CRATER DETECTION, CLASSIFICATION AND CONTEXTUAL INFORMATION EXTRACTION IN LUNAR IMAGES USING PROFILE-BASED ALGORITHM. S. Vijayan[1], K. Vani[1] and S. Sanjeevi[2], [1]Department of Information Science and Technology, Anna University, Chennai, India. [2]Department of Geology, Anna University, Chennai, India. (vijayansiva@gmail.com, vani@annauniv.edu, ssanjeevi@annauniv.edu)

Introduction: Impact craters are the dominant feature on any planetary surface and this dominance is used for the estimation of age of planets by crater count [1]. Such dominance gathered attention to detect them automatically in DTM [2] and panchromatic [3] images. Most of the crater detection algorithm (CDA) fall short to classify the crater and extract contextual information (presence/absence of ejecta) from it. The algorithm proposed in this paper aims to automatically detect, and extract contextual information from the simple lunar craters from the Selen Terrain Camera images. Apart from detection, the ability of our algorithm is to classify the simple lunar craters into round- and flat-floor type, indicate the presence of ejecta and associate it with the corresponding crater. This algorithm was designed to detect craters of considerable size and diameter to avoid small craters from where no morphological information can be obtained.

Methodology: The crater detection algorithm shown in Figure 1 involved thresholding technique to delineate the bright and shadow parts of the craters. The demarcated bright and shadow part are matched using the minimum distance technique. The occurrence of ejecta is a random process and this represents the contextual information adjoining the crater. This adjacency property handled using the Markov Random Field theory, was used to delineat the ejcta and associate with the corresponding crater.

The structural pattern recognition approach is utilized to classify the round- and flat-floor craters. The panchromatic image derived 2-dimensional crater profile depicts the variation in the round- and flat-floor craters. The round floor craters have no distinct floor at the bottom, while the flat floor craters have a distinct floor and wall [4]. The difference in the structural pattern of the round- and flat-floor craters along with their derivative is used to classify it. Moreover, the image derived from the Getis-Ord process is utilized to cross validate the crater classification. The panchromatic profile and the Getis-Ord profile are taken derivative and the peaks are analysed to classify the lunar craters. The CDA output image is co-registered with the Selene DTM data to extract the crater-depth details.

Results: We have applied our CDA to sixteen images acquired by Selene Terrain Camera. The chosen images include highly cratered area, low/high illumination angle, terrain with non-crater features (rilles), etc.

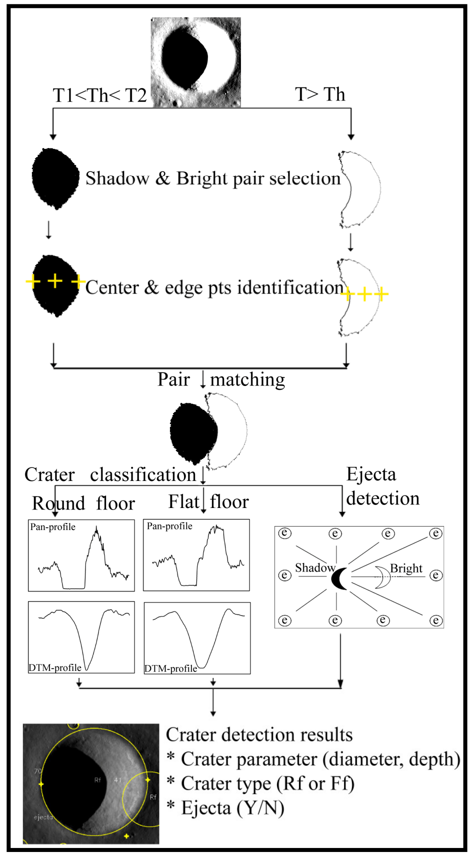

Figure 1. Schematic framework and processing steps of the crater detection algorithm.

Each image is of the size ~20kmX30km and the CDA processes each image individually. The craters detected and classified by our CDA are shown in Figure 2. It also shows that each detected crater is bound by a circle, with their edges marked, classified either as round- or flat-floor, assigned an unique number, the presence of ejecta is indicated and its association with the corresponding crater is also indicated. Manual verification of each image was performed as the ground truth for the qualitative assessment. The total number of craters detected from this CDA is 16,304. The detected number of round-floor craters is 15,566 and the remaining 738 are classified as flat-floor craters. Moreover, from the test images the craters with diameter <250m tend to be ~11,000. On the other hand, the craters with depth <50m tend to be ~15,000. Table 1 shows the evaluation parameters for the algorithm.

