Utilizing 3D Laser Scanning Technology for Remodeling Work of Building Inside

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ABSTRACT

Laser scanning technology is a maturing measurement technology which is capable of obtaining 3D measurement data of objects with high-accuracy, high-resolution and in a short time. Laser scanners are used more and more as surveying instruments for various applications. This paper describes the procedure of 3D data acquirement using terrestrial LiDAR and section drawing extraction through a series of processing for remodeling the interior of a department building..

Accurate drawings are needed for improvement construction of building interior. However if the design drawings of that time of construction work were lost or damaged or actual dimensions of drawings differ from those of design drawings, the interior should be resurveyed. In this study, the extraction process of interior plane figures were suggested through using laser scanning and related reverse engineering software

Keywords: *Laser Scanner, Reverse Engineering, 3D Measurementt and Plane Figure., Inside Improvement, Terrestrial*

1. INTRODUCTION

The market of laser scanners for terrestrial applications has developed over the last years quite successfully and the laser scanners are seen as surveying instruments which meet the requirements of industrial applications. Traditional surveying instruments, CMM(coordinate-measuring machine) and so forth have been used for 3D digital data of objects. A CMM is limited in a installation position and require much time and skill for measurement, while a laser scanner is able to acquire data very simply and in a short time because it is measures automatically by a non-contact manner[1].

Laser scanning technology is a maturing measurement technology which is capable of obtaining high-accuracy and high-resolution 3D data in a short time. The data collected by laser scanners are point-clouds representing 3D coordinates of points which reflect the laser signals back to the receiver[2].

The objective of 3D scanning is to restitute the accurate shapes of objects in space, store them as digital data and obtain various data through the stored data. That is, 3D scanning is a series of process for restituting a 3D model with actual dimensions by generating surface using polygon data formed from point-cloud and acquiring various data and information.

The reverse engineering is the technique which restitute shape and is composed of steps which measure objects, transform measured data into structured point-cloud, and transform point-cloud into 3D CAD model or 3D model with texture. The reverse engineering is in great demand in the industry at large including not only manufacturing industry such as automobile, aero space or electric home appliance which need making 3D models promptly and accurately but also cultural industry such as advertisement, movie and so on which intend to obtain lifelike 3D models[8].

Field surveyors became to get a great number of point-cloud data on the surface of objects in a short time by means of a 3D laser scanner equipment which is also called Terrestrial LiDAR(light detection and ranging). In Korea, a terrestrial LiDAR has been utilized for volume measurement of a underground cave, deformation measurement of a tunnel, a retaining wall, etc, design of steel box girder bridge and slope stability, preservation and restoration of cultural assets and

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modeling of buildings and structures.

Also combining a terrestrial laser scanner and digital terrestrial photogrammetry, the models of old architectures were generated and through the construction project of overall information system of national cultural assets, which carried out by support of Ministry of Culture, Sports & Tourism in Korea, 3D digital data were completed for about 200 main antiquities in the possession of 12 national museums and 25 public and private museums.

Terrestrial laser scanners have been utilized in wide area such as transportation section in Traffic Department of USA IOWA State, structural monitoring, recording and modelling of old infrastructure and cultural asset conservation state, monitoring of land slide and glaciers, observation of facility around rail track, and structural measurement of hydro power plant and so forth. In this research, we suggested plane figures extraction procedure for remodeling execution of a building interior through a series of processing of data acquired by a terrestrial laser scanner.

2. DATA ACQUISITION

1.2 Specifications

A Z+F 3D Laser Scanner used in this research is capable of measuring the maximum of 500,000 points per second at accuracy upto at least 0.1mm with rotation upto the range of 360° arc horizontally and 310° arc vertically, and the maximum observation distance of 79 meter as you see in Table 1 [7].

