CJ TECHNICAL UPDATES

CAWANGAN JALAN

Bulletin on:
LiDAR SURVEY

THEME OF THE MONTH:
KERJA UKUR UDARA BAGI PROJEK SARAWAK – SABAH LINK ROAD

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1.1 Introduction

LiDAR or Light Detection and Ranging is a remote sensing method uses to examine the surface of the earth. These light pulse are combined with other data recorded by the airborne system to generate precise, three-dimensional information about the shape of the Earth and its surface characteristics. LiDAR creates an image using thousands of points of data.

1.2 Objective

The purpose of the detailed Airbone Survey (LiDAR) & Digital Imagery survey is to provide all the necessary data information required for ongoing studies, preliminary investigation, and preliminary alignment design for the above project.

1.3 Project Brief

This project focuses on the acquisition and processing of LiDAR and image data for the area covered by a proposed road corridor and its surrounding, Sarawak region-Malaysia with a focus on topographic and geography data. LiDAR survey method is definitely a suitable method to survey the corridor with uniform survey accuracy.

1.4 How Does LiDAR Work

A LiDAR instrument consists of a laser, a scanner and a GPS (Global Positioning System) receiver mounted on a platform. This platform may be mobile or stationary, aerial or terrestrial, based on the needs of the application the laser, scanner and GPS receiver are the only constants.
Topographic LiDAR measures distances on land using a near-infrared laser. This is essential for the majority of civil engineering, roadwork and mining operations, which require measuring distances on land.

LiDAR works by using a laser that is fired from a sensor or scanner. The laser then bounces back from whatever it hits and the sensor records the time it takes to return with a simple equation using the time, multiplied by the speed of light (300,000km per second) and divided by two to counter the return journey, used to determine the distance travelled.

This in turn gives an accurate positioning point of where that single laser beam hit; only the sensor is capable of firing out hundreds of thousands of beams in quick succession, which quickly builds up into a detailed 'visual' representation of what the sensor is focused on – be it directly below, above or at an oblique angle, while also filtering out any additional reflections or 'backscattering' from the laser's travels. As one relatively simple example, LiDAR technology is used in police speed guns, with several readings of the car's distance over a very short period enabling the device to calculate its speed.

The LiDAR component of the flight was required to generate a point cloud with +12 pts/sqm minimum. The point cloud was to be classified in ground, non-ground points stripe wise, a final calibration between the stripes to perform, adjustment to previously measured GCP (Ground Control Point) and DTM (Digital Terrain Model) data with 1m resolution to provide as one large file covering the largest area.

1.5 Flying Permit

Flying permit must be obtained from Unit Pemodenan Perkhidmatan Negeri (UPPN) from CM Department, Sarawak and Jabatan Ukur Dan Pemetaan Malaysia (JUPEM).

1.6 Survey Area

The Area of Interest (AOI) for the LiDAR survey are 1 Kilometer width corridor, which is 500 meters on the left and 500 meters on the right of the centerline. The total distance of the centerline given are 90 Kilometer approximate, which passes through Long Sukang to Long Lopeng and ends at Kg. Pa' Berunut. The total area covered is 9000 Hectares.

1.7 Ground Survey Prior To LiDAR Flight

3 Survey Parties mobilized to the site to do the reconnaissance surveys, and to look for the Survey Origin That to be used for this Survey. 3 Survey Mark namely; STG8421, STG6845 and STG5434 were selected and being used as the survey datums.

1.8 GPS Base Station

2 locations within the survey corridor were selected as the GPS Base Stations. GPS Base Station is consisting of Global Navigation Satellite System (GNSS) Receiver that configured with 1 second epoch observation, with Static Survey method were implemented. This GPS are required to provide post-processing correction to the

LiDAR data captured from the aircraft platform. In this survey exercise, we designed the GPS Base Station and the radius for each station

1.9 Sunday Aircraft

The acquisition flights were done using GAF Nomad N22C (Reg.9M-LL1) fix wing aircraft based in Miri – Sarawak and operated by local Malaysia aircrew M/s Layang-Layang Aerospace Sdn. Bhd.

