Lunar Crater Morphology Characterisation: A Special Emphasis On Floor Fractured Craters. Suchit Purohit[1] , Khushali Shah[1], Savita Gandhi[2*] and Prakash Chauhan[2**], [1,2,2*]Department of Computer Science ,Gujarat University, Ahmedabad, INDIA (suchit.s.purohit@ieee.org), [2**] Space Applications Centre, ISRO, Ahmedabad, INDIA.

Introduction: Morphological and Morphometric analysis of Impact craters serve as an important source of information about geological processes and properties of the lunar surface. Morphological analysis is subjective interpretation based on qualitative analysis. It suffers from perceptual differences because qualitative features of craters appear differently when the images are taken from the different viewing point, at different lighting angles, and at different resolutions. On the other hand morphometric analysis is a quantitative approach; it provides objective analysis and is useful for quantification of processes like determining the morphological class of craters, degradation state of the crater leading to understanding of chronological evolution of planetary surfaces.

Over the years, morphologic analyses are done using visual interpretation and parameter measured manually using GIS based tools. The methods are expensive in terms of time, tedious for small craters and depend on a degree of subjectivity. The complexity increases further when there is large volume of data differing in format, representation, and resolutions. So there is need of automated methods for deriving morphometric parameters.

This study focuses on development of algorithms for automatically determining morphometric parameters from DEM of Lunar crater. The parameters under study are diameter(D), depth(d), rim width(w) and rim height(h).The algorithms have been applied to LOLA DEMs of 44 Lunar floor fracture craters. Floor fractured craters were volcanically modified due to the collection of magma produced under impact craters which causes rise of the floor and develop cracks[5].They are characterised by shallow floors cut by deep floors of radial and concentric geometry and exhibit interior feature like moats and ridges.

Objective: The objective is to develop algorithms for automatic determination of morphometric parameters of Lunar floor fractured craters .

Techniques and Algorithms: In this study, we used LOLA gridded data which are map projected DEM derived from altimetry data acquired by LOLA instruments [1]. The morphometric parameters are evaluated using topographic profile obtained from DEM(Fig.1). Comprehensive algorithm for the determination of Diameter, depth, rim height and rim width is shown in Fig.2 . To take asymmetry of craters into account, the parameters in all the eight directions were calculated which were then averaged out to get the final values. The sample output of the program for TYCHO has been summarized in Table 1. The algorithms were implemented in MATLAB (version R2016b) using mapping, image processing. The programs were executed on workstation with 12GHz internal RAM and processor Intel core i7 CPU with 3.60GHz.

The proposed techniques were implemented on floor fractured craters belonging to all the six classes. Though 164 FFCs have been catalogued[2], we selected only those craters which were available with 1024 PIX/DEG. We were left with 8, 12, 24, 21, 26 and 8 craters from class 1 to 6 respectively. Since the distribution of craters in each class is not uniform, we sampled 50% from each class. Finally, we used 44 craters from class 1 to 6 respectively.

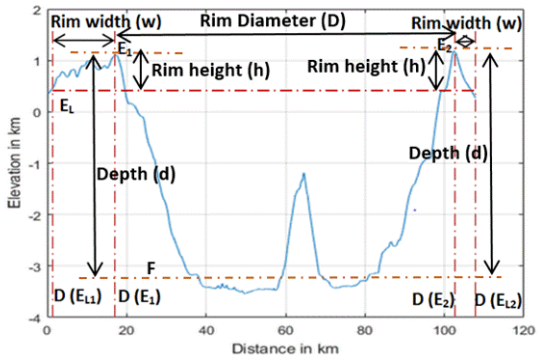

Figure 1: Topographic profile of TYCHO

Results and discussion: The results were validated statistically against available data set[3]. We fitted our observed values against expected values as per

$$Y = X \pm 0.02$$

where, X=expected value and Y=observed value in km It was found that our method produces accuracy of 97% for diameter, 77% for depth ,70% for rim height in and 80% for rim width (Fig.3).

