Crater Detection on Moon Surface

Arpita Baronia, Jyoti Sarup

Abstract*: Moon is major object of research and crater is one element. Impact craters are initial feature in lunar and planetary science. Estimation of crater is major challenges. Lunar surface is very interesting part of study specially detection of crater and its age. So, exact detection of crater is necessary. For morphological analysis and detection of crater size distribution lunar craters is necessary. Detection of craters from visual analysis may be a tough task because it needs vast information regarding that particular area also it need skill and lots of manpower. Thus cheapest and Powerful automatic crater detection methodology is required. For better detection of crater here image based crater detection is proposed. In this, the crater will detected with different methodology like SVD, KNN and Hybrid method using CHANDRAYAAN-1 TMC image with the help of MATLAB.KNN found better than SVD and hybrid method takes advantages of both.

***Keywords* : Crater Detection, Crater size detection Euclidean distance, Image Segmentation, SVD, Wavelet Transform,**

I. INTRODUCTION

Basically Impact Craters are the impressions on any planetary bodies caused by collision of meteoroids, asteroids or comets. Impact craters are very common on the surface of solid bodies like moon, earth, mercury and mars in the planetary surface. Lunar craters give knowledge of different geologic process[1]because moon surface is not hyperactive as like earth that means erosion rate on the moon surface is very slow so it provides a knowledge of age of the moon surface with respect to other planetary surface[2]. Therefore they are necessary for lunar evolution history study. One of the major challenge during the lunar surface age estimation per unit area crater density calculation [3] is correct crater detection and morphological attribute detection that is Shape and Size of crater. Crater detection is important aspect for lunar surface age detection. If the number of crater is high than surface is old[4]. Therefore, correct lunar crater detection is very important. Manually and visually detection of craters is very hard because in this case skill man power is needed. Hence cheapest and effective crater detection algorithm is needful [3].

II. METHODOLOGY

Proposed methodology is developed several phase to segmented data and crater detection.

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***** Correspondence Author
Arpita Baronia*,Remote Sensing, GIS and GPS center , MANIT, Bhopal, India. Email: arpita.baronia@gmail.com
Dr. Jyoti Sarup, Civil Engineering Department, MANIT, Bhopal, India. Email: Jyoti.sarup@gmail.com

It is developed using four phases, is described below.
1. Data(input)
2. Preprocessing
3. Automatic Crater Detection from image
4. Decision

based on all process we design architecture as shown Fig. 1

Phase 1: Data

It is basic and important task to collect data or data base to detection of crater in moon.Chandrayaan-1 TMC data having spatial resolution 5m is used.

Phase 2: Pre-processing

Pre-processing is initial task to make sure data is correct or not and to remove object that are not the part of craters by using series of filters (Median filter, Area filter and Shape filter) and to remove features or bugler data that have shapes not like craters.

Phase 3: Automatic Crater Detection

Automatic Crater Detection is major section of detection process which is segment image and detect phase of object

Image Based Crater Detection

The image based crater detection approach consists of two techniques viz. Generalized Hough Transform and Wavelet Transform.

Hybrid Crater detection method takes advantage of both KNN and SVD algorithm. Hybrid Crater detection takes the coefficient of wavelet for further analysis.

Phase 4: Decision

Decision is major task to indentify the parameter of crater like morphological attribute.

In the current methodology, initially we collect data from different sources and literature. After it applies Wavelet transform based image segmentation technique has been used for the image based crater detection approach which is used in SVD and KNN hybrid algorithm. Haar ripple transformation found simplest transformation for effectively served the edge detection purpose. This analysis has been done in MATLAB software. Then compare the result of SVD, KNN and hybrid result .

In preprocessing first extract image pixel information then enhanced contrasts of pixel as show in Eq. 1as (1)

Enhance the dynamic range by linearly stretching the original gray levels to the range of stretching the original gray levels to the range of

g (f) af = + b

[s1 s2]=>[t1 t2]

g(f)=(f-s1)*(t2-t1)/(S2-S1)+t1 ....(1)

The transformation function g (f) ((= f 100−) / 50) *255, for 100 ≤ f 150.

