Land Parcel 3D Mapping Using Terrestrial Laser Scanning(TLS) Case study: Mutiara Beach, Jakarta, Indonesia

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Key words: Terrestrial Laser Scanner, Static Mode, 3D model

SUMMARY

Terrestrial laser scanning (TLS) is a promising technique and has the potential to be accepted as additional surveying technology. In practical terms and comparison to conventional surveying methods, the laser scanning technology offers a much higher point density data, an increased speed of data capture and the possibility for enhanced imagery and 3D visualization through specific processing and modeling tools. In this paper the registration process, which separates the registration by two points scanning, which scans registration. Both registration integrated to establish a complete object. Data collection was performed with a static mode. In the static mode, the TLS is used to produce a detailed map of the topographic features of the area around the static location that is occupied by the scanner. Prisma placed on the GPS points and at points around the Mutiara beach, then scanned from the two points where standing TLS instrument, which is on the roof of an apartment building and on the road. Furthermore, after the filtering process, a process geo-referencing using GPS points. By using Geo-magic, Auto CAD, and Google Sketch Up software, can be obtained solid models of 3D. Scanning building on the parcel required permit scanning of parcel owners. Therefore, building height and building detail in this paper is less complete. Building height is measured from georeferenced 3D models.

RINGKASAN

Terrestrial Laser scanning (TLS) adalah teknik yang menjanjikan dan memiliki potensi sebagai teknologi surveying tambahan. Secara praktis dan dibandingkan dengan metode survei konvensional, teknologi laser scanning melakukan pengukuran data dengan kepadatan titik yang jauh lebih tinggi, pengambilan data dilakukan dengan cepat dan memungkinkan untuk meningkatkan visualisasi citra 3D melalui perangkat lunak spesifik dalam proses pengolahan dan pemodelan. Dalam makalah ini proses regristrasi dilakukan dari dua titik regristrasi pemindaian. Kedua regristrasi diintegrasikan untuk membentuk objek yang lengkap. Pengambilan data dilakukan dengan mode statis. Prisma ditempatkan pada titik-titik GPS dan pada titik-titik di sekitar pantai Mutiara, kemudian dipindai dari dua titik tempat berdiri TLS, yaitu di atap sebuah gedung apartemen dan di jalan. Selanjutnya setelah proses *filtering*, dilakukan proses *geo-referensi* dengan menggunakan titik-titik GPS. Dengan menggunakan perangkat lunak Geo-magic, AutoCAD, dan Google Sketch Up, diperoleh model solid 3D. Pemindaian bangunan pada bidang persil memerlukan izin dari pemilik bidang tanah, sehingga tinggi bangunan dan ukuran detail dari gedung pada makalah ini kurang lengkap. Oleh karena itu tinggi bangunan diukur dari model 3D *geo-referensi*.

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1. INTRODUCTION

Laser scanning is one of the latest techniques applied in 3D survey and mapping. Currently it is the leading survey technology providing spatial data information. Laser scanning is a process of recording precise 3D information of real world objects or environments. There are many types of measuring instruments that use laser scanning technology with a range of capabilities for a variety of applications (Staiger, R., 2003). Heinz Stanek (2004), stated that applications of lasers scanners are successful in wide areas of documentation of surfaces and objects. Almost, the general principle of data acquisition must be optimized in specific ways. For the data acquisition the demanded precision and density, but also the number and distribution of reference points may vary. According to Jagannath Hiremagalur *et.al* (2009), TLS measure thousands of data points (distance, angle, and reflected return signal power) per second and generate a very detailed "point cloud" data set. Using TLS will dramatically improve safety and efficiency over conventional survey methods. However, to fully realize the benefit of using TLS, they must be used properly and in appropriate applications. Mike Pinkerton, (2010) stated that how Terrestrial Laser Scanning solutions have been applied on projects where up until very recently traditional surveying methods would have been the norm. As more people are made aware of the benefits of laser scanning, then their expectations from their spatial data suppliers will rise accordingly. Concurrent with this change in attitude will be ongoing further refinement of technology (both hardware and software). The end result will be that laser scanning technology, like real time GPS did before it, will inevitably become commonplace within the realm of mainstream land surveying. According to R H Alkan and G Karsidag (2012), data obtained from laser scanner has a high quality and widely used in various fields, particularly those surveys that include topographic surveys, environmental and industrial. The main advantage of mapping surveys using laser scanning technology, can provide complete facilities to perform data acquisition and can give detailed data in 3D, as well as the results can be obtained quickly dam costs could be reduced significantly. Laser scanning technology is one of the latest techniques in 3D mapping and survey technology is the latest survey to obtain information on the spatial data. There have been many kinds of measuring instrument that uses laser scanning technology with a range of capabilities. In the field of survey mapping, laser scanning equipment is a new dimension in spatial data collection (Sadikin Hendriatiningsih *et.al*, 2014).
This article is about the 3D mapping areas of parcel by the method of Terrestrial Laser Scanning (TLS) for the purposes of coastal management that is required by the Government of DKI Jakarta. In this study, the building height is measured from georeferenced 3D models.

