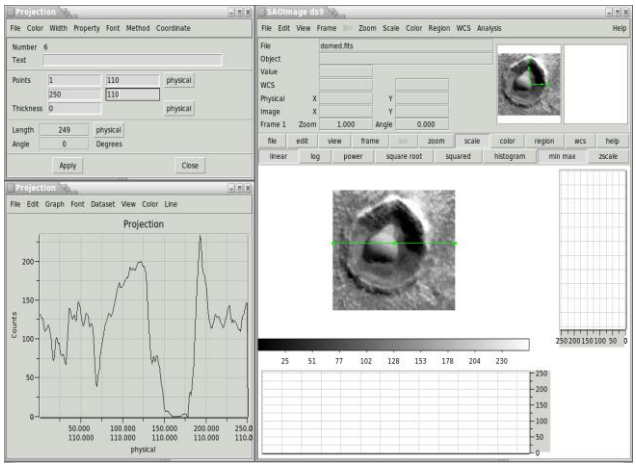

Figure – 2 DS9 Tool Projecting the Intensity Graph

Consider the segmented portion of the image and select the shape from the region menu. Here line is used for intensity projection. Consider the Figure – 3, the line is drawn across the segmented crater image and plotting the intensity graph.

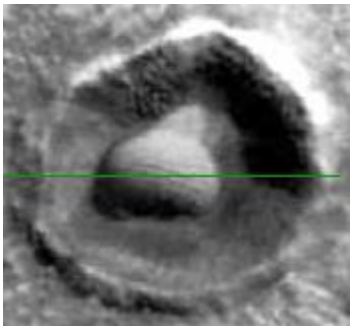

Figure – 3 Crater Image and Region Line with Angle: 0

The Figure – 4 shows the pixel distribution in the domed crater image, it is varying from 0 to 255. That is from white to black due high intensity to very intensity because of the shadow in the image

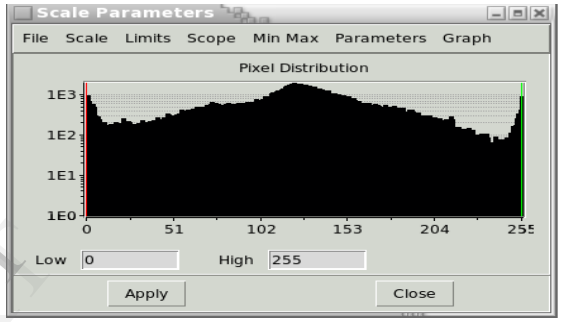


Figure – 4 Pixel Distributions with Region Line Angle: 0

Rotate the line at different angles, up to 1800 so that it will cover the entire crater image. Plot the intensity graph at different angle as shown in Figure – 5. Compare developed graph with expected intensity graph at different angles, most of the graph are matching with expected graph. Out of 21 graphs 20 graphs are matching with the expected one. From the graph, middle peak represents the intensity of the dome, and side peaks represents intensity of the circumference of the crater. From the Figure – 5, the Angle: 140 quite far from matching with expected one. Remaining 20 graphs are matching with the expected one.

Considering different graphs at different angles because the sun light can fall in any angle. Consider the image with angle: 0 and angle: 180 both are mirror image of another one. Intensity is very low because of the black pixel value due to black shade. And the intensity is very high due to the high projection of the dome and crater circumference. In most of the graph the ending two peaks denotes the intensity values of the circumference of the crater and the middle peak represents the intensity of the dome. Consider the angle: 90, middle peak and side peaks exist. From the above graphs middle peak and two side peaks represents domed crater. All the peaks are gradually increasing as well as decreasing indicates domed crater.

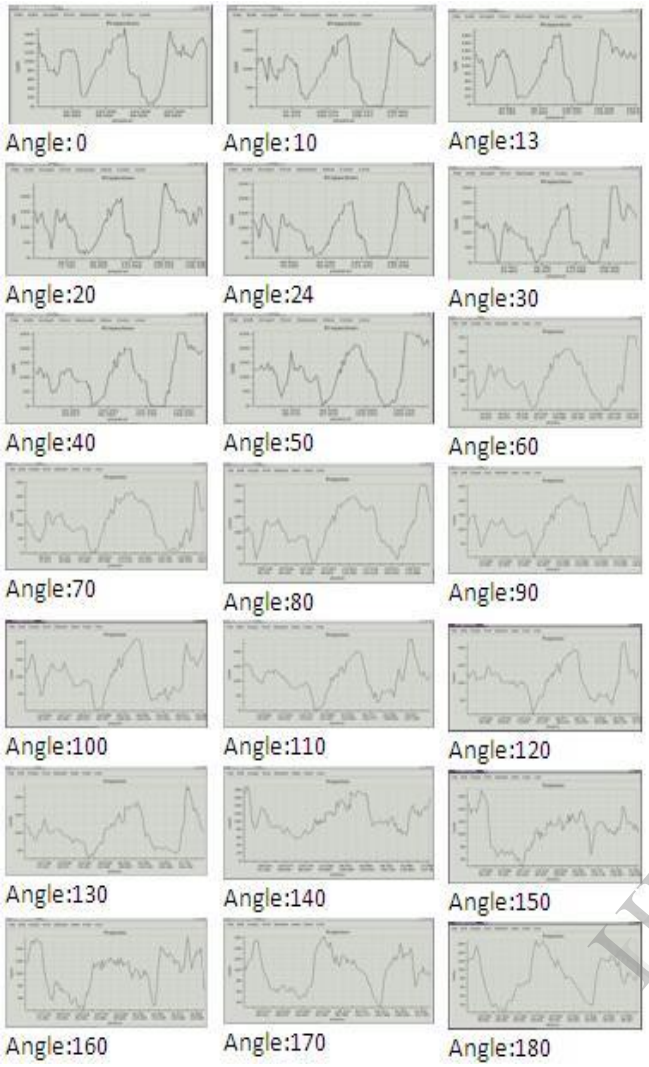


Figure – 5 Intensity Graph at Different Angles

## V. CONCLUSION.

This image processing steps are not considering the depth information, formation of the crater, ageing of the crater etc. The region intensity features of the image at different angles are considered here to detect domed craters. Out of 21 image plots, 20 graphs are showing the expected intensity values. So the accuracy is high, while considering the intensity parameter.

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