

**DIGITAL PHOTOGRAMMETRIC MAPPING NEAR THE SOUTH POLE OF THE MOON BASED ON CLEMENTINE IMAGES AND ULCN2005**Xiaogang Ning<sup>1</sup>, Xiaotao Chang<sup>1</sup>, Jixian Zhang<sup>1</sup>, Bruce King<sup>2</sup><sup>1</sup>Chinese Academy of Surveying and Mapping, Beijing, P.R.C. ningxg(changtao, zhangjx)@casm.ac.cn<sup>2</sup>Department of Land Surveying & Geo-Informatics, Hong Kong Polytechnic University, Hung Hom, Hong Kong, P.R.C. bruce.king@polyu.edu.hk

**Abstract:** In the 17th Century, when Galileo first turned his telescope heavenwards, planimetric mapping of the Moon began. Detailed lunar photogrammetry and topographic mapping began almost fifty years ago as global attention focused on the "space race" plan, at the same time, the new imaging sensors technology, cameras, were applied to Lunar exploration. The first images were obtained by the Soviet Union's Luna-3 mission in October 1959 which also provided the first ever sight of the far side of the Moon. Following several decades, the United State's Ranger Series (1962-1965), Surveyor Series (1966-1968), Lunar Orbiter Series (1966-1967), Apollo Series (1969-1972), Clementine (1994) and Lunar Prospector (1998) provided images with increased spatial and spectral resolution and supplementary sensors including gravimeters, magnetometers, particle spectrometers and laser altimeters. In recent years, interest in the Moon has increased with the European Space Agency's Smart-1 launched in 2006, the Japanese Kaguya launched in 2007 and the Chinese Chang'e-1 launched on October 24 2007. Chang'e-1 made the 385,000 km trip to the orbit from the moon surface 200 km and the first image was displayed to the world on 26 November 2007.

In order to research the necessary specialist techniques that are required in undertaking extraterrestrial topographic mapping with the Chang'e-1 remote data, a pilot study was undertaken which based on imagery from the Clementine mission and the Unified Lunar Control Network 2005 (ULCN2005).

The study selects Clementine imagery as data source to photogrammetrically create a DTM of a portion of southern polar region, by which to construct a credible and feasible methodology for photogrammetric mapping of the Moon with Chang'e-1 imagery. An important aspect of this study is to make use of existing photogrammetric software rather than to develop specialised processing algorithms to accomplish lunar mapping. By several digital photogrammetric softwares being evaluated and tried out, the Leica Photogrammetric System (LPS) finally been chosen.

This study firstly presents a review of the Clementine mission and how its data has been used. Following this, the methodology for photogrammetric mapping of the Moon which based on Clementine and

ULCN2005 is presented. And the important steps like images selection, Pre-processing, Control for images, Photogrammetric processing are described. Last, the experiment demonstrates the feasibility that using Chang'e-1 data to create DTM and relief map. The experiment selects a portion of the southern polar region of the Moon (W109.7°-W163.4°, S69.3°-S84.2°, the area is about  $1.5 \times 10^5 \text{ km}^2$ ) to create DTM and relief map in which 60 Clementine UVVIS images from 10 orbits, 408 ULCN2005 points, among which 56 were check points, and 1337 tie points are included. The planimetric and vertical resulting RMS error of the control points were 98.639 meters (0.19 pixels) and 1003.751 meters (1.93 pixels). The final part presents a methodology for photogrammetric mapping of the Moon which uses the Chang'e-1 imagery and the method in this article followed by the feasibility to be analysed.