COMPARISON OF DEMS FROM TERRAIN MAPPING CAMERA IMAGES WITH LOLA. Krishna Sumanth T , V.Nagasubramanian, P.V.Radhadevi, D. Sudheer Reddy, S.S.Solanki, M.V Jyothi, J.Saibaba and Geeta Varadan. Advanced Data Processing Research Institute, Department of Space, Manovikasnagar P.O., Secunderabad 500 009, India, e-mail: drpvr@adrin.res.in

Introduction: The Terrain Mapping Camera (TMC) of Chandrayaan-1 has three CCD arrays acquiring stereo triplets from Fore (F), Nadir (N) and Aft (A) views with a spatial resolution of 5m. In this paper, we compare the TMC DEM with LOLA 256 pixels per degree (PPD) interpolated DEM. The quality of these DEMs is quite visible when features are compared with LOLA DEMs. The vertical accuracy is of the order of 100 to 200mts. The results presented here are generated from the software package called Lunar Mapping System (LMS), which will handle full-pass data for operational generation of Digital Elevation Models (DEM) and Ortho products from TMC images of CH-1.

Methods: The main objective of LMS is the generation of accurate DEMs and orthos from TMC images. The orbit attitude model is based on the viewing geometry of the satellite, combining the principles of photogrammetric collinearity equations. Clementine UVVIS ortho images and LOLA DEM are the references used from which Lunar Control Points for correcting the EO parameters are identified. Area based image matching using cross correlation is used for DEM generation. Hierarchical approach for matching is performed at different levels from coarse-to-fine images. For each level, the mismatches are removed using a spike removal algorithm and automatic quality control algorithms are also incorporated. Least square matching methods is implemented to achieve sub-pixel accuracy at the final level pyramid. As the results of image matching between Fore and Aft combination is poor, matching is done between Nadir-Aft and Nadir-Fore combinations for DEM generation**.** Full strip data with approximately 3,00,000 lines are processed and long strips of DEMs are generated. The sensor viewing geometry and process of DEM generation from TMC is given in [1], [2], [3].

Data Description: Two data sets are used for testing namely 1174 and 440 orbits whose lengths are 900km and 960km respectively. The minimum and maximum heights over the area of 1174 are -2052m and 656m and that of orbit no 440 are -2724m and 2202m.

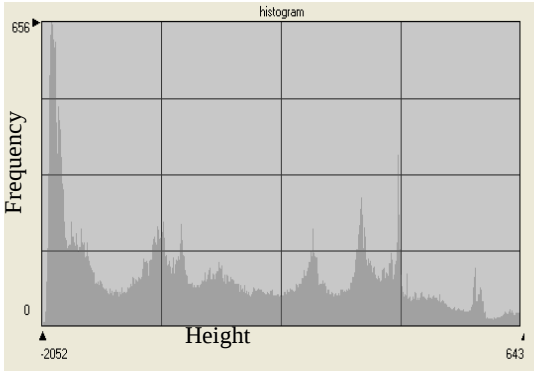
Results and Discussion: A comparative study is also made to select a reference DEM between available 64, 256, and 1024 PPD LOLA interpolated DEMs. The difference in heights between LMS-DEM and LOLA-DEM is calculated for every pixel. The result obtained for 256 PPD LOLA DEM and for orbit 1174 and 440 of LMS DEMs is shown in Table-1.

Table 1 Height error range and corresponding %

Orbit no: 1174 Total points compared: 617818		Orbit no: 440 Total points compared: 1819817	
Error Range (m)	% of points	Error Range (m)	% of points
0 to 34	29	0 to 78	26
34 to 102	37	78 to 156	33
102 to 170	17	156 to 235	18
170 to 238	7	235 to 313	7

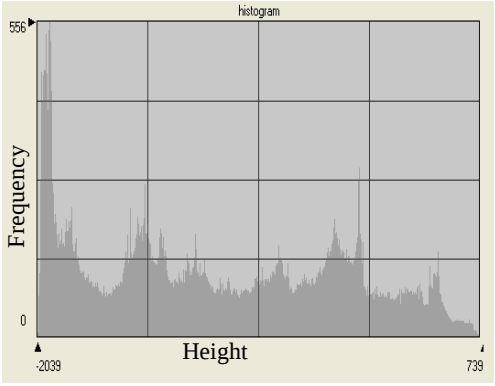
Table 1 describes the total number of points compared and the % of points that resulted in the corresponding error range. it is clear that that 83% of the points are within the height error of 170m for orbit 1174 and 77% of the points are within 235 m for orbit 440. Around 15% of the points have errors beyond 250 m.

The histograms of full profile of 1174 and the corresponding area extracted from LOLA are shown in figures (2a) and (2b). Perfect similarity in histogram of heights between these two can be observed.