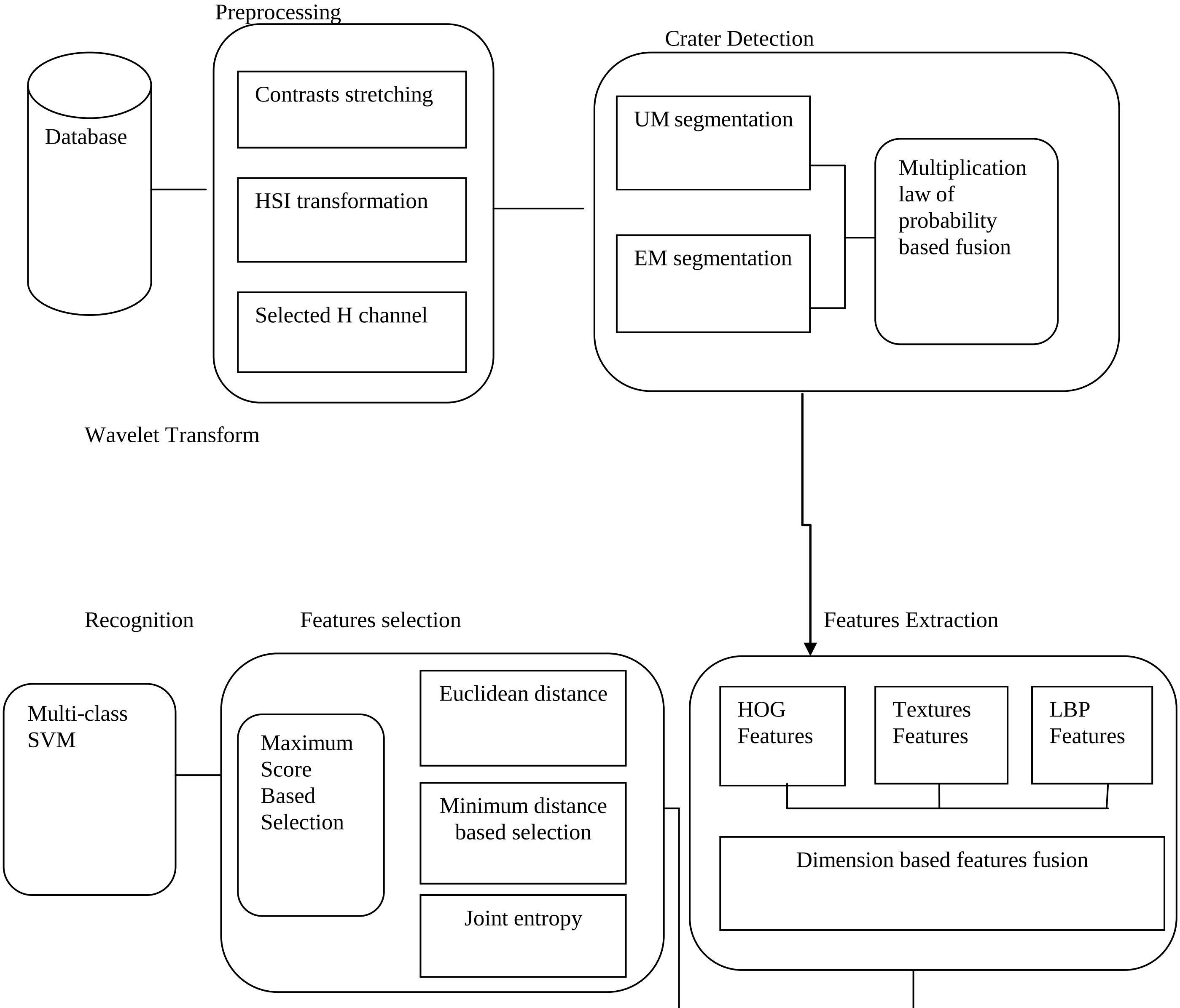
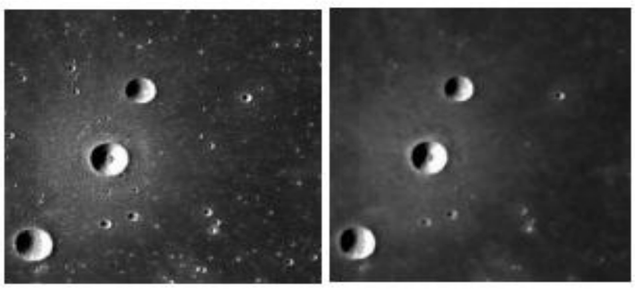


Fig. 1. Proposed hybrid Method Structure

III. RESULT & DISCUSSION

According to image quality parameter the Mean Square Error (MSE) which is having very small value gives better result and Peak Signal to Noise Ratio (PSNR) which is having high value gives better result.



