3D TERRESTRIAL LASER SCANNING FOR SABAH HISTORICAL LANDMARK DOCUMENTATION AND VIRTUAL TOURISM

Anwar Mohammed Ali
School of Mechatronic Engineering
Universiti Malaysia Perlis, 02600 Perlis, Malaysia

Shazmin Aniza Abdul Shukor
School of Mechatronic Engineering
Universiti Malaysia Perlis, 02600 Perlis, Malaysia
Email: shazmin@unimap.edu.my

Razak Wong
Geodelta Systems Sdn. Bhd.
22, Jalan SS20/11, Damansara Utama,
47400 Petaling Jaya, Selangor, Malaysia

Robert Cheng Chung Piao
Survey & Mapping Section, Lands and Survey Department
88100 Kota Kinabalu, Sabah, Malaysia

ABSTRACT

The documentation of historical items has increased rapidly in recent years. As they are very fragile and prone to disruption, documenting them can help towards their preservation. The growth of such process is due to the advancement of 3D terrestrial laser scanning (TLS) technology that has been notably improved and stabilized in the past few years. Laser scanning systems that are available in the market have been capable to capture high density, full dome scan data with good range and accuracy. Historical items, which may consist of landmarks, sites, buildings, and sculptures, are scanned, modelled and documented in a digitalized format. By utilizing this, the architectural shapes and characters obtained are more accurate, compared to the traditional, manual measurements approach. Historical items are being documented for many purposes, including for future reconstruction, conservation, as well as for further research / education and tourism. This paper reports on the process of developing Sabah's historical landmarks documentation for virtual tourism purpose. A number of local historical landmarks have been selected to undergo this technology exploration. This is part of a continuous research, which currently focused on point cloud processing workflow in order to come up with varies 3D products. Based on recently conducted data collection and processing, show that the results can be conceptualized to be potential as a virtual heritage tourism material as a by-product result of the 3D as-built survey. The resulting model can be benefited by the local authority for virtual tourism as part of the promotion of Sabah landmarks.

Keywords: 3D terrestrial laser scanning, 3D as-built, Sabah historical landmark documentation, virtual tourism

Introduction

Historical buildings and archaeological sites are the pictures of the social identity and constitute the most basic part of the social legacy. Furthermore, they help and guide for our new generation to learn the past. As they are prone to annihilation, due to climate change and natural disasters like flooding and earthquakes, they need to be preserved.

Thanks to the progression in current technology, historical items like landmarks, sites, buildings, and sculptures, can now be conserved by documenting and recording them using advanced survey methods such as the 3D laser scanning technology. The 3D laser scanners have conveyed a new and best scene to the recording and preservation of our historical buildings. The traditional ways of surveying and measurements are very tough, time consuming and its results is not that much accurate, especially when we deal with items which is constructed and developed in a very complex forms. Due to these all drawbacks of the traditional methods of surveying measurement, laser scanner technology comes with the best solution which helps as automatically digitize the 3D model of the very complex shape of the building.

Laser scanner is preferred due to its capability in getting a very detailed and accurate 3D point cloud data of the subjected building (Wei, et al., 2010) (Shukor, et al., 2015). From here, a precise 3D model can be developed closely as to the original building. This is due to its ability in producing a highly dense 3D point cloud data. Therefore, it is known to be the best and sophisticated technology in collecting data of complex shaped historical building (Vatan, et al., 2009) and able to help in recording complex 3D data with high accuracy, high speed, and without touching or destructing any item (Yamada & Takase, 2003) (Hadjri, 2006) (Skarlatos & Kiparissi, 2012).

