Improving the efficiency of disaster assessment using smartphones and other devices utilising three-dimensional (3D) point cloud data

Shizuoka Prefecture

Background

In recent years, natural disasters have frequently occurred in various parts of Japan due to abnormal weather, etc., and this has caused extensive damage. Local governments must quickly restore damaged public civil engineering facilities, but as it is difficult for individual municipalities to cover the costs of restoration alone, the recovery project receives support from the national government. In order to receive this support, they are required to carry out surveys and prepare documents on subjects ranging from damage reports to disaster assessments within two months, which requires a lot of work. The Shimada Civil Engineering Office in Shizuoka Prefecture was the first in Japan to use mobile devices to carry out 3D measurements for assessing areas damaged by Typhoon No. 15 in September 2022, with the aim of improving the efficiency of the work.

Objectives

1. Reducing the number of personnel required to survey disaster areas
2. Reducing the amount of time required to prepare documents

Project Outline

1. 3D measurement using mobile devices

   In recent years, LiDAR sensors capable of collecting point cloud data have been installed in mobile devices such as smartphones, and anyone can operate them easily and cheaply. This has greatly lowered the barriers to 3D measurement. Instead of conventional on-site surveys using red and white poles, measuring instruments, cameras, etc., a mobile device equipped with a LiDAR sensor was used to measure the damaged area. Measurements were carried out with reference to the Mobile Scanning Association's Mobile Device Scanning Manual[1].
2. Create cross-sectional line diagram data from point cloud data

   Current topographical maps can be created by using point cloud processing software to extract and convert cross-sectional views from the point cloud data. These cross sections were used to create representative cross-sectional views of the damaged areas.

Features and Innovations

1. Preparation of disaster assessment materials by local government employees alone

   Since this disaster was recognised as a large-scale disaster, the use of representative cross-sectional diagrams, etc. was approved as design documents for assessment[2]. As mentioned above, as all the work—from the 3D measurement to the preparation of the cross-sectional design drawings—can be completed using a mobile device or a personal computer, local government employees can prepare the assessments, which is expected to reduce the burden on surveying companies, etc. In addition, this enables a reduction in the number of people involved in surveys, as on-site surveys only require a minimum of two people.

2. All work is carried out with free software
   This initiative utilises free measurement and point cloud processing software, so it only involves the cost of purchasing a mobile device. Initial costs were reduced to the bare minimum, minimising the financial barriers to its implementation.

Results of the Project

1. Visualisation of the disaster situation
   The 3D measurement data is in a form that can be intuitively understood, and can clearly convey the disaster situation without the need to visit the site. Therefore, it is useful not only for sharing information among employees, but also as explanatory material for office assessments.
2. Post measurements are easy
   Conventional surveys of disaster-stricken areas often require extra time, because if the measurements are insufficient, re-measurements and additional photographs must be taken. However, 3D measurement reduces the time and effort involved in going to the site, as you can use the data to check the values of the entire measurement range.

Issues, Problems and Responses

1. Points to note and issues when using 3D measurement
   The measurement range of a mobile device's LiDAR sensor is limited to about five metres, so measuring may be difficult depending on the field conditions.
   In addition, as attention is focused on the screen during measurement, attention to the surroundings is neglected, so it is necessary to always check the surroundings before measuring, and have at least two people there to ensure safety.
   Furthermore, since measurement may be difficult due to the characteristics of the object, it is important to understand the characteristics of objects unsuitable for measurement, such as glass, and other characteristics such as the need for data conversion depending on the purpose, and to judge whether 3D measurement is applicable or not.
2. Learning processing methods for 3D point cloud data
   In order to promote the use of 3D point cloud data, it is necessary to become proficient with the software. Therefore, using paid point cloud processing software, which comes with operational support, etc., reduces any barriers to its introduction. Learning how to use the free software is an issue, but Shizuoka Prefecture has prepared a manual to enable the creation of simple cross-sectional diagrams, and is working on promoting its use. In order to expand this initiative, Shizuoka Prefecture staff created operating instructions themselves so that even beginners can perform simple cross-sectional extraction tasks.

Future Developments (expected effects and project vision and issues)

1. Expectations for future use
   Shizuoka Prefecture is working on the realisation of a digital twin space by promoting the 'VIRTUAL SHIZUOKA' concept[3)], which uses laser scanners, etc. to acquire and store 3D point cloud data of the entire prefecture, and is making it openly available. The momentum for utilising point cloud data is growing not only in the fields of disaster prevention and infrastructure management, but also in various other fields. Currently, 3D measurement data from mobile devices is in the form of an arbitrary coordinate system, but if accurate location coordinate data can be acquired in the future, it can easily be superimposed on the VIRTUAL SHIZUOKA data. This will make it possible to compare changes over time with river and steep slope patrols, etc., as well as to visualise

damage and share information between inspectors and repair personnel. In addition to dealing with disasters, it is thought that this will be useful in various situations, such as daily maintenance.

The use of mobile devices with LiDAR sensors is still in its infancy, so there are challenges. First of all, we are working on training personnel who can handle point cloud data, promoting its widespread use, and aiming for infrastructure management based on the premise of 'VIRTUAL SHIZUOKA' and mobile LiDAR, which is expected to improve productivity.

Figure -1: 3D measurements at the disaster site

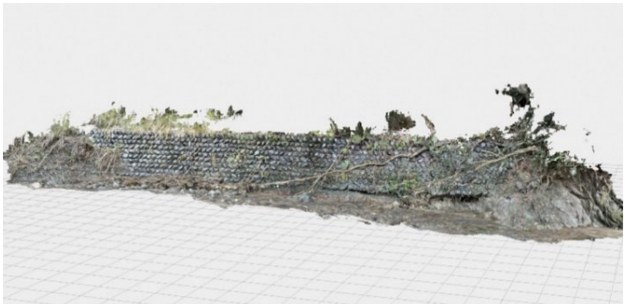

Figure -2: 3D measurement data from the disaster site

Figure -3: Confirmation of numerical values in the data

URL Reference

1) Mobile Scanning Association: Mobile Device Scanning Manual (https://mobilescan.jp/)

2) Ministry of Land, Infrastructure, Transport and Tourism: Ministry of Land, Infrastructure, Transport and Tourism official website (https://www.mlit.go.jp/report/press/mizukokudo06_hh_000233.html)

3) Shizuoka Prefecture: Shizuoka Prefecture official website (https://www.pref.shizuoka.jp/machizukuri/1049255/1052183.html)

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Meaning of Technical Terms and Coined Terms Used

LiDAR: Light detection and ranging

→ Optical radar. Or it refers to the optical radar method, which is a measurement method to calculate the distance to an object by projecting a light pulse onto it and measuring the time it takes to reflect back.

3D point cloud data: Coordinate data obtained by 3D measurements. By taking photos at the same time, colour information can also be added, making it possible to express latitude, longitude, altitude, light intensity and colour (RGB) as numerical values.