GAF Nomad N22C (Reg. 9M-LL1) Aircraft

1.10 Project Time Frame

LiDAR data were collected on 10 separate days throughout between the 24 to 28 of November 2019 and 2 to 5 of December 2019. The flying days are not consecutive due to bad weather conditions in the survey area. Table 1 shows the flying dates and the flown lines of the project flight plan. Also, there were 2 different flight plans used including re-flight plan.

Table 1: dates and flown lines of the project flight plan

Date	Lines/Area
24 & 25.11.2019	Installation & Calibration LiDAR Equipment
26 & 27.11.2019	Middle
28 & 29.11.2019	South
02 & 03.12.2019	North
04 & 05.12.2019	Re-flight Plan

Instrument Used: Riegl LMS-Q780 Scanner

Figure 2: Riegl LMS-Q780 Scanner

The LMS-Q780 long-range airborne laser scanner uses a powerful laser source, Multiple Time Around (MTA) processing, echo digitization and waveform analysis. This combination allows operating at varying flight altitudes and is ideal for aerial survey of complex terrain and high altitudes.

- Up to 266000 measurements/sec on the ground;
- Operating flight up 15500 ft AGL (above ground level);
- Multiple time around processing: more than 10 pulses (MTA zone 10) simultaneously in the air;
- Full waveform analysis for unlimited number of target echoes;
- High laser pulse repetition rates up to 400 kHz;
- Various laser power settings for different fields of application;
- High ranging accuracy ≤ 20mm;
- High scan speeds up to 200 lines/sec;
- Wide scan field of view of 60^{o};
- Parallel scan lines;
- Interface for smooth and direct GNSS-time synchronization;
- Seamless integration and compatibility with other Riegl ALS-systems and software packages.

1.11 Survey Origin for LiDAR & Test / Calibration Point

Station Name	Coordinate in Borneo RSO		
	Easting (m)	Northing (m)	Elevation (m)
STG8421	2628357.486	5456437.770	624.14
STG6845	2642957.694	5504042.577	528.82
STG5434	2638072.898	5532737.991	30.54

Figure 4: Survey Origin

Figure 5: GPS Ground Base Station for LiDAR Flight

Station Name	Coordinate in Borneo RSO		
	Easting (m)	Northing (m)	Elevation (m)
BASE 1	2635078.964	5514580.808	632.134
BASE 2	2641087.041	5482587.465	465.004

GNSS Receivers Used: Trimble R5 GPS Receivers (Antenna Type: Zephyr Geodetic 2)

1.12 Deliverables

i. Digital Elevation Models (DEM)

Digital Elevation Models (DEM) are a type of raster GIS layer. In a DEM, each cell of raster GIS layer has a value corresponding to its elevation (z-values at regularly spaced intervals). DEM data files contain the elevation of the terrain over a specified area, usually at a fixed grid interval over the “Bare Earth”. The intervals between each of the grid points will always be referenced to some geographical coordinate system (latitude and longitude or UTM (Universal Transverse Mercator) coordinate systems (Easting and Northing). For more detailed the information in DEM data file, it is necessary that grid points are closer together. The details of the peaks and valleys in the terrain will be better modeled with small grid spacing than when the grid intervals are very large.

In short: DEM is used to refer specifically to a raster or regular grid of spot heights.

ii. Digital Terrain Model (DTM)

A digital terrain model (DTM) can be described as a three – dimensional representation of a terrain surface consisting of X, Y, Z coordinates stored in digital form. It includes not only heights and elevations but other geographical elements and natural features such as rivers, ridge lines, etc. A DTM is effectively a DEM that has been augmented by elements such as breaklines and observations other than the original data to correct for artifacts produced by using only the original data. With the increasing use of computers in engineering and the development of fast three-dimensional computer graphics the DTM is becoming a powerful tool for a great number of applications in the earth and the engineering sciences.

iii. Digital Surface Model (DSM)

Digital Surface Model (DSM) represents the MSL (Mean Sea Level) elevations of the reflective surfaces of trees, buildings, and other features elevated above the “Bare Earth”.