3D laser scanner has been used by others in collecting 3D data of buildings for various purposes. Shukor, et al. (2015) has highlighted the usage of laser scanner in collecting existing building data for 3D as-built development. Various tasks from preservation to renovation work can be done from the 3D as-built model. Advantages of having 3D as-built for managing existing buildings are also mentioned in this paper. Meanwhile, laser scanner is also being used in monitoring a hydro project operation, where it is utilized for engineering survey and structural inspection of Nizhegorodskaya HPP (Ustinov & Bolodurin, 2016). It is also being preferred as the tool in preserving heritage buildings and sites (Remondino, et al., 2009) (Shih, et al., 2007). However, the authors did not mention any specific application that can be utilized from the developed preservation model. This paper will highlights on the usage of 3D laser scanner in developing Sabah's historical landmarks documentation. Their 3D products, the 3D rendered model and 3D point cloud data, are utilized in generating animation documentary that can be used by the local authority for virtual tourism purpose. Here, virtual tourism refers to the capability of the public to have virtual access towards the selected historical sites without having to physically be in the places. Thanks to the advancement of the 3D laser scanner, this can be performed and done by viewing the animation documentary, where exterior and interior of the historical sites can be accessed and appreciated. All data of the historical sites stated here were collected by Geodelta Systems Sdn. Bhd. In total, there are 4 Sabah historical sites that will be covered:

1) Tinagat Lighthouse, Tawau
2) Atkinson Clock Tower, Kota Kinabalu
3) Bell Tower of Tawau
4) Tawau Mosque

Details on each project will be presented according to each historical site for easiness of reading, where it will starts with a little bit of the background of each site, followed by the technical processes, consist of data collection and processing. Results of each project towards virtual tourism will end each section's presentation, and finishes with a general conclusion.

TINAGAT LIGHTHOUSE, TAWAU

Background

This 1916 lighthouse is one of the oldest, located at the east of Tawau, Sabah, Malaysia (refer to **Figure 1**). It has a unique cylindrical shape with conic shape on the top. It is made out of cast iron with 9 meters in height. This historical lighthouse is still exist and its exterior is maintained from time to time, however it is now inactive but preserved as historical site.

Figure 1: Tinagat Lighthouse, Tawau, Sabah

The Process

For this project, a Leica HDS6000 laser scanner, as in Figure 2, was used to collect the 3D data of its exterior, with 19 scan stations around it. All data were then processed using Leica Cyclone 8.0.3 software to generate its 3D rendered model and 3D point cloud data, as well as AutoCAD 2012 for the 2D drawings. Overall, it took 8 hours for onsite scanning process, 2 working days for data processing and 14 working days to generate its 3D modelling. A Truview file and an animation documentary were published as the tool for virtual tourism of this site.

Figure 2: Leica HDS6000 laser scanner (Source: Leica Geosystems, 2016)

The Results

Figure 3 shows the 3D point cloud data collected by the laser scanner, as well as its 3D model developed from it. For the virtual tourism purpose, a TruView and an animation file were generated, where from here, details of the sites can be explored further. Figure 4 shows a sample of more details for the lighthouse which can be done from the animation file, which shows on how virtual tourism can be performed.

