DEVELOPMENT OF ATTRIBUTE-ASSIGN-EDITOR FOR ROAD SURFACE POINT CLOUD DATA

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1. INTRODUCTION

Point cloud data is a very high accuracy three-dimensional external surface data of an object that comes with two types of information: three-dimensional coordinating and color. It has been known for making surface reconstruction of various structures. However, research regarding the use of point cloud data in construction life cycle management like in Japan is rarely found. Japanese researchers have been applying point cloud data for the use in various stages of various structures such as buildings, but it has not been applied to the road.

This current study explores how a single use of point cloud data can be applied to road surface data management. Furthermore, it shows how attributed point cloud data can improve the present road register, how the result from the editor can make an efficient strategy in for the whole area, and shows the convenience in checking the road surface data in elevation view by using three-dimensional viewer.

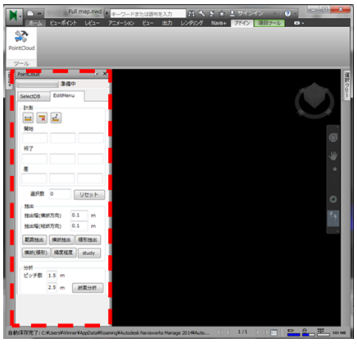

Fig. 1 Maintenance Data Output Tool (MDot+)

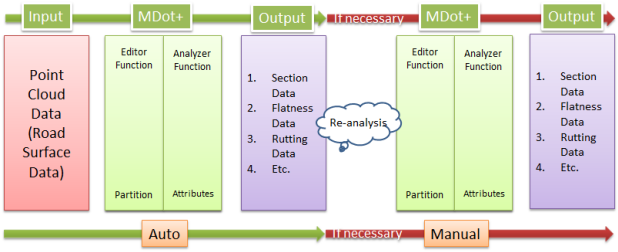

Fig. 2 Process of MDot+

2. PROBLEMS CONCERNING ROAD REGISTER

In the current status of road register, there are two main problems. First, the data for road register is stored inside the server and main storage without any use. Second, spread sheet, 2D CAD, and GIS, which are deployed for road register, are independently presented which leads to the lack of cross-profile section view and time-consuming problems. GIS is a system which provides data of maps and drawings of the Earth. It is possible to integrate all the data inside GIS, but the re-production of the road state and the elevation view of the road surface data are very weak. On the other hand, the three-dimensional point cloud data has a better understanding in elevation view as well as cross and profile section of the object, but it lacks attributes. Most recently, there has been a need for data that encompasses information. Attributed data is very convenient for information management. However, as the point cloud data does not contain any attribute, the authors in the current study will use the developed system to assign attributes to the data which leads to visualization for the maintenance stage in road management and eventually leads to the use of point cloud data in construction life cycle management.

3. DEVELOPMENT OF MAINTENANCE DATA OUTPUT TOOL PLUS (MDot+)

3.1 Partition Function

MDot+ has a function to separate a group of point cloud data. The point cloud data is split according to the length of the linearity. The length of the line can be set freely. The data is split into sections (Si {i = 1,2,...,n}). By dividing Si, it is possible to assign attributes to the point cloud data in each section.

3.2 Analyzer and attributes

Rutting, flatness, and cracking ratio are used to compute MCI value.

Rutting formula is shown below;

$$W_i = Z_{iMax} - Z_{iMin} \quad (1)$$

Flatness formula is shown below;

$$\sigma = \sqrt{\frac{\sum_i^n (Z_i - Z_{ave})^2}{n-1}} \quad (2)$$

Cracking ratio formula is shown below;

$$C = \frac{(b_1 * 0.6) + (b_2 * 1.0) + b_3}{\text{Total Number of Blocks}} \quad (3)$$

Keywords Road Register, Point Cloud Data, MMS, Editor System, Attributes Assigned Data, Road Maintenance
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By using these equations, MCI value, which a comprehensive evaluation index used to determine the maintenance and repair of the road, is computed. This leads to the classification and colorization of the roads inside the 3D viewer.