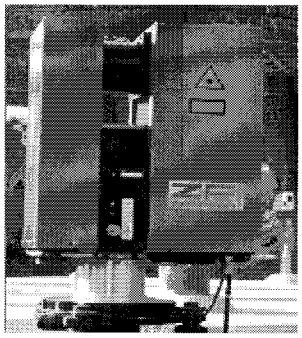


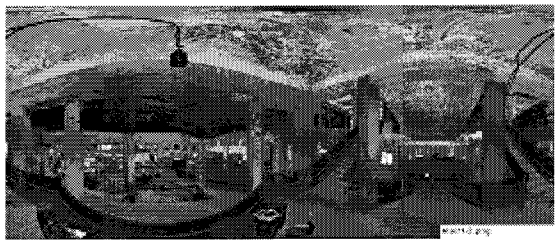
Fig.1. Z+F 3D laser scanner

Table 1. Specification of Z+F 3D laser scanner

maximum distance	79m
minimum distance	1.0m
Resolution	0.1mm
data acquisition speed	< 500,000pxl/s
Accuracy	<1mm
vertical revolution	310-degree arc
horizontal revolution	360-degree arc

(a) 1st Floor

(b) 2nd Floor



(c) Stair

Fig.2. Inside image of a remodeling department building

A laser scanner measures and records relative coordinates and transfers data from receiving apparatus to a laptop PC. The size of inside of department building is about 49×59m in plane size of each floor. Fig.2 shows scan image data of first and second floors and stair, which combines both floors in department building inside.

Total 96 control points were stuck on side walls and stair walkway walls of first and second floors of remodeling object and surveyed by a total station, Sokkia 2BII. Scan data were acquired respectively at several stations in first and second floor. Table 2 shows 3D coordintes of 96 control points.

Fig.3. Data acquisition scene

Table 2. 3D coordinates of 96 control points surveyed by a total station.

Point No.	X	Y	Z
103	159.797	111.408	38.304
102	145.551	129.992	37.176
104	163.695	129.754	37.934
...	...	...	...
150	164.486	148.907	45.445
151	181.787	152.477	46.459
152	190.292	140.038	46.540
...	...	...	...
209	152.483	129.879	33.998
210	160.156	156.341	32.791
211	158.109	148.214	34.234

3. REGISTRATION AND GEOREFERENCING

Continuous scan clouds of a object should pass through the registration procedure which is related to relative spatial matching and joining and the georeferencing procedure which is related to transformation to absolute coordinates. Registration is a procedure which compute relative positions by aligning scan data measured at different stations as shown in Fig.4 [5]. This is the process that performs coordinate transformation to form the same coordinate system. Here coordinate transformation is determined by translation and rotation factors in space.

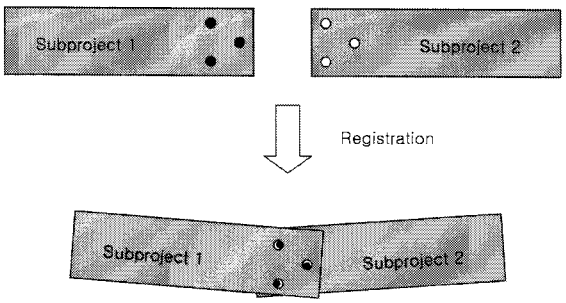
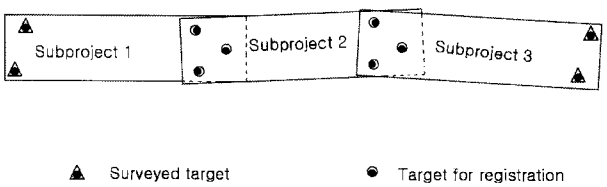


Fig. 4. Registration of continuous scan data

Scan data which are aligned in the same coordinate system after registration are transformed into absolute coordinates by combining with ground control points through the georeferencing as shown in Fig. 5 [5].



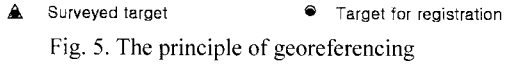


Fig. 5. The principle of georeferencing

Rapidform was used as a 3D scan modeling software for post-processing laser scan data for reverse engineering or inspection. It makes 3D scanning an extremely powerful tool for a variety of applications and is used in manufacturing, R&D, quality inspection, medical research, civil engineering and more

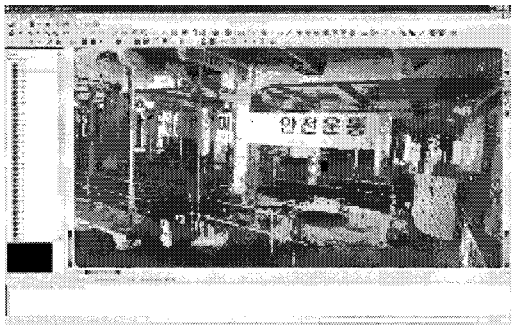


Fig. 6. Scan data acquired at a station of 1st floor

4. DATA PROCESSING

Point-clouds with 3D coordinates(X,Y,Z), which are generated from the data of the object surface, are edited for deleting unnecessary data by 3D modeling sofrware, Rapidform[9]. And then through registration and merging processing on Rapidform software, scan data acquired respectively at several stations in first and second floor were merged in a unified coordinate system using 96 control points which were arranged properly. Fig.7 shows the merged scan data of 1st floor and Fig.8 shows merged scan data of 1st and 2nd floors on the Rapidform S/W.

