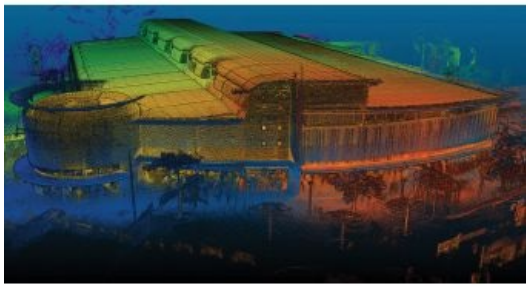
FUTURE PROOFING SINGAPORE

3D Mobile Mapping Technology Inspires Positive Change



Singapore is home to some of the most profitable financial services, manufacturing and oil-refining corporations in the world. An island state just off the coast of southern Malaysia, its small size has clearly not impeded the success of residents or firms choosing to locate themselves there. But with its accomplishments come some very specific challenges for a city which is limited by space but still demanding growth. This article discusses how 3D mobile mapping is contributing to one of the most ambitious digital twinning projects the world has ever seen, in the hopes of paving the way for better future-proofing and infrastructure planning for Singapore's government.

Future planning is a vital focal point for Singapore's powers that be, and so technology projects that support and prepare for any necessary improvements in legislation, commercial operations or infrastructure have seen significant increases in funding.

How to Future-proof Singapore's Success

Examples of challenges range from the commercial to the medical. For example, a boost to the economy and infrastructure may subsequently require improved wide-reaching, high-quality coverage of 3G or 4G networks. Conversely, with a population increase, there may be a need to update existing protocols for emergency evacuations in the most densely populated part of the state.

To respond to 21st-century challenges, comprehensive, interactive, easily interpreted data is useful to a whole host of stakeholders – and not just those familiar with urban planning and development. But how do you best facilitate this, given an environment that is so densely populated, routinely altered and complex in arrangement?

Thinking Smarter

One answer is to explore the concept of 'smart cities', using 3D mobile mapping and other technology to create an interactive, highly detailed platform which can be used by any third party to solve emerging and evolving challenges for any given location.

Defined as an "urban development vision to integrate information and communication technology (ICT) and Internet of things (IoT) technology in a secure fashion to manage a city's assets", a 'smart city' will allow Singapore to develop solutions to tackle urban problems more effectively and efficiently. 3D mobile mapping is a crucial element of this.

For this particular region, one key smart city solution is titled 'Virtual Singapore', a dynamic 3D city model and collaborative data platform, including 3D maps of the region. Championed by the National Research Foundation (NRF) and delivered by a joint partnership between Dassault Systèmes, the Singapore Land Authority (SLA) and Government Technology Agency of Singapore (GovTech), the scope and scale of the project is huge.

Once completed in 2018, Virtual Singapore will be the authoritative 3D digital platform intended for use by the public, private and research sectors. The tool will contain previously-collected and real-time data, allowing users to simulate both present and future scenarios. Costing $73 million (SGD) for the development of the platform as well as research into latest technologies and advanced tools over a period of five years, Virtual Singapore relies on the key input datasets from multiple sources to build up a clear, accessible, comprehensive tool to

analyse Singapore's built environment.

How 3D Mobile Mapping Supports Virtual Singapore

Interactive 3D maps require accurate data acquisition and digital replication of data in order to create an as-close-to-reality environment as possible. This is where new handheld scanning technology comes into its own.

AAM, an international geospatial services company specialising the in collection, analysis, presentation and delivery of geospatial information, has been working with the SLA to build and develop a national 3D map of Singapore since 2013. Combined with AAM's data, Virtual Singapore will integrate existing geospatial and non-geospatial data sources to describe the city with the necessary dynamic data ontology, whether this be demographics, movement of people or climate to name a few.

The project commenced with an airborne LiDAR and imagery survey to produce terrain and building models. After importing the 160,000 standalone 3D building models into Virtual Singapore, an obstacle emerged. Certain housing blocks maintained by Singapore's Housing and Development Board would require additional measurement at ground level since an aerial survey would not adequately capture information on 'void decks' in enough detail.

This issue soon became city-wide, due to the prevalence of these 'void decks', which are open spaces typically found on the ground floor of the region's apartment blocks. These spaces are routinely used for community endeavours such as socialising, functions, and other commercial enterprises such as grocers, dental clinics or bakeries. Arguably, one of the most interesting functions of these void decks is the ability for pedestrians to walk across blocks at ground level, rather than circumnavigating around them.