(A) Input Image
(B) Noise Removal

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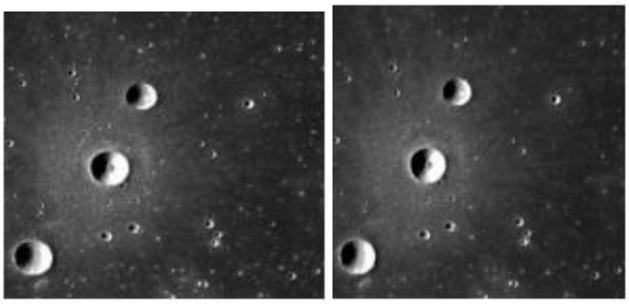

(C) Quality Improve **(D) Border Remove**

Fig. 2. Preprocessing step of crater detection algorithm.

Fig. 2. shows all the preprocessing steps as discussed in Methodology part.

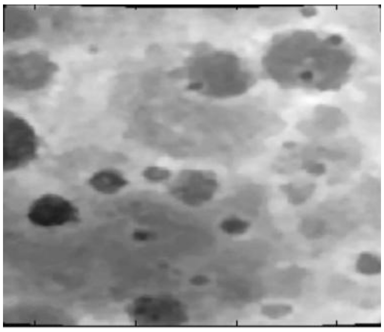

Fig. 3(a). Input Image.

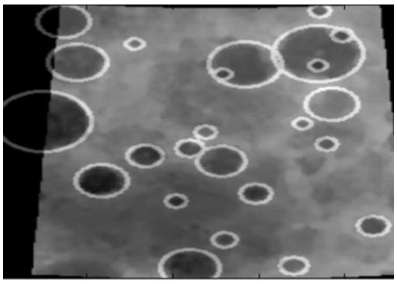

Fig. 3(b). Crater Detection By hybrid method.

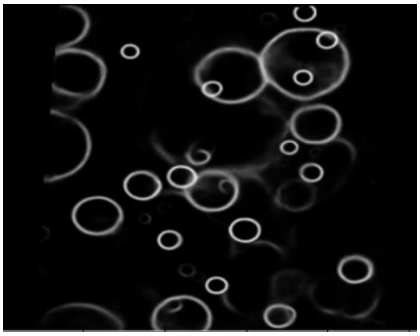

Fig. 3(C). Region mark by hybrid.

Fig. 3(a), 3(b), 3(c) shows the result of proposed hybrid method.

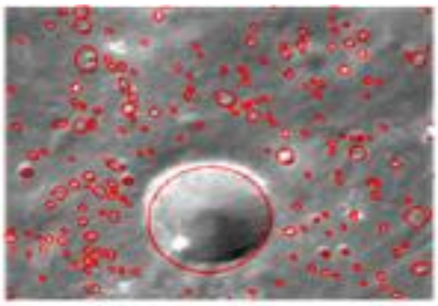

Fig. 4(a) Crater marked by KNN method

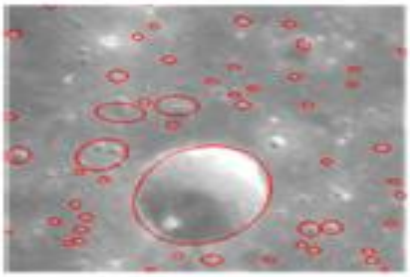

Fig. 4(b)crater maked by SVD Method.