Figure 3: The 3D point cloud data of Tinagat Lighthouse and its 3D model

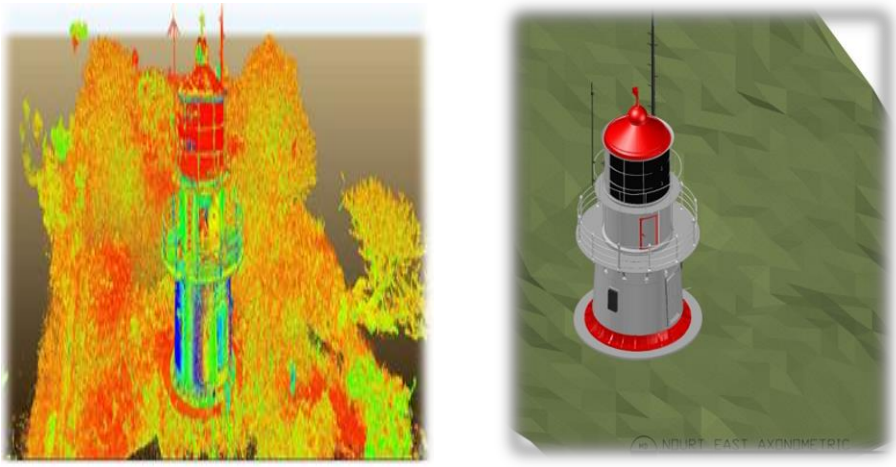
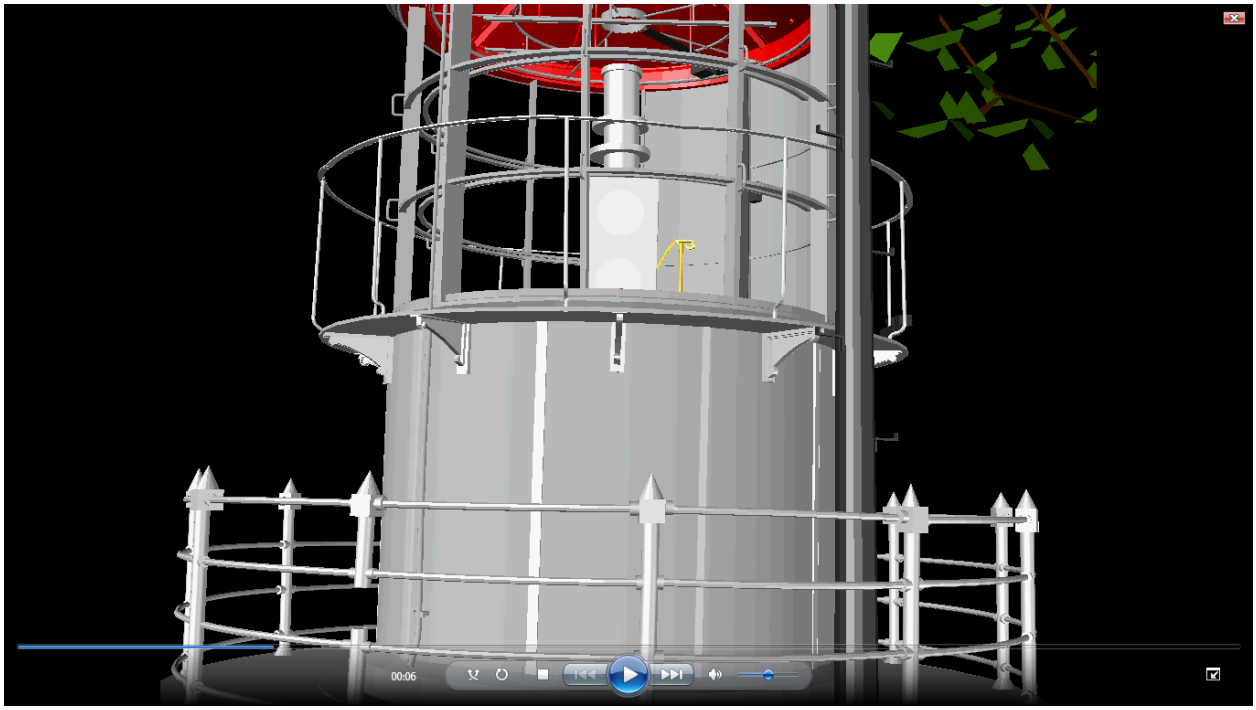


Figure 4: One of a sample of virtual tourism, where a more detail exploration can be accessed and learnt from the animation



ATKINSON CLOCK TOWER, KOTA KINABALU

Background

Atkinson Clock Tower, as shown in Figure 5, is located at the foot of Signal Hill, off Jalan Bukit Bendera, Kota Kinabalu, Sabah, Malaysia. It is of one the most historical landmark in Kota Kinabalu, which is built in 1905, in honour of the first district officer of Jesselton, Francis George Atkinson. It has famously survived the Second World War when the rest of the building were destroyed and vanished.

Figure 5: Atkinson Clock Tower, Kota Kinabalu, Sabah, Malaysia

The Process

Leica ScanStation C10, as shown in Figure 6, is used to collect the 3D data of this site from 14 different scan stations. Leica Cyclone 8.0.3 software and 3D Reshaper were used, together with AutoCAD 2012. The duration for onsite scanning was 8 hours, and only 24 hours were taken to process the data. Its 3D modelling and 2D tracing took 96 hours respectively to be done. Similar to the previous site, a Truview file and an animation documentary were published as the tool for virtual tourism.