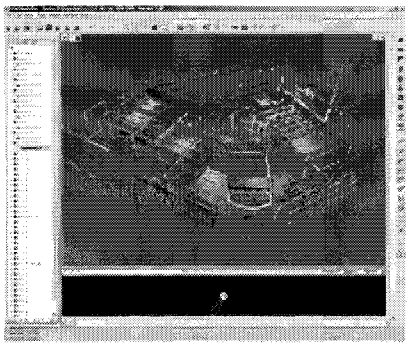


Fig.7. Merging scan data of 1st floor

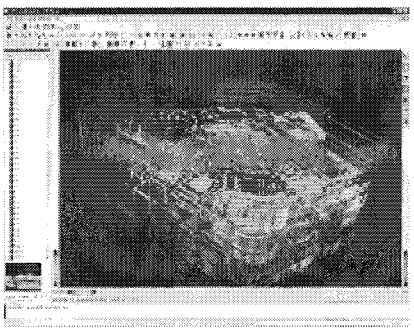


Fig.8. Merging scan data of 1st and 2nd floor

Fig.9 shows the slicing function of the Rapidform for extracting a plane drawing from 3D model data. The black plane shows the position of a cross section in this figure.

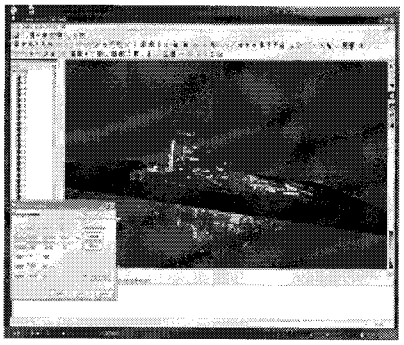


Fig. 9. Slicing for extracting plane drawing using post-processing software

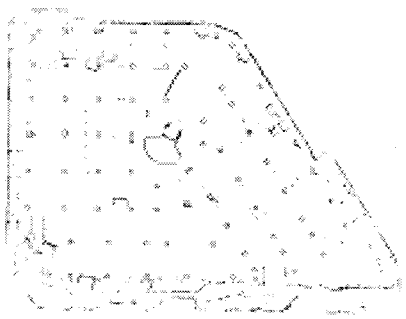


Fig.10. Extraction of a plane figure from combined scan data

The plane figures were extracted as you see in Fig.10 by slicing of a combined scan data and Fig.11 shows a plane design drawing at that time of construction.

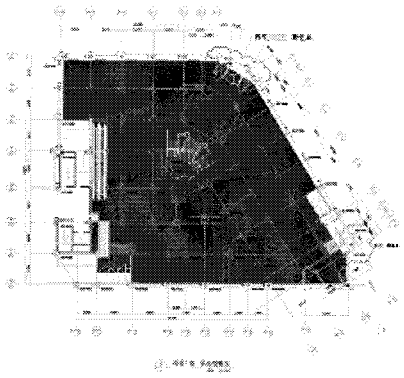


Fig.11. Design drawing at that time of construction

For recording or preserving the shape information of a building, the data of not image concept but digital concept are required and so 3D shape data should be produced applying reverse design technology. Laser or optical noncontact measurement methods are so speedy and precise that it can be utilized as a optimal method for 3D measurement of a intricate building interior.

5. CONCLUSION & DISCUSSION

The products obtained by laser scanning are point-cloud data which are composed of a great number of points. Because the products themselves are nothing but basic data for the end products, they are tranformed into 3D data which they require only when they go through postprocessing by proper softwares

Remodeling execution of a building interior is in need of accurate drawing maps. However if design drawing at that time of the building constrction are lost or damaged or it is different from reality in dimension, resurvey of interior is needed. In this case laser scanning and drawing data extraction function of related processing software raise greatly work efficiency.

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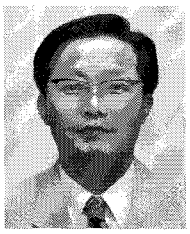

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