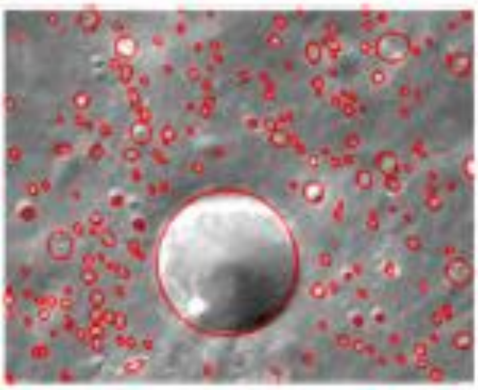

Fig. 4(c)crater maked by hybrid Method.

Fig. 4(a), 4(b),4(c) shows Crater marked by KNN, SVD and Hybrid method.
TableI and Figure 5 shows crater detected by the SVD method

Table I: SVD based Actual craters and detected Craters.

Images	***Crater***	***Detection***
Chandrayaan - TMC 1 (8a)	380	360
Chandrayaan - TMC 2 (8b)	310	300
Chandrayaan - TMC 3	244	227

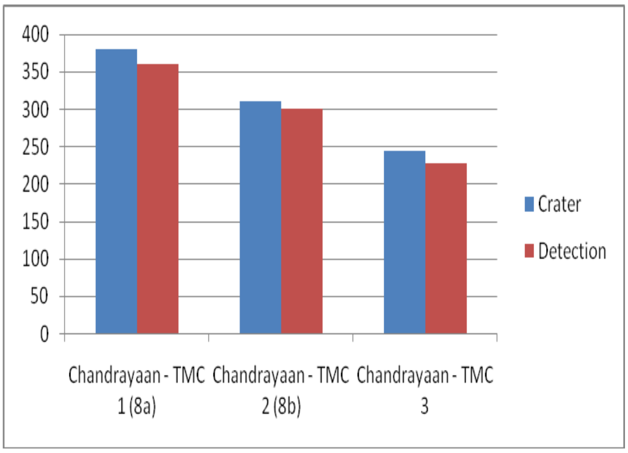

Fig. 5. Charts of actual craters and detected craters.

Table II: KNN based actual crater and detected crater.

Images	*Crater*	*Detection*
Chandrayaan - TMC 1 (8a)	381	361
Chandrayaan - TMC 2 (8b)	309	301
Chandrayaan - TMC 3	240	229

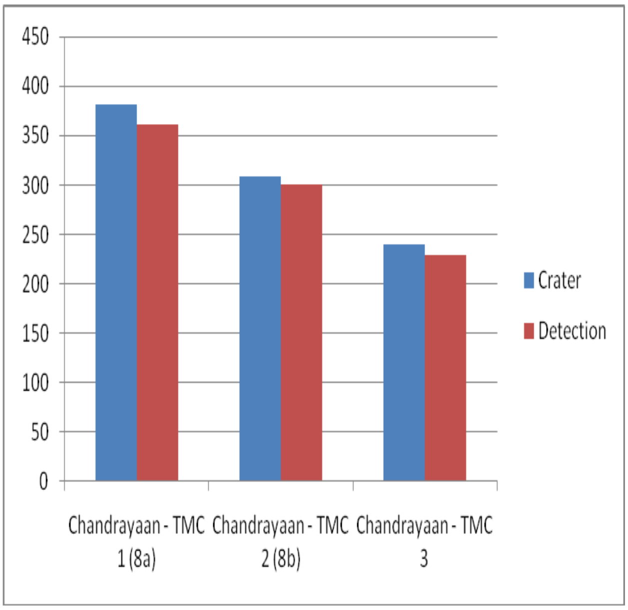

Fig. 6. Chart of KNN basedactual craters and detected craters.

Table III: Hybrid based Actual craters and Detected craters

Images	*Crater*	*Detection*
Chandrayaan - TMC 1 (8a)	378	363
Chandrayaan - TMC 2 (8b)	311	298
Chandrayaan - TMC 3	241	228