Figure 6: Leica ScanStation C10 (Source: Leica Geosystems, 2016)

The Results

Figure 7 shows the point cloud data and the 3D model for Atkinson Clock Tower, while Figure 8 shows the sample of animation file generated from the collected data for virtual tourism purpose.

Figure 7: 3D point cloud data and its model for Atkinson Clock Tower

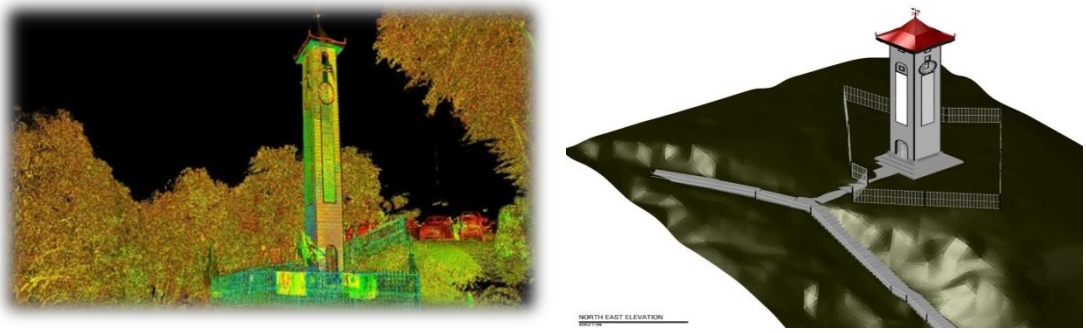
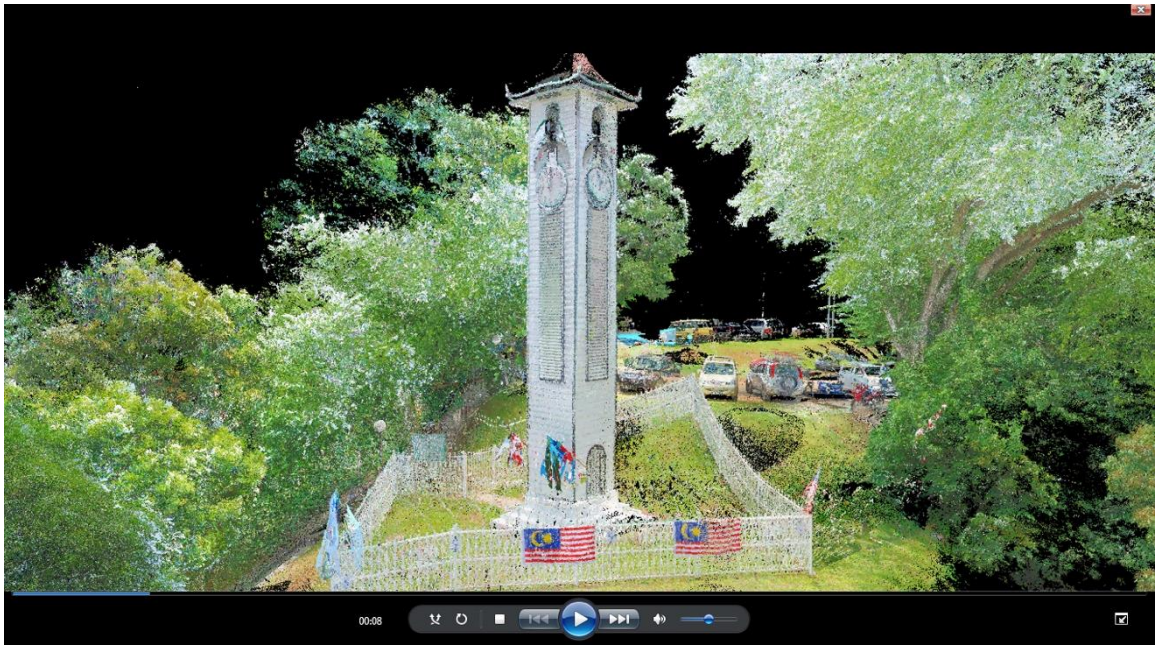


Figure 8: Atkinson Clock Tower animation video generated from the laser scanner data



BELL TOWER OF TAWAU

Background

The Bell Tower is one the oldest and historical site in Tawau, Sabah, Malaysia. It was built by a Japanese business man in 1918 during the First World War. Its unique six sided structure with a cone-shaped roof is made out of wood. It was went through rebuilt and reconstruct in 2006. Figure 9 shows the Bell Tower of Tawau.