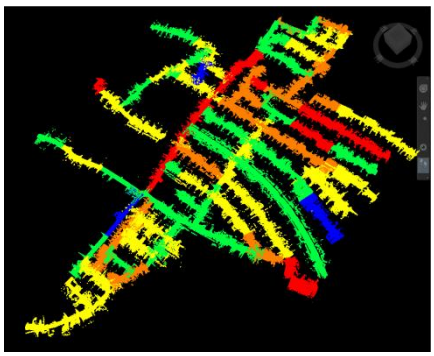

Fig. 3 MCI Rank of A Town after Colorization

4. APPLICATION AND RESULT

In figure 2, the process of MDot+ is shown. First, the point cloud data is being inputted inside the editor. Then, the editor will automatically compute the data. Finally, section data, attributes, etc. will come out and are already organized by the editor. If there is a need for re-analysis, point cloud data can be computed manually. Thus, the authors have applied MDot+ in a part of A town. This case study uses the point cloud data of A town that is measured by using a three-dimensional survey equipment—MMS. The current study is being used for purposes of road maintenance in road information management. The application site has a total distance of 194 kilometers and total points of 10 million. The application started from partitioning all the road data of A town by 100 meters interval. After that, all the attributes were automatically computed using MDot+. From the data table, the authors assigned the attributes to each road in the A town. From there, the authors colorized and labeled the data.

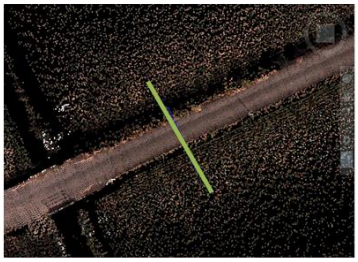

Fig. 4 Profile and Cross Section Checking

5. DISCUSSION

First, with automatic and manual analysis of the road surface data, the process of road maintenance can be completed swiftly and two times faster than the original way. It is possible to perform the re-analysis rapidly since the process in using this editor does not require much time. Once MDot+ process started, the attributes files will be accordingly organized; therefore, there is no need for re-organization after the analysis is done.

Second, by computing MCI rank from the analyzed attributes, the authors can distinguish the state of the roads using MLIT's standards by colorizing the road surface point cloud data according to its rank and attributes. The labels can also be added to the data. With such combination, it is much easier to identify which road in need of re-evaluation or re-pavement.

Third, by using Navisworks as a viewer, it is possible to check the profile and cross section of the road. With this, it is possible to check the location where the flatness or rutting occurs on the road surface date as seen in figure 4. Furthermore, it is possible to link the spread sheet (Excel) data to the attributed point cloud data. With this linkage, the user can change not only the values inside Navisworks, but also those outside Navisworks by using the data table. With just a click on the road surface, all of the input data—road name, rutting, flatness, cracking ratio, etc.—are automatically came out on Navisworks screen. by linking the photograph of the road taken from MMS (Figure 5), it is possible to see how the rutting or crack looks like in the reality. With virtual and actual reality checking combination, it greatly increases the convenience in road maintenance.

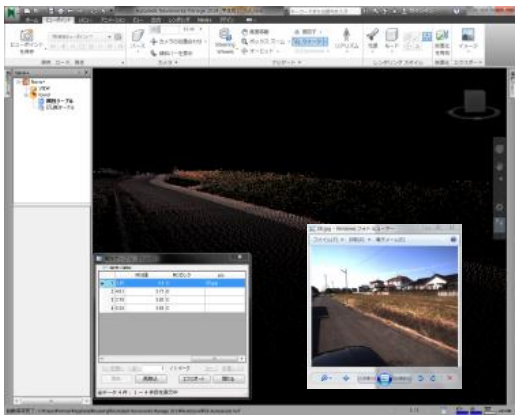

Fig.5 Data Linkage

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