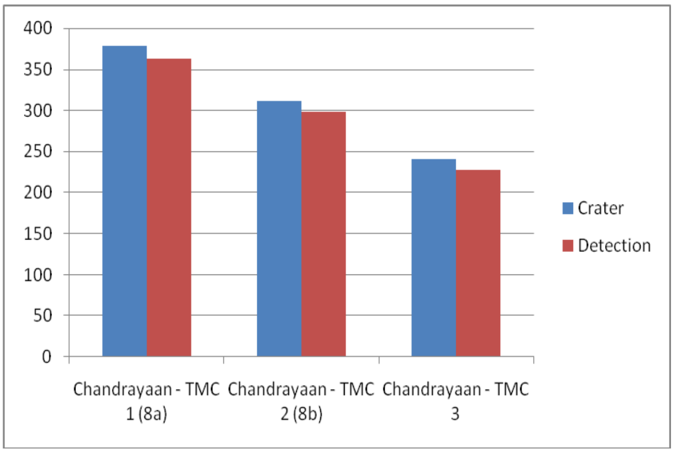

Fig. 7. chart of Hybrid method for actual craters and detected Craters.

Table IV : MSE and PSNR analysis of SVD Crater detection method

Images	*MSE*	*PSNR*
Chandrayaan - TMC 1 (8a)	0.86	28.13
Chandrayaan - TMC 2 (8b)	0.74	29.41
Chandrayaan - TMC 3	0.79	26.56

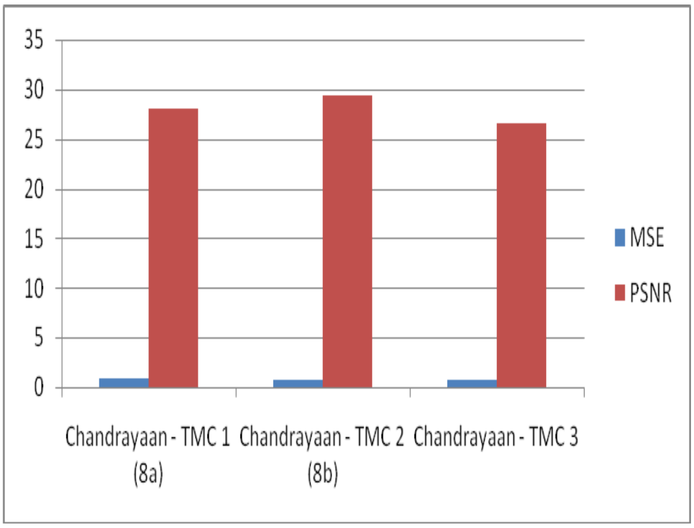

Fig. 8. Chart of MSE and PSNR analysis of SVD Crater detection method.

Table V: MSE and PSNR analysis of KNN Method

Images	*MSE*	*PSNR*
Chandrayaan - TMC 1 (8a)	0.82	29.91
Chandrayaan - TMC 2 (8b)	0.78	30.36
Chandrayaan - TMC 3	0.81	29.51

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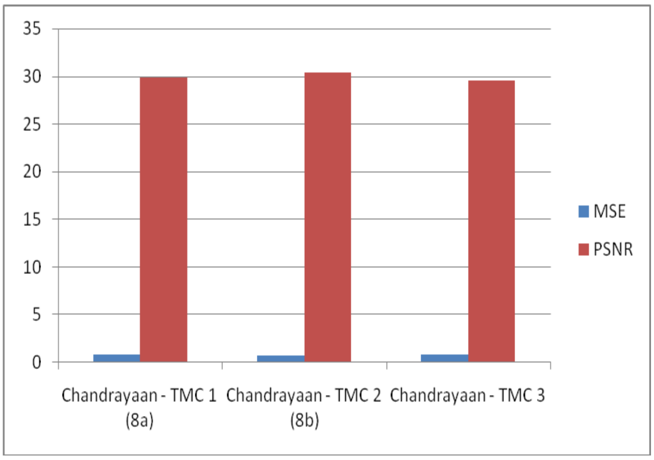

Fig. 9. Chart of MSE and PSNR analysis of KNN Crater detection method.