Figure 9: The Bell Tower of Tawau, Sabah, Malaysia

The Process

For this project, Leica HDS6000 was used to collect the 3D data of this site from 10 scan stations, and the software used are Leica Cyclone 8.0.3 and AutoCAD 2012. As the tower is smaller compared to the rest of other historical sites covered here, it only took 5 hours to scan the site. 8 hours were taken to process the data, and 32 hours for producing its 3D modelling and 2D drawing. Output also included a Truview file and an animation.

The Results

Figure 10 shows the point cloud data and its 3D model generated from the data representing the Bell Tower and its surrounding. Meanwhile, an extract from the animation can be seen in Figure 11.

Figure 10: 3D point cloud data for the Bell Tower

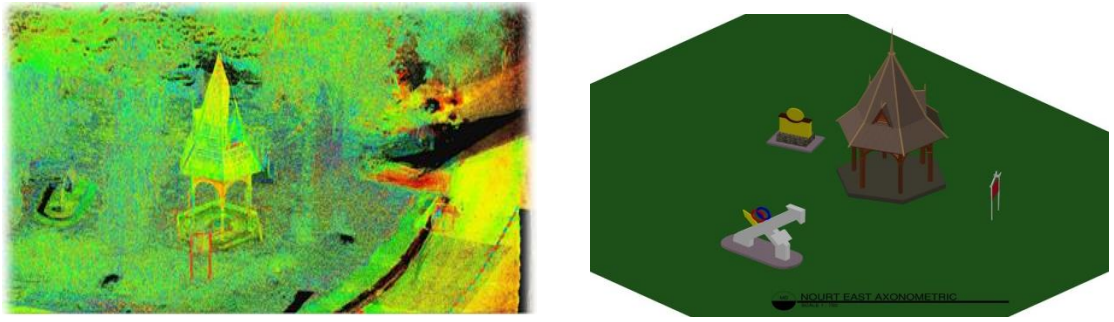
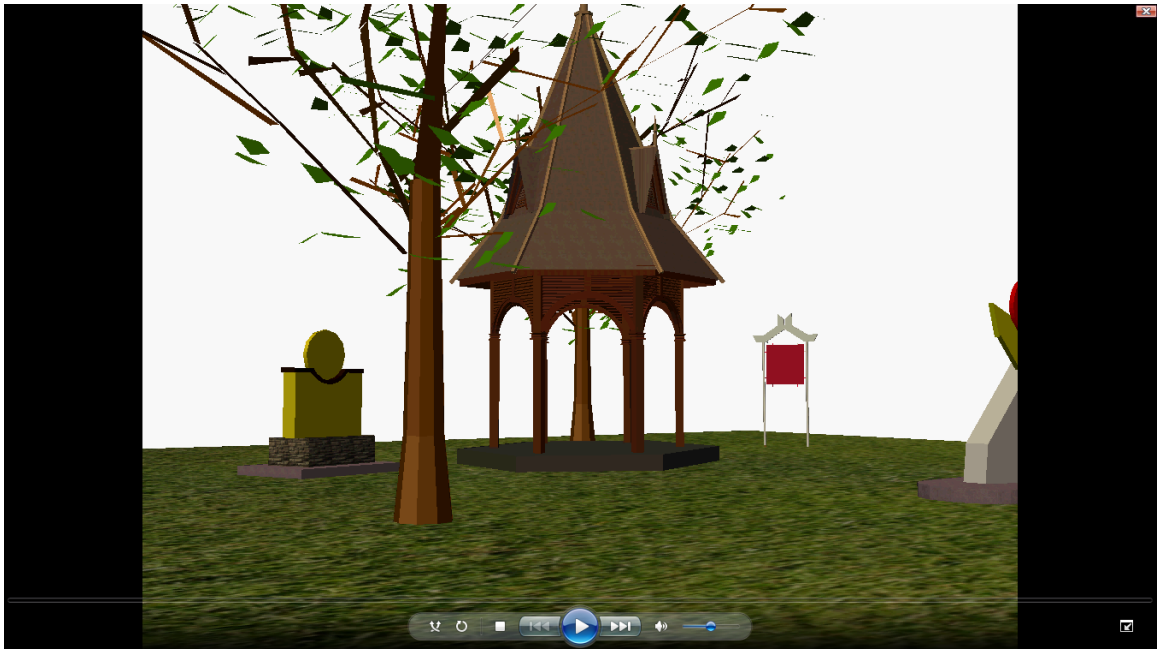