In short: digital surface model represents the earth’s surface and includes all objects on it.

iv. Digital Orthophotos

Mosaiced, corrected (ortho-rectified) & Geo-Referenced to BRSO Digital Orthophotos shall be submitted. The digital Orthophotos files shall be delivered in GeoTIFF or ECW (Enhanced Compression Wavelet) Format with suitable image resolution.

v. LiDAR Raw Data

The completed data collection raw output in ASCII (American Standard Code for Information Interchange) (all recorded returns), GPS time, Intensity x, y, z for points used to generate DEM. Point cloud data shall be provided in LAS (LASer) format and shall record intensity value for each laser return.

1.13 Advantages Of LiDAR

- **Speed:** LiDAR can collect a million points of data per second, making it an exceptionally fast method of surveying. Scans of building interiors can last an average of three minutes, but even large-scale surveys can take under an hour to complete, making LiDAR one of the fastest surveying methods available.

- **Accuracy:** LiDAR systems collect extremely dense data with very little room between points. This means that the results are highly accurate, allowing professionals to plot and model natural and man-made geographies with the level of precision they need to plan detailed projects.

- **Flexibility:** When it comes to surveying land with LiDAR, there are plenty of options to choose from. LiDAR systems can be mounted on a variety of platforms based on the needs of an application. For small-scale surveying, a stationary tripod may suffice. LiDAR systems could also be mounted to airplanes, helicopters or drones to survey larger areas. LiDAR data can even be collected at any time of day or night since it uses light as the measurement tool.

- **Safety:** LiDAR systems work relatively quickly and can be operated from a distance, making them a good choice for locations that may be unsafe for human operators to stay for extended periods of time. Their ability to be mounted to aerial crafts also allows them to be used to survey dangerous areas that human surveyors may not normally be able to access.

PHOTOGRAPHS DURING LiDAR MAPPING

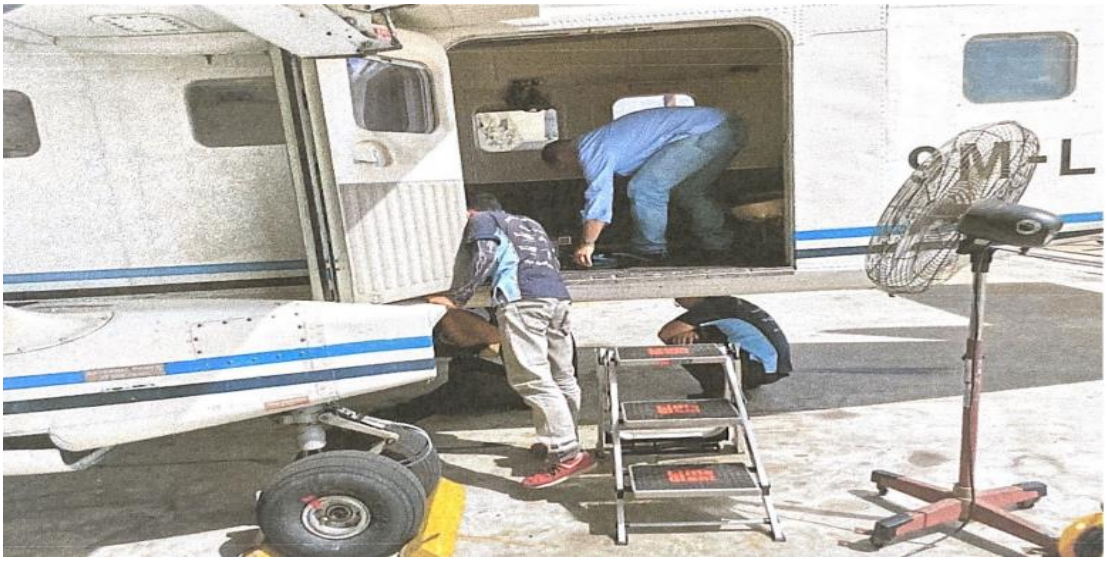
GPS BASE STATION

GPS Base Station 1 (E2635078.964, N5514580.808 H: 632.134m)

GPS Base Station 2 (E2641087.041, N5482587.465 H: 465.004m)

GPS base station during LiDAR flight

AIRCRAFT NOMAD N22C (Reg. 9M-LL1)