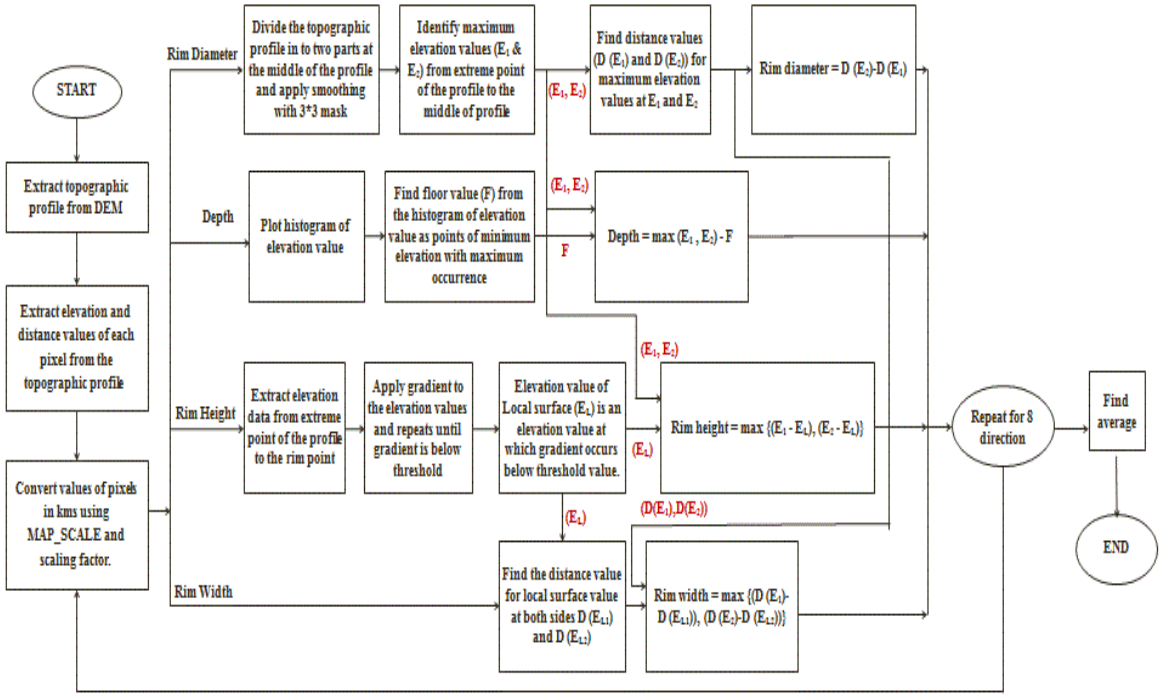

Figure 2 :Flowchart for the determination of Diameter, depth, rim height and rim width

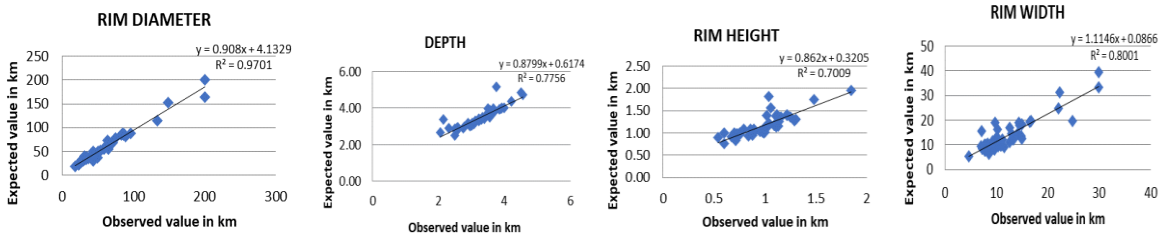

Figure 3 : Accuracy measurement of different parameters

Table 1: Measurement of Morphometric parameters in 8 directions of TYCHO crater

	Rim Diam-eter (km)	Depth (km)	Left Rim Height (km)	Right Rim Height (km)	Left Rim Width (km)	Right Rim Width (km)
Diretion 1	126.29	4.54	0.07	0.04	22.23	15.75
Diretion 2	85	4.7	0.07	1	16.9	6
Diretion 3	91.26	4.63	0.13	0.32	25.70	19.18
Diretion 4	87.89	5.19	0.64	0.488	22.23	16.43
Diretion 5	94.93	4.45	1.33	0.459	22.00	17.79
Diretion 6	69.76	5.09	0.94	0.723	4.974	11.66
Diretion 7	113.94	4.82	1.37	1.008	27.33	18.53
Diretion 8	97.60	5.13	0.98	1.911	17.61	15.69
Average	95.83	4.82	0.69	0.743	19.87	15.13
Finalvalue	95.83	4.82	0.74			19.876

References: [1] Explorer. (2015). LUNAR ORBITAL DATA EXPLORER. [2] Jozwiak, L. M., Head, J. W., Zuber, M. T., Smith, D. E., & Neumann, G. A. (2012). Lunar floor-fractured craters: Classification, distribution, origin and implications for magmatism and shallow crustal structure. Journal of Geophysical Research E: Planets, 117(11). [3] Lunar Exploration Summer Intern Program,2015 [4] Pike, R. J. (1976). Crater dimensions from Apollo data and supplemental sources. Earth, Moon, and Planets, 15(3), 463–477. [5] Schultz, P. H. (1976). Moon Morphology, 626 pp. Univ. of Texas.

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