Table 1. Algorithm evaluation parameters for crater detection, classification and ejecta identification.

	Q	P	B	TPR	FPR
Crater detection	79	0.90	0.11	0.86	0.09
Round-floor classification	84	0.92	0.07	0.90	0.07
Flat-Floor classification	58	0.67	0.49	0.80	0.32
Ejecta detection	-	0.79	0.55	-	0.44

Conclusions: Most of the previous CDA perform crater detection, mark their boundary and give their count. The proposed CDA is not only to detect the craters, but is also capable of classifying the round- and flat-floor craters and identify and associate the ejecta with the corresponding crater. The algorithm achieved qualitative factor for detection and classification are ~79% and ~71% respectively. For ejecta detection, the algorithm achieved a precision of ~0.79 and branching factor of ~0.55. The high precision achieved indicates that the algorithm has returned the relevant information. The CDA results reveals that the lunar surface is dominant with sub kilometer craters of lesser depths.

References: [1] Baldwin R. B. (1964) *Astron. J.* 69, 377-392. [2] Kim J. R. et al. (2005) *Photogramm.Eng. Remote Sens.* 71 (10), 1205-1217. [3] Urbach E.R. and Stepinski T.F. (2009) *Planet. Space Sci.* 57, 880-887.[4] Wood C. A. and Andersson L. (1978) *LPS* IX, 3669-3689.

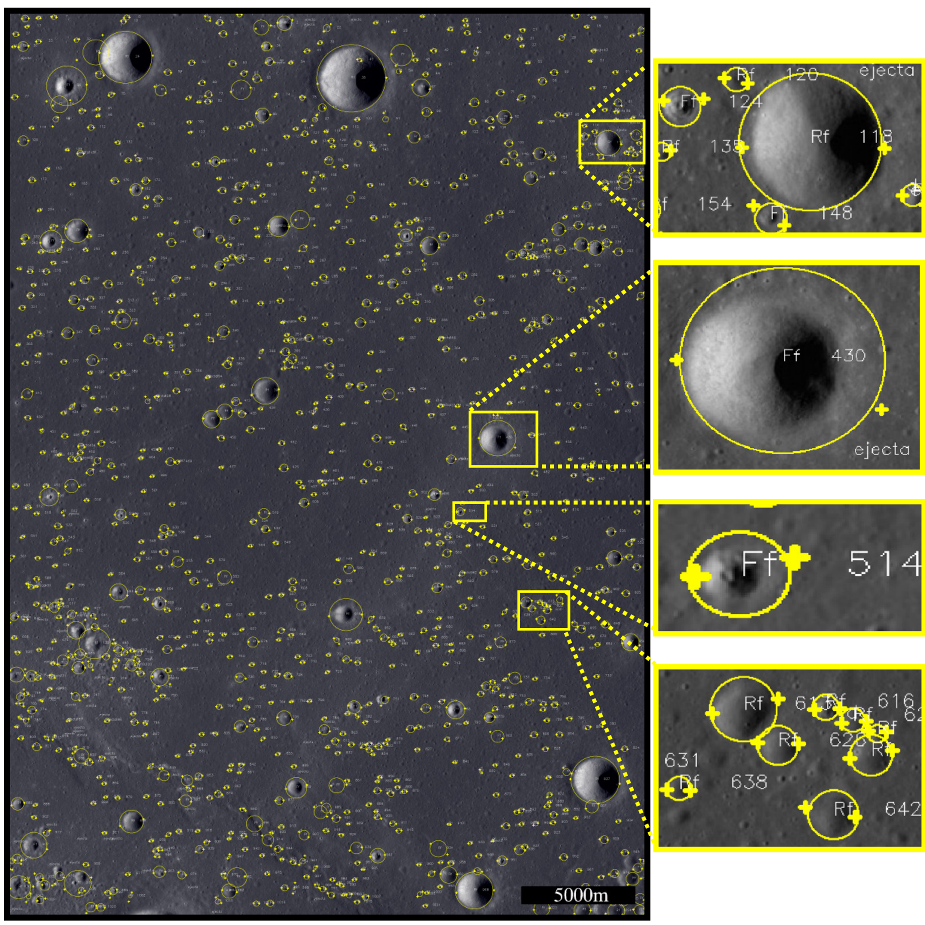

Figure 2. Results of the crater detection algorithm to Selene image (DTMTCO_03_05231N015E3165SC) showing the detected craters. The detected round floor (Rf) craters show an absence of the floor, whereas the detected flat-floor (Ff) craters show floor at their bottom.