Despite having access to the original floor plans, they were outdated, having not incorporated any changes to the void deck during the lifetime of the building, such as disability adaptations like access ramps or handrails. As such, after a ground vehicle based mobile LiDAR and imagery survey to add in models for transportation (roads, bridges, tunnels etc), it was soon apparent that further enhancement of detail within these blocks would be necessary.

Choosing the Detailed Scanning Technology

Virtual Singapore requires semantic 3D modelling, which comprises detailed information such as texture and material representation of geometric objects. In real terms, this means that models of buildings encode the geometry as well as the components of a facility, such as walls, floors, and ceilings, down to its fine details, as in the composition of granite, sand and stone in a building material.

A new stage to the project was therefore conceived to enhance the existing building models. Using the original data taken in the airborne and ground level scans as a foundation, additional measurements taken using a handheld scanner would then create a better picture of the textures on building façades to include these void decks. Better detail would also mean increased accessibility for all, given the optimised nature of the map when viewed on the web.

AAM modelled 60 buildings in this fashion during an initial trial project in the Yuhua precinct of Singapore, followed by a larger project of 400 buildings in Ang Mo Kio. This gave the opportunity for AAM personnel to test out a number of different scanning methods for capturing the required ground data – and the GeoSLAM ZEB-REVO handheld scanner proved to be the most innovative and efficient method for the task at hand.

How the Technology Works

Handheld mobile mapping systems utilise laser light to identify unique 3D structures within a survey environment, this is then coupled with software to build up a three-dimensional map of the survey.

In many scanning solutions, a combination of GPS satellites and fixed tripods provide the ability to capture information to create a 3D map. However, in enclosed, indoor or underground spaces whereby direct line of sight to satellites is impossible or impeded, precisely like these void decks in Singapore, GPS-reliant mapping solutions are not suitable.

As such, AAM's chosen tool utilises technology that was developed by the robotics industry, Simultaneous Localisation And Mapping (SLAM). GeoSLAM's ZEB-REVO uses a 3D SLAM algorithm to establish its position autonomously and collects over 43,000 measurement points per second with an average accuracy of +/-15mm. As well as requiring minimal training and a 'walk and scan' method of data collection, rapid mobile mapping is conducted with a ZEB-REVO much more quickly than traditional surveying methods, such as cumbersome tripods or trolleys with trip hazards.

For a project the size of Virtual Singapore, the ability to survey locations up to 40 times faster than static traditional scanning tools was a huge plus point. Saving time walking through the desired scan location led to significant cost-saving without compromising on data quality.

After capturing the scan data, most professional CAD or modelling packages allow direct import of scan data, and once complete, AAM could export their map into the required file format - in this case, the CityGML file format. Ultimately, using a ZEB-REVO resulted in a much quicker process from start to finish, which then subsequently speeds up the next stage of the Virtual Singapore project.

Results

With a ZEB-REVO, AAM's field teams were able to quickly capture a dense and accurate point cloud of an entire void deck, which was then used to model the deck geometry and incorporate this into the existing building models.

Once processed, the data allows a much better understanding and analysis of these structures. Throughout the course of the Virtual Ang Mo Kio project, 376 buildings with void decks were scanned using the ZEB-REVO, taking approximately 100 hours – a huge time-saving exercise which would have ordinarily taken up to 40 times longer if using traditional surveying methods.

Looking Ahead at Singapore’s Future

Virtual Singapore, when complete, will offer four major capabilities, namely virtual experimentation, test-bedding to validate the provision of services, planning and decision-making and future research and development (R&D). The GeoSLAM ZEB-REVO provided a huge contribution into ensuring that tight deadlines could be met without compromising the quality of data being produced. In fact, the ZEB-REVO was actually faster and more accurate than other methods trialled.

The speed of data acquisition and huge reductions in personnel on-site time have led to massive cost savings. Similar large-scale engineering projects have seen savings of two-thirds when compared to traditional, static scanners. With such clear cost-saving benefits, together with the opportunity for highly detailed and rapid results, it is little wonder that AAM chose to use the ZEB-REVO for this daunting and large-scale project.

The R&D capabilities of Virtual Singapore are expected to soon allow the creation of new technologies for public-private collaborations to create value for the region.

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More Information

www.tech.gov.sg/TechNews/DigitalGov/2017/03/5-things-to-know-about-Virtual-Singapore

Singapore Towards a Smart Nation, GIM International