Table VI: MSE and PSNR analysis using HYBRID method

Images	*MSE*	*PSNR*
Chandrayaan - TMC 1 (8a)	0.72	31.13
Chandrayaan - TMC 2 (8b)	0.71	30.46
Chandrayaan - TMC 3	0.76	31.25

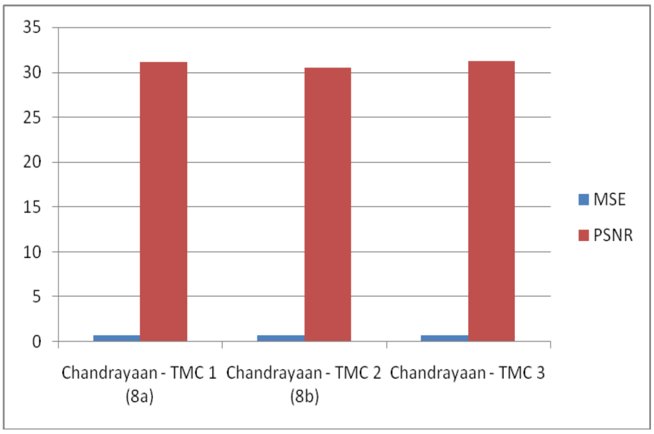

Fig. 10. Chart of MSE and PSNR analysis using HYBRID method

IV. CONCLUSION

Moon crater detection is big challenge. This paper proposed KNN, SVD for detection of crater based on shape and sizeand also Hybid method takes the advantages of both SVD and KNN From Fig. 2- Fig. 10 and Table I- Table VI it is clear that hybrid method gives better result in case of MSE and PSNR.KNN performs better than SVD .Crater attributes (shape, size) have been computed by using segmentation and distance approximation method. In a process we used Chandrayaan 1 data for estimation and detection of crater.

A. Abbreviations and Acronyms

SVD- Singular Value Decomposition
KNN- K- Neraest Neighbour
MSE- Mean Square Error
PSNR- Peak Signal to Noise Ratio
TMC- Terrain Mapping stereo Camera

REFERENCES

1. E.R. Urbach and T.F. Stepinski, “Automatic detection of sub-km craters in high resolution planetary images,” *Planet. Space Sci*., vol. 57, 2009, pp. 880–887.
2. Z. Yue, J. Liu and G. Wu, “Automated detection of lunar craters based on objectoriented approach,” *Chin. Sci. Bull.*, vol.53, 2008, pp. 3699–3704.
3. J.R. Kim, J. Muller, S. van Gasselt, J.G. Morley and G. Neukum, “Automated crater detection, a new tool for Mars cartography and chronology, ”*Photogramm. Eng. Remote Sens.*, vol. 71, 2005,pp. 1205.
4. Rohan Sood, LoicChappaz Henry, J. Melosh C. Kathleen, Howell Colleen, Milbury, , David, Blaird Maria and T. Zuber, “Detection and characterization of buried lunar craters with GRAIL data,” *Elsevier*, vol. 289,2017, pp. 157-172.
5. R.S. Kumar, A. Lavanya, K. Vani and S. Sanjeevi, “Fusion Based Approach For Automatic Lunar-Crater Detection,” *ActaFutura* vol. 5, 2012, pp. 163-172.
6. Amee Jain ,Suresh K , DarshakThakore , Narendra Patel, “Automatic Crater Detection On Lunar Surface,” *International journal of Innovative research in science, engineering and Technology*, vol. 2, 2013, pp. 92-96.
7. J.B. Saraiva, P. Pina, “A Structured Approach to Automated Crater Detection”,37th Annual Lunar and planetary Science Conference, 2006.
8. Yang Cheng, Andrew Edie Johnson, Larry H. Matthiesand Clark Olson, “Optical Landmark Detection for Spacecraft Navigation,” 13th AAS/AIAA Space flight meet, 2003.

AUTHORS PROFILE

Arpita Baronia obtained her Bachelors Degree in Computer Science and Engineering from RGPV, Bhopal and Master Degree in Remote Sensing GIS and GPS From MANIT, Bhopal. She is Research scholar at centre for Remote sensing, GIS and GPS at MANIT, Bhopal ,India. Her area of interest is Remote Sensing, Planetary Research, Image Processing.

Dr. Jyoti Sarup, Associate Professor Civil Engineering Department MANIT, Bhopal. She has published more than 43 papers in different International and National Journals and Confrences. She has Received Young Scientist award by MPCOST , Bhopal, Her research areas include image processing, Remote sensing, GIS, Microwave Remote Sensing.