THE TERRAIN MAPPING CAMERA ON CHANDRAYAAN-1 AND INITIAL RESULTS. A. S. Kiran Kumar, A. Roy Chowdhury, K. R. Murali, S. S. Sarkar, S.R. Joshi, V.D. Patel, A.B. Dave, K.J. Shah, A. Banerjee, A. S. Arya, Prakash Chauhan, K. Mathew and B.N. Sharma. Space Applications Centre (ISRO), Ahmedabad – 380058 (India), kiran@sac.isro.gov.in, arc@sac.isro.gov.in.

Introduction: The Terrain Mapping Camera (TMC) [1,2] is the streoscopic imaging instrument in the visible spectral band on Chandrayaan-1 which was successfully launched on 22 October 2008. The first operation of TMC was during one of the earth transfer orbits where it took images of the Earth and the Moon. Chandrayaan-1 reached the 100km polar circular orbit around Moon on 12 November 2008. TMC is now imaging the lunar surface in the operational mode after completion of the checkout phase. This paper gives a brief description of the TMC instrument and initial results.

TMC instrument: TMC is a panchromatic, stereoscopic instrument for mapping the entire lunar topography - near side, far side and the polar regions. This will enable preparation of three dimensional atlas of the Moon with high spatial sampled data. TMC images the lunar surface in push-broom mode in the visible spectral band. For obtaining the elevation information the camera has along-track stereo viewing, acquiring stereo triplet of the target scene in the fore, nadir and aft views, as the spacecraft moves in its 100km polar circular orbit. The entire lunar surface can thus be imaged without occlusion with at least one stereo pair. Elevation information from TMC is an important input for analysis and interpretation of data of other instruments on Chandrayaan-1. TMC is compact, low power dissipating and low weight instrument. The flight model is ahown in Fig. 1.

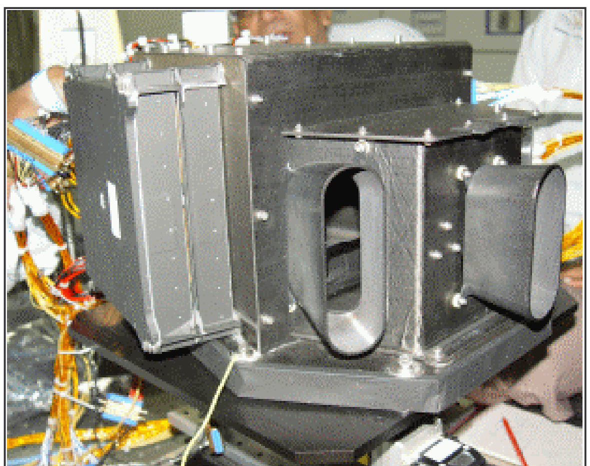

Fig. 1. TMC instrument flight model

Features: TMC images the lunar surface in the panchromatic spectral band of 500-750nm and has a spatial sampling of 5m. The fore and aft views are ± 25° w.r.t nadir view in the along track direction giving a base to height ratio of 1. The swath of the instrument is 20km and with orbital shift of 20km between two imaging seasons, total coverage of lunar surface at equator with adequate overlap is ensured.

TMC will measure the solar radiation reflected from the Moon's surface. The dynamic range of the reflected signal is represented by the two extreme targets – high albedo fresh anorthosite and low albedo mature mare soil. The other factors affecting the illumination are the seasonal variation, latitude-longitude of the scene, topography and anisotropic reflectance of lunar surface. TMC's radiometric range of 4096 levels will cover the total dynamic range. Four programmable gain and exposure settings are also available. The instrument can be set in a wide range from about 4 to 30 mW/cm^2-sr-μ, thus ensuring optimum coverage of different features. For low illumination conditions, improved SNR is achievable by increased integration time.

