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A STUDY ON THE LOW-COST DIGITAL ELEVATION MODEL (DEM) SURFACE MEASUREMENT OF LANDSLIDE MONITORING BY CLOSE RANGE PHOTOGRAMMETRY

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Abstract

This paper presents the preliminary results on a simulation study on the production of a low-cost Digital Elevation Model (DEM) on thelandslide study area in Seri Iskandar, Perak. The main objective of this paper is to present the potentiality of Close Range Photogrammetry (CRP) as a data acquisition tool in producingDigital Elevation Model (DEM) by using data from thesurface measurement. This method was applied using stereopairs photographs captured data from the ground level detection or known as close-range photogrammetry with the use of a digital camera mounted on a tripod as a tool for data collection. Close Range Photogrammetry (CRP) applications are useful for mapping of thearea that is difficult and risky to point manpower on terrain that consists of steep and dangerous slopes. Conventional methods require measurements using Electronic Distance Measuring (EDM), but this method is very costly and needs a survey team placed on land site area. The research data were carried out with two different epoch data. The result proves that CRP can produce DEM at less cost compared to other methods.

Keywords: *digital elevation model (DEM); close range photogrammetry (CRP); stereopairs; digital camera; electronic distance measuring (EDM).*

1.0 INTRODUCTION

Photogrammetry has been defined by (American Society for Photogrammetry and Remote Sensing) ASPRS as the art, science, and technology of obtaining reliable information about a physical object and the environment through processes of recording, measuring, and interpreting photographic images and patterns of recorded radiant electromagnetic energy and other phenomena [1].

In general, close-range photogrammetry (CRP) is a technique of representing and measuring 3D objects using data stored on 2D photographs, which are the base for rectification [2]. In order to obtain 3D information, two photographs of the same objects are necessary. CRP is a part of terrestrial photogrammetry but has dissimilarity in-camera to object distance. In CRP, the limit of a camera to object distance is less than 100m [3]. CRP is mostly used for deformation measurement of structures, architectural mapping, modelling buildings, documentation of artefacts, reverse engineering purposes, or remodelling traffic accidents and crime investigation. Architectural and archaeological photogrammetry are examples of CRP application that have widely been used since the 1960s [4].

The technique is implemented through stereo aerial photogrammetry and continuously developed parallel with the advancement of computer and digital technology [5]. Images on close-range photogrammetry can be captured using three types of camera: metric camera, semi-metric camera and nonmetric camera [6]. Measurements by using these digital cameras offer a low-cost imaging process, which is an attractive alternative in mapping data collection tools.

The accuracy of photogrammetric depends on camera resolution, quality of camera calibration, thegeometry of the camera position and the precision of marking the location on the images [7]. Most of the photogrammetry works need accuracy in the project. High accuracy work requires a well-calibrated camera. Landslides on sloped areas can be well detected by calculation of Digital Elevation Model (DEM) from at least two different epoch data, or by profiling of longitudinal sections or cross-section over the DEM observed slope area.

2.0 MATERIALS AND METHOD

This study was conducted in Parit, Seri Iskandar, which is located approximately at 4°23'04.03"N in latitude and 100°56'34.89"E in longitude. There are two different study sites represented in this research. This research aimsto demonstrate the capability and effectiveness of CRP as a data acquisition tool in generating DEM and inaccessible landslide monitoring.

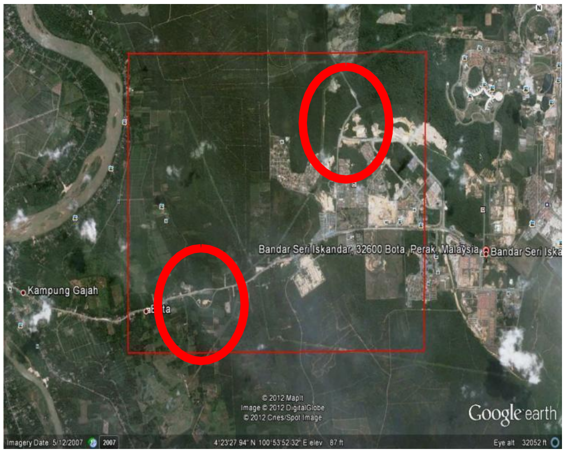

Figure 1. Location of Landslide from satellite image
(Source:http://earth.google.com)

2.1 Fieldwork Process and Control Points Establishment

The most crucial step to be carried out in this preliminary work is establishing the control point at the study site located in Seri Iskandar, Perak. It is needed to rectify images and produce a 3D model. At least three or four control points are needed in the rectifying process and six control points in producing 3D. The equipment used in establishing control points are one total station (Laser Reflectorless GTS -750 series), two tripods, prism and measuring tape.

Figure 2. Total station used in establishing control points.

Data are observations developed from monitoring the real world. Data are collected as facts or evidence that may be processed to give them meaning and then transferred into information. The data for this research were generated from field investigations at the study site.