Figure(2a) Histogram of DEM of orbit No. 1174 of TMC generated through LMS.

Figures (3a) and (3b) shows the profile considered over a single scan line (a particular latitude) of LOLA and LMS DEM respectively. Figures (4a) and (4b) shows a portion of DEMs generated from TMC and LOLA. More features are clearly visible in LMS-DEM compared to LOLA



Figure(2b) Histogram of DEM of an equivalent area of Orbit No. 1174 extracted from LOLA with 256 PPD.

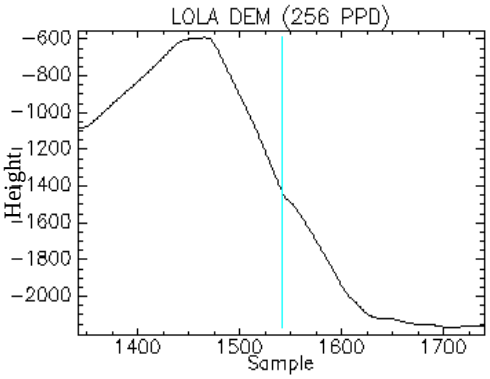


Figure (3a) Profile showing for LOLA DEM

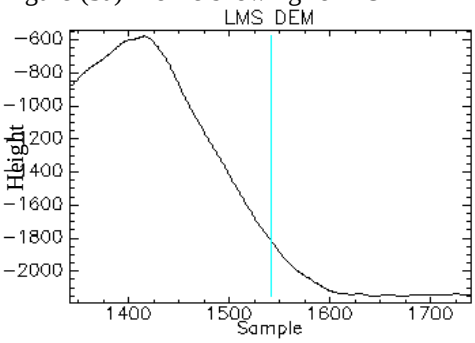
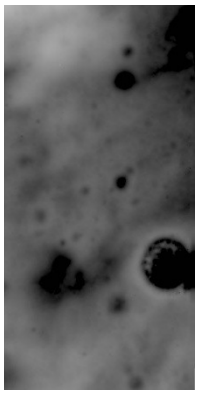


Figure (3b) Profile showing for LMS DEM

Figure(5) shows the 3D model generated with ortho overlaid onto DEM near "Roberston" crater at 21.8° lat and 105.2° lon.



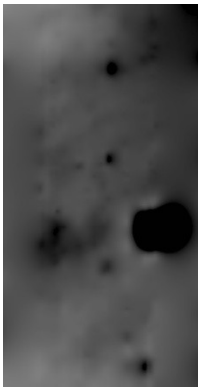


Figure (4a) TMC DEM (4b) LOLA DEM

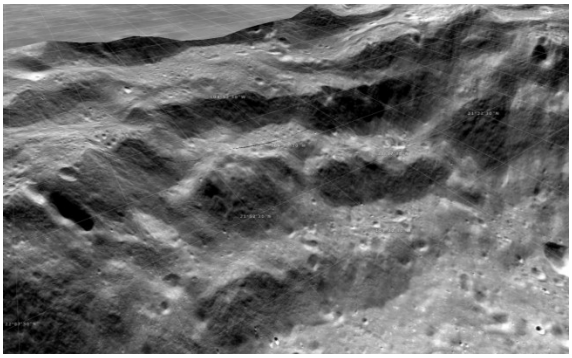


Figure (5) 3D model generated from orbit 1174

Conclusions: These results clearly show that the TMC DEMs are of high quality and accurate which also enables to construct 3D models. They are representative of the stability of the platform and the potential of CH-1 for accurate lunar referencing.The data products generated from LMS are made available in public domain through Indian Space Science Data Centre (ISSDC) which is designed to host the science data archives from the Indian science missions. (www.issdc.gov.in).

References: [1] B. Gopala Krishna, Amitabh, Sanjay Singh, P. K. Srivastava and A. S. Kiran Kumar, Digital Elevation Models of The Lunar Surface From Chandrayaan-1 Terrain Mapping Camera (Tmc) Imagery – Initial Results, 40th LPSC conference, P.No., 1694, 2009.

[2] V.Nagasubramanian, P.V.Radhadevi , Krishna Sumanth T, D.Sudheer Reddy, J.Saibaba and Geeta Varadan, 3D visualization of the lunar surface from images of terrain mapping camera. 42nd LPSC Conference, P.No. 1389, 2011.

[3] P.V.Radhadevi, V. Nagasubramanian, S.S.-Solanki, Krishna Sumanth T, J. Saibaba and Geeta Varadan, Rigorous Photogrammetric processing of Chandrayaan-1 Terrain Mapping Camera (TMC) images for Lunar Topographic Mapping. 42nd LPSC Conference, P.No. 1384, 2011.