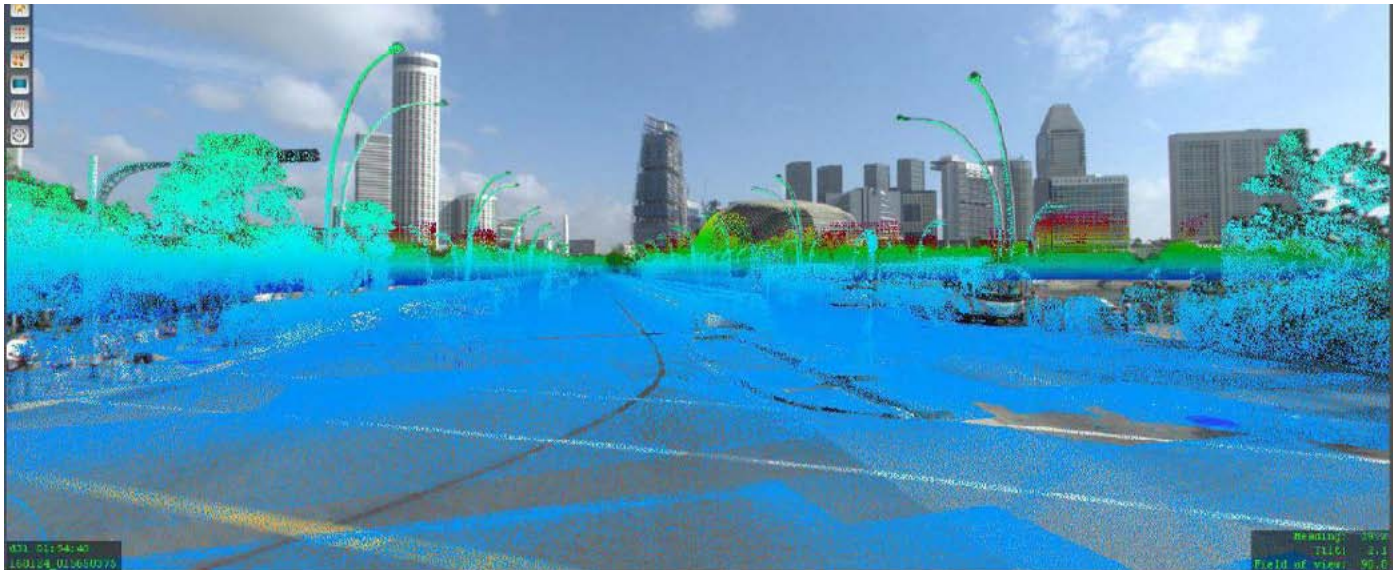
SINGAPORE SMART NATION EMBRACES 3D LAND MANAGEMENT

AS PART OF SINGAPORE'S QUEST TO BE A SMART NATION, THE SINGAPORE LAND AUTHORITY (SLA) EMBARKED ON A 3D NATIONAL MAPPING INITIATIVE IN 2014. THE INITIATIVE INVOLVES MAPPING THE ISLAND NATION OF SINGAPORE VIA AIRBORNE LASER SCANNING, ALONG WITH AERIAL IMAGERIES AND MOBILE LASER SCANNING & IMAGING. ORBIT TECHNOLOGY WAS USED TO MANAGE THE CONTENTS OF THE DOWNSTREAM MOBILE LASER SCANNED AND IMAGED DATA. THE EASE OF USE AND THE INTERACTION OF THESE HIGH-QUALITY DATASETS WITH ORBIT TOOLS HAVE OPENED UP MANY POSSIBILITIES FOR STAKEHOLDERS WITHIN THE GOVERNMENTAL AGENCIES TO EFFICIENTLY MANAGE FEATURES AND ASSETS OF INTEREST. ORBIT GT IS PROUD TO PLAY A PART IN SINGAPORE'S SMART NATION QUEST.

Overlay extracted objects on spherical view and reference map



A Singapore skyline in spherical view with point cloud overlay

Introduction

The Singapore Land Authority (SLA) is a statutory board formed in June 2001, which manages Singapore's land resources. Its vision: managing the country's limited land to create unlimited space. SLA is thus dedicated to optimising land resources for the economic and social development of Singapore. As Singapore is a small island nation, land needs to be managed in the most efficient way. This can be achieved by creating space above and below ground.

When spaces are created above and below ground, 2D maps are no longer adequate to fully represent the real-world GIS information in Singapore. The airspace and subterranean spaces are all being overlapped together with the ground level, making it hard to visualise and represent them on a map.

In 2014, SLA embarked on a journey to create a Singapore Advanced Map (SAM) by mapping the whole island nation of Singapore with 3D Geospatial Data through the 3D National Mapping project. This is part of the Smart Nation initiative led by the Smart Nation and Digital Government Office, Singapore. The aim? Improving the lives of citizens, creating more opportunities and building stronger communities by harnessing technology and gathering insights from data to the fullest.