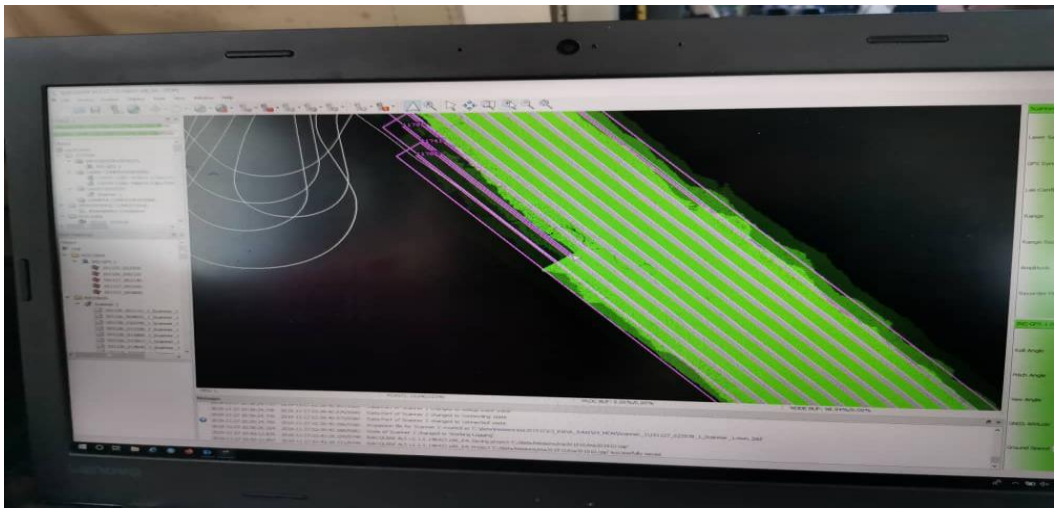


INSTALLATION OF LiDAR EQUIPMENT

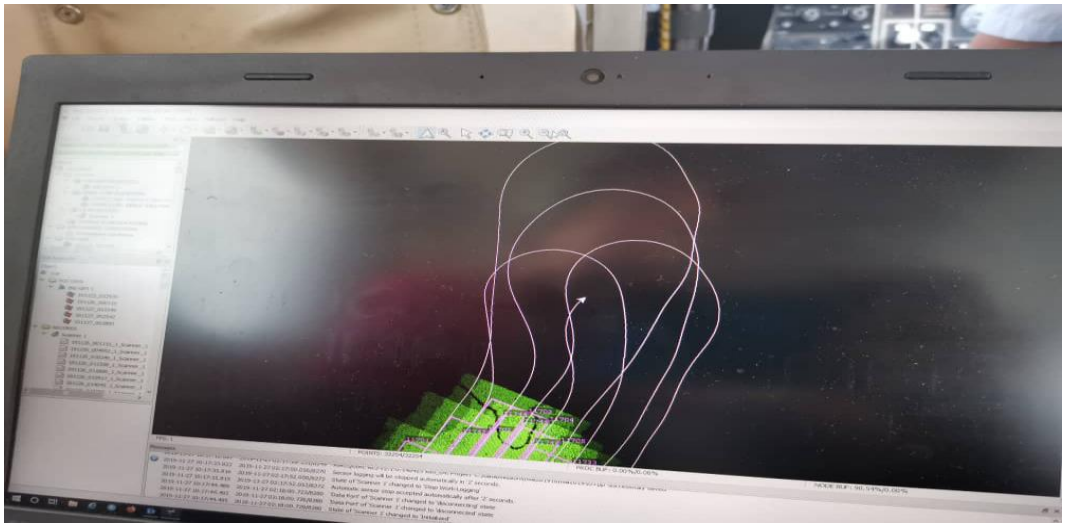
LiDAR Equipment Installation in Progress

LiDAR OPERATING AND SCANNING

Operating LiDAR inside the plane



Screenshot during LiDAR Scanning on Board



VIEW FROM PLANE DURING LiDAR MAPPING FLIGHT

View from Plane – Lawas Town

View from Plane – Long Sukang Old Stoll Port

Long Sukang Settlement Area

Long Sukang River