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DEM Generation Using Cartosat-I Stereo Data and its Comparison with Publically Available DEM

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Abstract

Cartosat-I or IRS P5 (Indian Remote Sensing Satellite) is a remote sensing satellite meant for cartographic applications like generation of Digital Elevation Model (DEM) and was launched by Indian Space research organization (ISRO). The paper aims to generate a high quality DEM from Cartosat-I stereo data by means of Leica Photogrammetry Suite (LPS) and thereby comparing the generated DEM with publically available DEMs like ASTER DEM, SRTM DEM and three versions CartoDEMs from NRSC. Results from the study shows that the DEM generated from Cartosat-I stereo data using LPS is more accurate than the publically available Carto DEMs but less accurate than the ASTER and the SRTM DEMs.

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1. Introduction

A Digital Elevation Model (DEM) is a representation of altitude of Earth surface with latitude and longitude i.e. X, Y horizontal coordinates and height Z [1]. The terms Digital Elevation Model (DEM), Digital Terrain Model (DTM) and Digital Surface Model (DSM) are synonymously used in scientific literature. However, the term digital surface model represents the earth's surface and includes all objects like plants and buildings. But,

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the DTM or DEM represents the bare ground surface. Though there are several versions, the suitability of a variety of DEM data for a particular situation depends on the project specifications [2].

DEMs that are available in public domain are ASTER (Advanced Spaceborne Thermal Emission Radiometer Stereoscapy), SRTM (Shuttle Radar Topography Mission) and CartoDEM. Three versions of CartoDEMs are available and these versions can be downloaded from 'Bhuvan' of (NRSC). Cartosat-I provides stereo data which can be used to generate DEM with higher spatial resolution. However, having higher spatial resolution may not ensure higher accuracy in elevation data. Hence it becomes essential to have an accuracy assessment of DEM generated from different sources, in Kerala where unique topographical features exist. If a DEM with better accuracy can be developed for Kerala, a lot of manpower and money can be saved. Measurement of Ground control points from fields requires a lot time and money. Hence current study is an attempt to verify whether the accurate DEM can be generated without using any Ground Control Points.

National Remote Sensing Agency [3], has published a report on the evaluation of Indian National DEM generated from Cartosat-1 Data. This report provides the overall quality of CartoDEM version 1 in terms of absolute accuracy and a comparison with other globally available DEMs like ASTER and SRTM in terms of accuracy. These are carried out for three test areas, viz, Jagathsinghpur in Orissa, Dharmsala in Himachal Pradesh and Alwar in Rajasthan. An accuracy of 8m at 90% confidence level was obtained. Panday and Venkataraman [1] illustrates the generation of DEM from Cartosat-1 data for Chhota Shigri glacier (Himachal Pradesh, India). Leica Programmetry Suite (LPS 9.3) was used in the study to generate Digital Elevation Model. Study mainly highlights the quality of DEM generated for a hilly and glacier covered terrain. Analysis was carried out by generating DEM using Ground Control Points (GCP) and without using GCP. They found that DEM generated using GCP can be used for various applications like landslide study, climatological study and hazard study. Bhardwaj [4] demonstrated the potential of ortho-image (generated from Cartosat-1) in feature extraction and visualization. The study evaluated the accuracy of triangulation and Digital Elevation Model (DEM). The study area is taken as Jaipur city in Rajasthan. It is observed that accuracy of DEM generated from Cartosat-1 Stereo data could be improved by using good distribution of GCP's. However, collection of ground control points is an expensive affair especially when large area to be covered. Moreover, the accuracy of the generated DEM may depend on the terrain and topographical features. Such an accuracy has not been assessed in the Kerala region where unique feature of topography exists. Hence it becomes essential to compare the accuracy of publically available DEM with that of Carto DEM for this region. In this study, DEM from Cartosat-I stereo data is compared with publically available Cartosat-I DEM version 1, version 2 and version 3 and also other DEMs like ASTER and SRTM. The accuracy assessment by taking field measurement is carried out for categorically assessing the usefulness of the Cartosat I data and publically available DEM as against the already available DEM. This assessment can give an indication of how accurate currently available DEMs like SRTM DEM, ASTER DEM and CartoDEMs for general purposes. As indicated earlier, it is essential to assess the accuracy of the DEM from stereo data without using ground control points because the collection of control points requires a lot of money and time.

2. Study Area

Thrissur district is in the central region of Kerala state lying between $10^{\circ} 10'$ and $10^{\circ} 46'$ north latitude and $75^{\circ} 57'$ and $76^{\circ} 54'$ east longitude. Fifteen scenes of Cartosat-I stereo images are required for covering the entire Thrissur district. Out of the many scenes available, the one surrounding the Government Engineering College is selected. For DEM generation and evaluation purposes, one scene of Cartosat-I satellite imagery is acquired from National Remote Sensing Centre (NRSC), Hyderabad, covering the western most part of Thrissur district. This scene covers an area lying between $10^{\circ} 43'$ and $10^{\circ} 25'$ north latitude and $76^{\circ} 11'$ and $76^{\circ} 26'$ east longitude and is shown in (Fig.1).

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