2. METHODS AND RESULTS

The equipment used is TLS Optech ILRIS Model 36D, the prism used as targets, computer, software Polywork, Geomagic Studio 2013, AutoCAD, Google SketchUp, and accessory equipment

for completeness. Location GPS control points in the area of Pantai Mutiara, as in Figure 1, as follows:

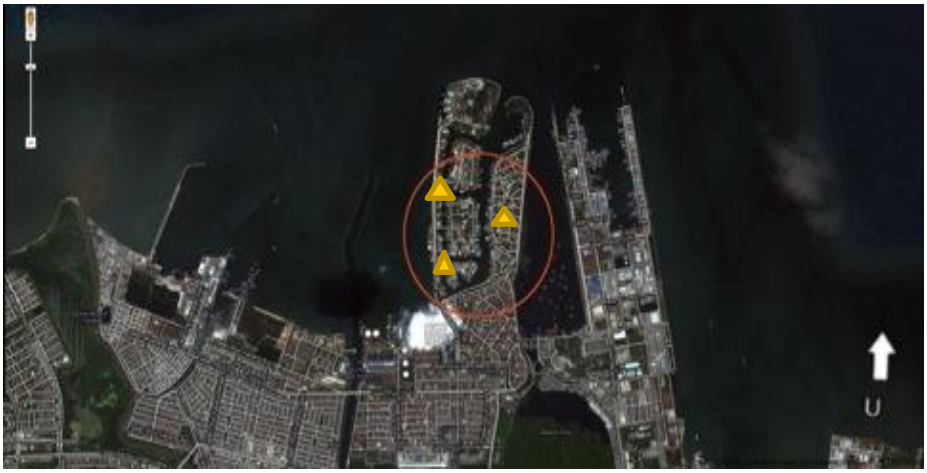

Figure 1. Location of GPS control points in Pantai Mutiara (A P Suherman P, 2014)

The control points are in zone 48 S in the UTM projection system, and the coordinate data points that the GPS control point NRP_1, NRP_2, and NRP_3 are shown in Table 1 as follows:

Table 1. GPS Control points coordinates (A P Suherman P, 2014)

ID Number	Latitude (° ´ ¨)	Longitude (° ´ ¨)	h Ellips (m)	East UTM (m)	North UTM (m)
NRP_1	06 06 01.9896 S	106 47 25.5396 E	18.831	698140.741	9325351.016
NRP_2	06 06 10.4719 S	106 47 29.7328 E	18.795	698268.818	9325090.000
NRP_3	06 06 05.6357 S	106 47 42.7376 E	18.429	698669.218	9325237.245

The next is to plan the placement of TLS instrument for scanning. Field of view of the equipment TLS is 40 ° x 40 °, then scanning the object consists of four sections in one place standing instrument TLS with overlap of 4 °. Scanning from the roof of the apartment as in Figure 2, as follows:

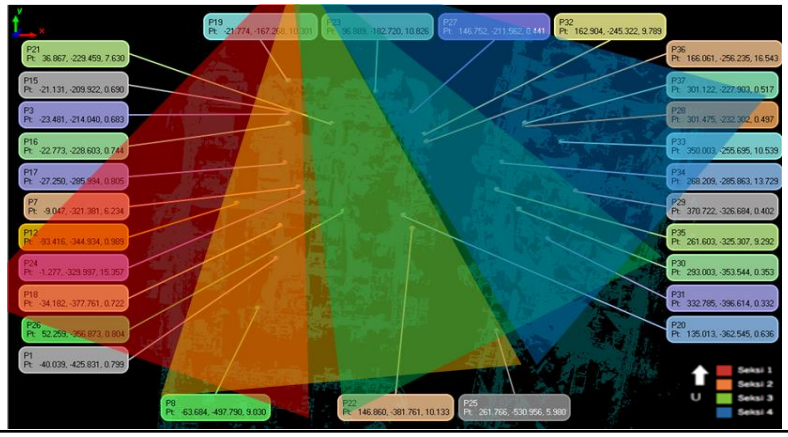

Figure 2. Scanning from the roof of the Apartment (A P Suherman P, 2014)
To complete the area being scanned from the roof of the apartment, the next scan is done on the road (from the street) to complete the data scanning. Scanning from the street to the prism point location, as in Figure 3 as follows:

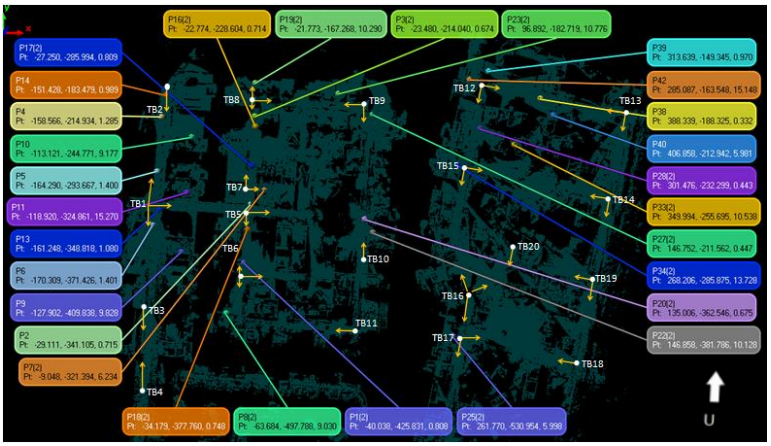

Figure 3. Scanning from the street (A P Suherman P, 2014)

