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 acquisition 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 Measurement 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.

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.

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 process of reconstituting 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 reconstitute 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, aerospace 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.

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 an underground cavity, 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 up to at least 0.1mm with rotation up to the range of 360° arc horizontally and 310° arc vertically, and the maximum observation distance of 79 meter as you see in Table 1.

![Fig.1. Z+F 3D laser scanner](image)

<table>
<thead>
<tr>
<th>Table 1. Specification of Z+F 3D laser scanner</th>
</tr>
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<tbody>
<tr>
<td>maximum distance</td>
</tr>
<tr>
<td>minimum distance</td>
</tr>
<tr>
<td>Resolution</td>
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<tr>
<td>data acquisition</td>
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<tr>
<td>speed</td>
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<tr>
<td>Accuracy</td>
</tr>
<tr>
<td>vertical revolution</td>
</tr>
<tr>
<td>horizontal revolution</td>
</tr>
</tbody>
</table>

![Fig.2. Inside image of a remodeling department building](image)

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 x 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 28H. Scan data were acquired respectively at several stations in first and second floor. Table 2 shows 3D coordinates of 96 control points.

![Fig.3. Data acquisition scene](image)
Table 2. 3D coordinates of 96 control points surveyed by a total station.

<table>
<thead>
<tr>
<th>Point No.</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>159.797</td>
<td>111.408</td>
<td>38.304</td>
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<tr>
<td>102</td>
<td>145.551</td>
<td>129.992</td>
<td>37.176</td>
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<td>104</td>
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<td>...</td>
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</tr>
<tr>
<td>150</td>
<td>164.486</td>
<td>148.907</td>
<td>45.445</td>
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<td>151</td>
<td>181.787</td>
<td>152.477</td>
<td>46.459</td>
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<td>190.292</td>
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<td>160.156</td>
<td>156.341</td>
<td>32.791</td>
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<tr>
<td>211</td>
<td>158.109</td>
<td>148.214</td>
<td>34.234</td>
</tr>
</tbody>
</table>

3. REGISTRATION AND GEOREFERENCING

Continuous scan clouds of an 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. 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.

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.

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.

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 software, Rapidform®. 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.
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 transformed into 3D data which they require only when they go through post-processing 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 construction 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.

REFERENCES


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