Figure 11: The generated Bell Tower animation



TAWAU MOSQUE

Background

The Tawau Mosque, as shown in Figure 12, is considered as one of the historical site by the local government as well. It was built in 1963 and went through modification and repainting in order to preserve it best geometrical shape. It is still in used and Muslim citizens in Tawau are still preforming their prayers here.

Figure 12: Tawau Mosque, Sabah, Malaysia

The Process

The Leica HDS6000 laser scanner was also used, together with Leica Cyclone 8.0.3 and AutoCAD 2012 software. In general, 8 hours were taken to scan the site, two working days for data processing, and 14 working days for 3D modelling and 2D drawing generation. Like the rest of the projects, Truview and animation documentary were also developed.

The Results

Figure 13 shows the point cloud data and the 3D model for Tawau Mosque. Sample of animation file representing this historical site can be seen in Figure 14, where from here, parts of its interior could also been seen and accessed.

Figure 13: 3D point cloud data and its model for Tawau Mosque

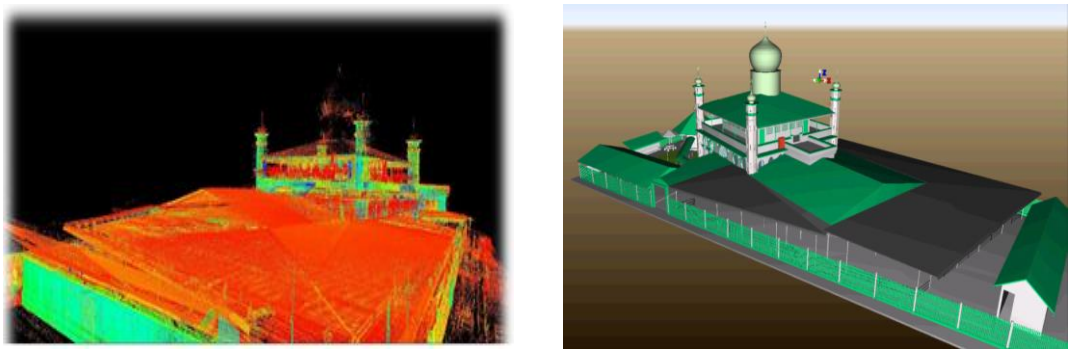


Figure 14: The animation file of Tawau Mosque

Conclusion

Conservation of historical sites is important and it needs to be done accordingly through the appropriate documentation. This paper has shown that the usage of 3D laser scanner can be utilized in collecting the data representing these sites, and with the help of related software, their respective models and animations / videos can be generated. These outputs can be utilized by the respective authority body to promote and educate society in learning the history. Publics can have access towards the historical sites virtually while appreciating and learning more on the exterior / interior of the buildings, and these are significant for the purpose of virtual tourism.

However, there are a few limitations from the outputs that can be improved further. Notice that some of the resulting models are missing some details, like for example, detailing of the roof of the Bell Tower is very coarse and almost absent. Integration with other approaches like photogrammetry or a triangulation-based laser scanner can improve the results. Apart from that, in order to ease the process of sharing the outputs to serve the virtual tourism purpose, further works on developing and integrating them into applications like Google Maps are needed to enhance their accessibility and values.

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