TB = TLS location
P = Prism point location

Data processing point clouds to get a 3D solid model is doing some stage, namely registration, filtering, georeferencing, and modeling.
The registration process carried out by separating the registration based on the location decision, namely the registration scanning from the roof of Apartment and from the street. Then the two registrations are combined to form complete object. The registration model can be seen in Figure 4, as follows:

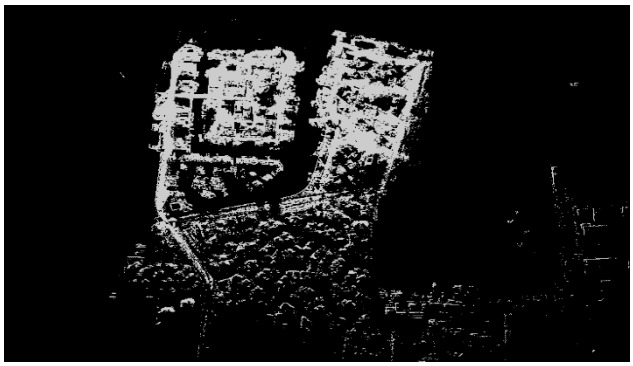
Figure 4 Regristration model (A P Suherman P, 2014)

And the average registration error is 0.0191 m.
Filtering is delete for unnecessary data. This is done by manual, by identifying the objects that are not necessary, then the objects been removed. Before filtering, as Fig.5 as follows:

Figure 5 Before filtering (A P Suherman P, 2014)

And after filtering, as Fig.6 as follows:

Figure 6 After filtering (A P Suherman P, 2014)

Next, calculate the undulation and orthometric elevation of GPS control points, and the results are as shown in Table 2 as follows:

Table 2. Elevation of GPS Control Points (A P Suherman P, 2014)

ID	Ellipsoid Elevation h (m)	Undulation N(m)	Orthometric Elevation/ H (m)
NRP_1	18.8313	18.6911	0.1402
NRP_2	18.7949	18.6928	0.1021
NRP_3	18.4291	18.7072	- 0.2781

In the GPS control points, placed prism and scanning, which prism P14 installed at the control point (NRP_1), the prism P1 at the control point (NRP_2) and the prism P29 at the control point (NRP_3), in order to obtain geo-referenced models, such as the Fig.7 as follows:

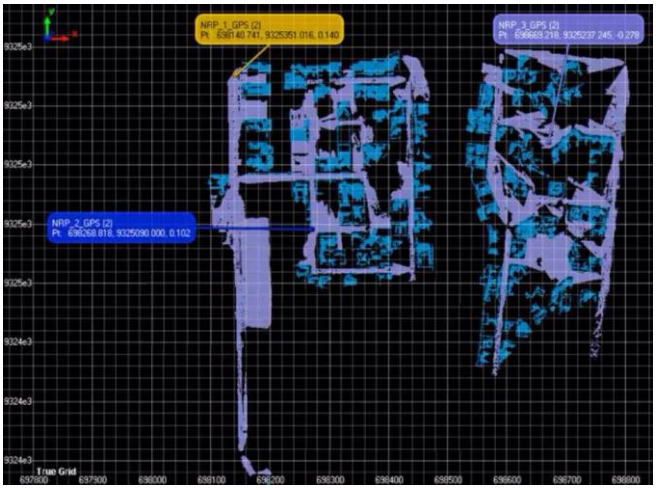

Figure.7 Geo-reference model (A P Suherman P, 2014)

Building height is measured from the model geo-referenced as follows:

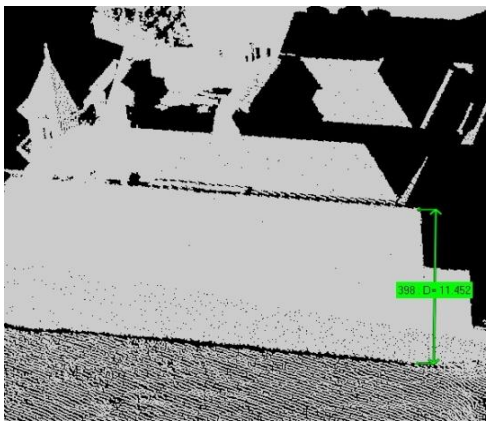

Figure.8 Building height on the model (A P Suherman P, 2014)

Furthermore, the modeling is done using software Geomagic, AutoCAD, and Google Sketch Up, 3D solid model is obtained as follows:

Figure 1 3D Solid Model (A P Suherman P, 2014)

3. CONCLUSION

- Mapping 3D parcels can be done with a laser technology equipment as TLS and building height is measured from the model geo-referenced
- In 3D cadastre, requiring detailed shape of the building, so it should be no permission for the scanning from the owners of the parcels.
- The 3D solid model, can support the management of coastal areas of Government of DKI Jakarta.

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