The TMC data is losslessly compressed for transmission, a compression bypass mode is also available. The TMC requires 1.8W regulated supply and weighs 6.3kg. The operating temperature limit of the instrument is 10 to 30°C and is maintained with passive thermal control technique augumented with auto / commandable heaters.

The development of the flight model of the instrument was carried out in stages with independent verification and performance optimization at subsystem level and at final instrument level. The integrated payload has undergone successful environmental testing including thermo-vacuum cycling and vibration test. Various electro-optical parameters have been measured during these tests and are found to meet the specifications with sufficient margins. The Square Wave Response (SWR) is better than 25 and the system performance is photon noise limited.

The ground test results of the instrument indicates satisfactory performance [3].

Imaging plans: Scene illumination over the moon varies as the solar aspect angle goes through a yearly cycle. Limiting the solar aspect angle to ±30° at the equator to minimize variation of illumination conditions will provide about two months of prime imaging period every six months leading to four prime imaging seasons during the two year mission life. During the prime-imaging seasons, regions between 60°N and 60°S will be covered. This requires 20min imaging per orbit for six orbits per day. The solar illumination at polar regions (above 60° latitude) is poor in all seasons, and these regions will be covered during the remaining periods, termed as the secondary imaging seasons.

Discussion: On-orbit, TMC was first operated on 29 October 2008 from the earth transfer orbit. The first image of Earth taken from a distance of ~70,000km shows parts of the Australia. Fig. 2 shows images taken by TMC. Details of the on-orbit performance will be presented.

Acknowledgements: The authors acknowledge with thanks the contribution of all colleagues. We also gratefully acknowledge the constant encouragement and guidance received from Dr. RamRattan, Associate Director and Dr. R.R Navalgund, Director Space Applications Centre.

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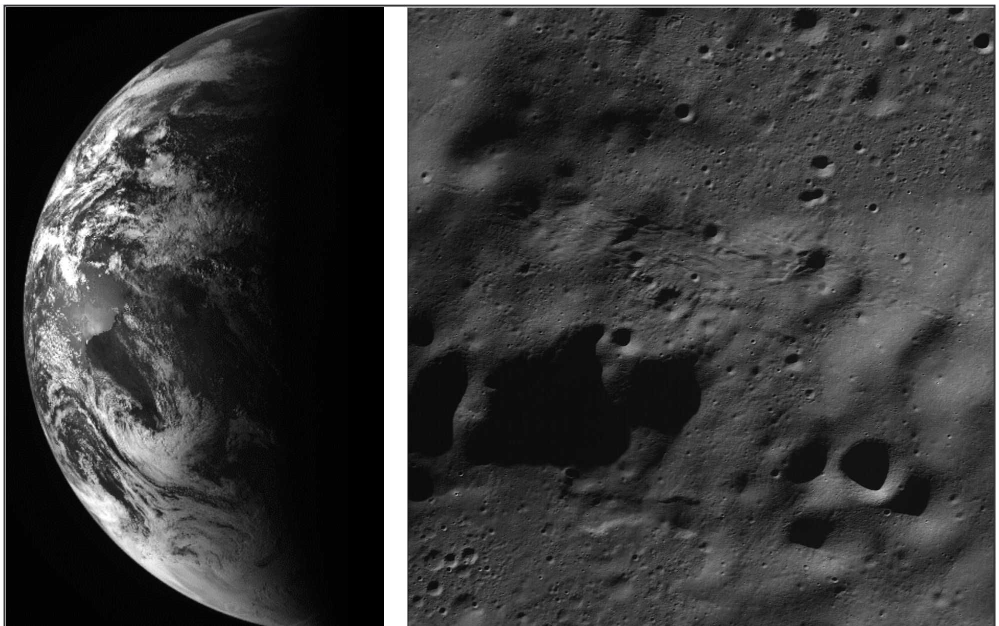

Fig. 2. a) Earth view on 29-10-08 (Altitude ~ 70,000 km)
b) Near South pole from the 100km orbit on 12-11-08