3D National Mapping

The demand for 3D map data is increasing, as 3D data can assist in land development planning, management of underground utilities and infrastructure, flood management, urban airflow analysis, solar potential studies and many other applications.

There are some factors to consider when defining the methodology to collect 3D data. They are: accuracy, level of detail, reliability, area coverage, data format and appearance. In the traditional method of collecting GIS data, it is possible to just perform a 3D topology around Singapore, but the level of detail and appearance will not be adequate for the creation of 3D models; the physical appearance will not match the real-world appearance. By using and exploring advanced mapping technologies, it was clear that 3D laser scanning with imagery is the best available solution that addresses the considerations for collecting 3D data.

The 3D National Mapping initiative aims to create and maintain an accurate national 3D map that is developed once and used by many. The main objectives are to have high-resolution data in order to meet the requirements of most government agencies, to have an open standard data exchange format for interoperability and data sharing, to have a common, authoritative 3D base map to support collaboration among agencies and to create a workflow for continuous maintenance to ensure currency of data.

The 3D National Mapping Project is carried out in two phases. Phase one is to capture and create an Orthophoto map of Singapore and to capture the digital terrain and digital surface data of Singapore. Phase two is to collect road and street data as furniture to supplement the data collected in the first phase of the project.

To achieve the goal for phase one, airborne laser scanning and imagery equipment was used. Two twin-engine aircrafts were mobilised, and one set of equipment mounted on each aircraft. The aircrafts were pre-programmed with the flight path data and were launched to capture both vertical and oblique images. They simultaneously performed 3D laser scanning. The whole data collection exercise was

completed in 40 days. Collected 3D data was then processed and put to use to create the Digital Surface Model (DSM) and Digital Terrain Model (DTM). The images were also used to create an Orthophoto of the whole of Singapore. The vertical and oblique images paired with the point cloud data were used to create 3D building models. This data also serves as a base to create the overall framework of the Singapore Advanced Map.

The second phase of the 3D National Mapping project involved a comprehensive mobile mapping project. This was carried out by a mobile mapping laser scanner with a panoramic camera mounted on a vehicle.
This way, ground-based laser scanning and a 360° panoramic imagery dataset was collected on approximately 6,000 km of roads in Singapore. This exercise captured all road and street features such as trees, fire hydrants, traffic lights, lampposts, etc. This mobile mapping 3D data enriches the airborne 3D data with fine detail, at the same time verifying the accuracy of all the building models.