The 3D Analyst extension allows 3D GIS data management and creation of layers with 3D viewing properties. Terrain mapping and analysis can use raster data, vector data, or both as inputs. Contouring is the most common method for terrain mapping. Contour lines connect points of equal elevation, the contour interval represents the vertical distance between contour lines, and the base contour is the contour from which contouring starts.

Suppose a DEM has elevation readings ranging from 44.883-62.628 meters. The concepts of 3D modelling description of the shape of an object consist determination of itsprincipalframe of reference and if required, creation of the textural database for the selected surfaces of the structure. The arrangement and pattern of contour lines reflect the topography. For example, contour lines are closely spaced in steep terrain and are curved in the upstream. Each commercial software has different advantages in processing the data. No measurement technology can be perfect, and all measurements involve performing approximation. ArcGIS 9.0 is no different. Not all the 3D coordinates result can be of the same quality.

2.2 Field Work Observation Results

The results of processing data from the study site consistofthree-dimensional points that have coordinate values for each of the Cartesion axes(X, Y, and Z). A 3D model is a set of connected 3D points, edges, curves and cylinders or shapes representing an object. Figure 3 represents the result of a 3D image generated from the collected data from the field site. A DEM represents a regular array of elevation points. The quality of a DEM can influence the accuracy of terrain measurements, including slope and aspect. Slope and aspect play aregular role in hydrologic modelling, snow cover evaluation, soil mapping, landslide delineation, soil erosion and predictive mapping of vegetation communities

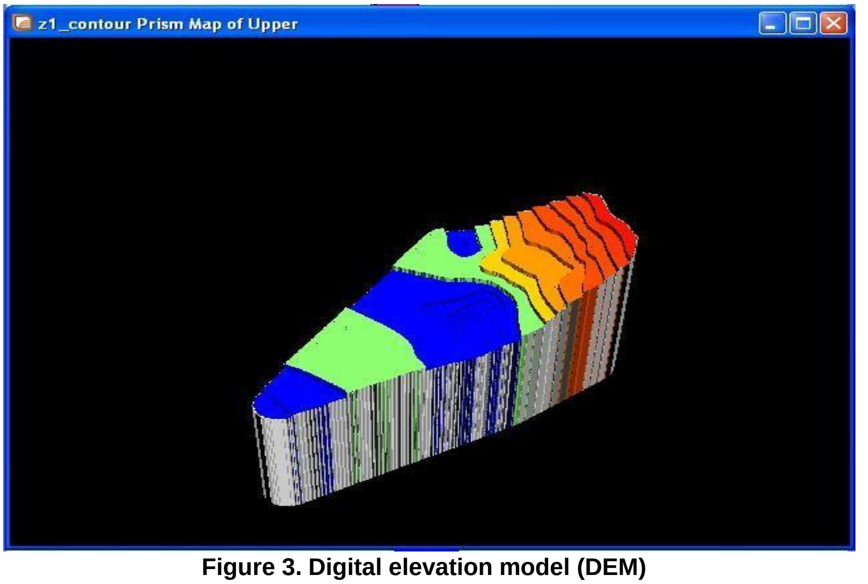

Figure 3. Digital elevation model (DEM)

Figure 4 and Figure 5 show the slope and aspect models from three-dimensional points represented by the measurement data. The slope measures the rate of change of elevation at the surface location. The slope may be expressed as percent slope or degree slope. For this paper, the result of slope is shown in degree. Aspect Model is the directional measure of a slope. Aspect starts with 0 degrees at the north moving clockwise and ends with 360 degrees also at the north. Slope and aspect were derived manually from the contour map. At the end of the study, the results show the performance of close-range photogrammetry approach generating an integration of GIS analysis as well as showing how such information can be integrated to improve our theoretical knowledge about landslide monitoring.

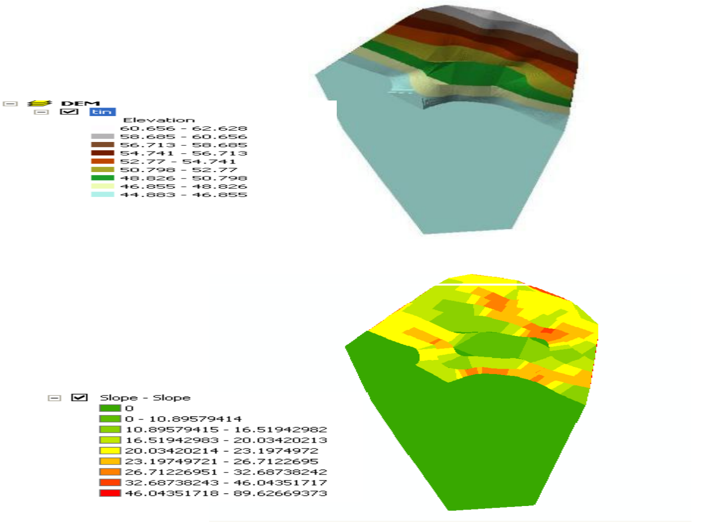

Figure 4. Elevation model (TIN)

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Sekian, terima kasih.

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Saya yang menjalankan amanah,

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