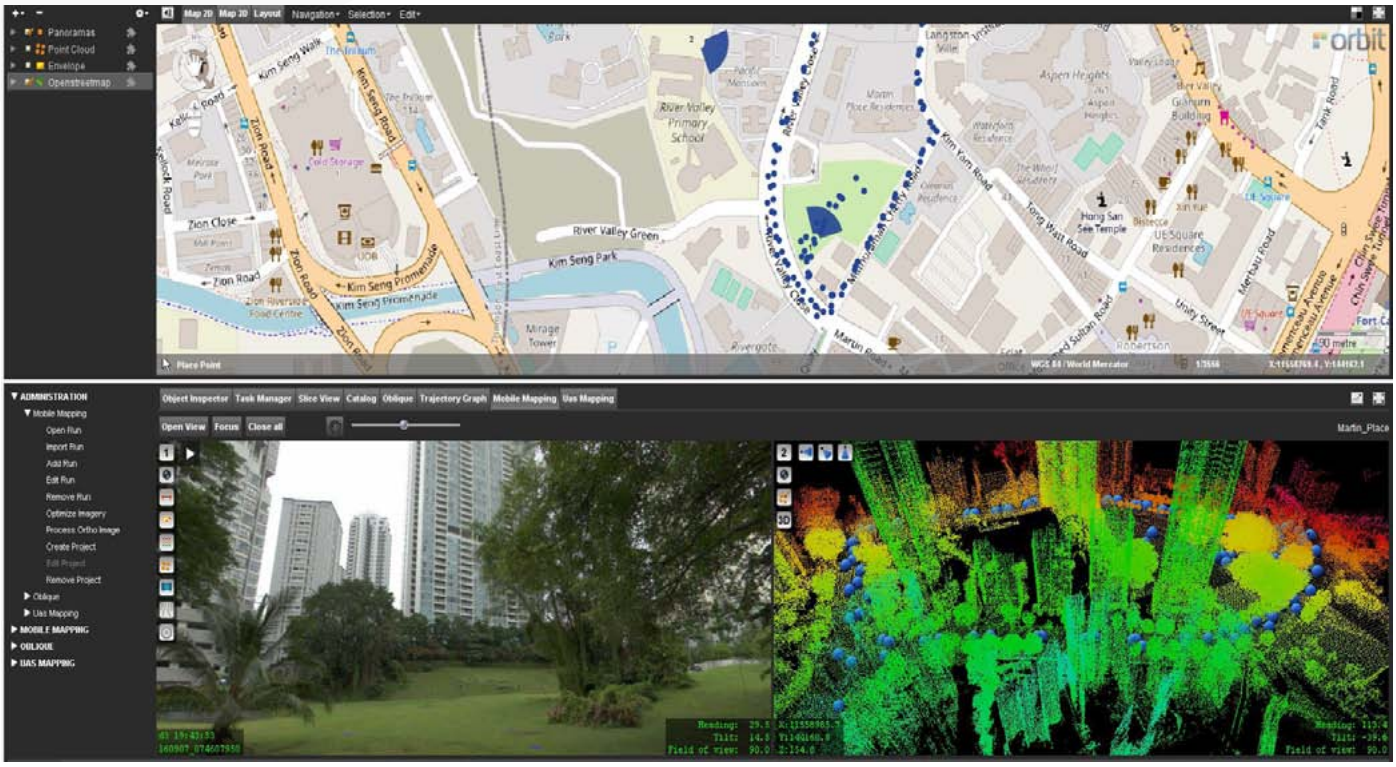
Orbit GT Smart City Solutions

When the data sets are collected and being processed, the question of how to combine all of them to verify and view them together comes in. The data sets are huge and the point cloud processing software available could not handle their size. They become useable when they are pieced together and can have features extracted from the data.

GPS Lands Singapore, an Orbit GT partner, approached SLA with a solution that allows SLA to piece all their data sets together in a single platform, where they can view and verify the data that was collected and processed.

This is made possible with the Orbit's 3DM Content Manager, which allows the processed pointcloud data and panoramic images to be imported as runs. All the imported runs can be loaded together for viewing as a whole. This is where the data sets can be verified in a large overall scale to check for any mismatched data. The pointcloud data also shows the accuracy of the orthophoto map created from the airborne imagery when overlayed as the base map in the 3DM Content Manager.

The features available within the 3DM Content Manager enable SLA to manage the data sets at ease by grouping the data and loading them separately when required. For example, the mobile mapping data of northern Singapore is made up of



Orbit 3DM Content Manager

several point cloud data sets. In the 3DM Content Manager, these data sets can be imported as runs and added into a project to be grouped together. In this way, data can be managed easily, and according to the user's requirements.

A critical component of the 3D National Mapping initiative is data sharing with stakeholders. The main stakeholders come from across governmental agencies, research institutes and other parties of interest. The next step is to be able to extract the 3D features from the GIS data. The Orbit 3DM Feature Extraction is the next tool to be used by SLA to perform feature extraction from their 3D data. In land management and administration, the exact details on the ground provide crucial information for the government to plan and make decisions. Being able to view rich data captured in 3D without having to be physically on the ground is an efficient allocation of resources.

In a particular example of collaboration with government agencies, tree features across Singapore are being extracted as points, with the attributes or coordinates and height. This information allows relevant agencies to manage the greenery of Singapore, to provide high-resolution information for carbon accounting and also to identify the location and estimate number of trees on State Land.

There are also other use cases where features such as lampposts, curb lines and manholes are extracted to perform verification of the existing GIS data of other agencies, as part of their asset inventory management. Exact coordinates of the data and accurate measurement can be done without having to go on the ground for GIS data collection.

By identifying the features on the ground, extracting and exporting those features allows them to be shown on a map at a single glance. This information can be exported and shared with different government agencies, using GIS data to provide them with visibility of their assets. Without having 3D geospatial data, the extracted features can be overlaid in 2D form as the data can be exported in various available formats which can be used immediately with 2D GIS data.

Moving forward

In Singapore's quest to become a Smart Nation, SLA continues to explore advanced GIS technologies to build and enhance the Singapore Advanced Map. As a plan to move forward on sharing data with various government agencies, SLA is engaging the Orbit 3D Mapping Cloud solution for publishing the 3D data. This enables agencies to benefit from the 3D GIS data for their own use cases.

ABOUT THE AUTHOR

Johnson Ang is the Project Manager in GPS Lands (Singapore). He has 10 years of experience working in the land survey industry.

Originally from the IT industry, Mr Johnson's subsequent experience with GPS Lands, has allowed him to integrate knowledge from the land survey industry with IT knowledge, and implement advanced GIS solutions.

His team specializes in GPS infrastructure system setup and customization and also Orbit GT solution setup.

ABOUT GPS LANDS (SINGAPORE)

GPS Lands (Singapore) was incorporated in 1999. The company's primary purpose is to carry out sales, service, training and support for Trimble GPS. Over the years, GPS Lands had evolved from a traditional GPS equipment selling company into a provider and consultant of technologically leading geospatial solutions. GPS Lands achieved this by keeping up with emerging market trends and staying in the forefront of geospatial technologies. GPS Lands strives to explore new technology and innovate to provide comprehensive geospatial solutions.

"We will continue to invest in equipping our team to be the best for the sole interests of our valued customers, who have placed their trust in us and supported us all these years." Gerry Ong (Founder & Managing Director – GPS Lands). www.gpslands.com