Apply Smartphone apps to real time 3D Modeling of Sediment-Related Disasters

○Che-Yu Li (李哲宇), Chen-Yu Chen(陳振宇), Kuo-Wei Chen(陳國威),
Yi-Yu Li (李易諭), Te-Hsiu Huang (黃德秀)
Agency of Rural Development and Soil & Water Conservation, Taiwan (台湾農村発展及水土保持署)

1. INTRODUCTION

During typhoons and heavy rainfall events, sediment-related disasters frequently occur on hill slopes, among which debris flows pose the most significant threat. It is imperative to swiftly collect pertinent disaster data to facilitate disaster mitigation and response initiatives. In recent years, remote sensing imagery and unmanned aerial vehicles (UAVs) have been increasingly employed for large-scale data collection and investigation of disaster sites. This methodology markedly enhances efficiency in comparison to traditional manual field surveys. Although both techniques offer insights into the geographical features of extensive areas, they face challenges in promptly capturing precise details of smaller zones. This study employs smartphones for on-site disaster surveys, utilizing 360-degree panoramas, LIDAR scanning, and photogrammetry. This approach is utilized to investigate disaster areas where remote sensing imagery and UAVs fail to capture.

2. RAINFALL AND SEDIMENT DISASTER

(1) Site condition

The case study presented in this research occurred at 3:00 PM on August 4, 2023, at Nanfeng Village, Ren'ai Township, Nantou County, Taiwan (**Fig. 1**, WGS84: 24.003126,121.086072). The site is located within the debris-flow torrent (DF013). Triggered by Typhoon Kanu, which brought significant rainfall from the southwest monsoon, a debris flow ensued. The flow eroded the rear tributary's banks on both sides, ultimately burying a gas station.

Fig. 1 Debris-flow torrent (DF013) and Gas station

(2) Research material and Method

This research employs the iPhone 14 Pro to utilize both LIDAR scanning mapping and photogrammetry methods, leveraging the phone's integrated LIDAR sensor and camera. Various free versions of mobile applications are tested, capitalizing on their unique strengths (**Fig. 2**). The objective of the study is to initially utilize the 360 panoramic mode to showcase panoramic images of the surrounding environment of potential debris-flow torrents in each river section. Subsequently, by focusing on critical disaster locations within these images, the research applies both LIDAR scanning mapping and photogrammetry methods to construct 3D models and perform rapid dimensional measurements. Upon the completion of 3D model construction, built-in functionalities such as 3D model measurement, volume measurement, and visualization modes are further utilized to analyze this case study (**Fig. 3**). It is anticipated that by applying the functionalities above, this study will provide a foundational reference for the rapid application by disaster prevention and rescue units.

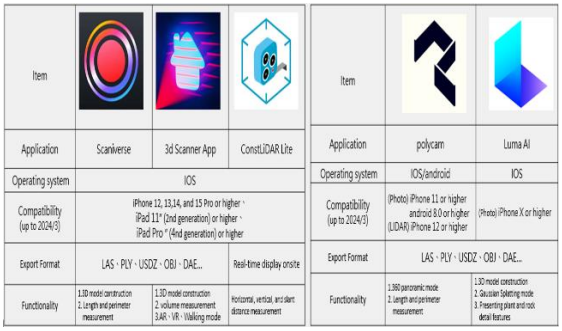

Fig. 2 Various free versions of mobile applications

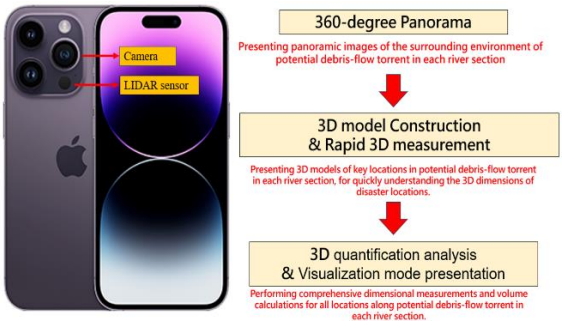

Fig. 3 The investigation methods of smartphone

3. RESULTS AND DISCUSSIONS

This study seeks to employ 360-degree panoramic functionality to enhance the understanding of specific structures, such as ground sills (**Fig. 4**) and a gas station that exists downstream of the stream (**Fig.5**). These two cases illustrate that 360-degree panoramic functionality can aid users in quickly comprehending the situation at debris flow disaster sites. After verifying the surrounding conditions of the disaster site in 360-degree panoramic mode, smartphones are utilized to swiftly construct 3D models of the disaster and perform rapid on-site measurement of dimensions, focusing on critical areas of debris flow disasters. For example, structures like ground sills installed in the middle reaches of the stream can have multiple 3D models created instantly on-site. Moreover, the slopes near the ground sills exhibit clear signs of debris flow marks. In the past, due to the excessive height of these debris flow marks, only rough estimates of their height could be obtained by scaling with a human. However, with smartphone measurement, real-time 3D measurement can be conducted, providing precise information about the debris flow site. Additionally, when the gas station is buried, quantitative analysis can be performed using the 3D model constructed with a smartphone. This analysis reveals that the maximum burial height is 3.2 meters, with sediment flowing towards the left bank of the stream, consistent with conditions during the disaster.

Finally, after the completion of 3D model construction using a smartphone, users can freely repeat the analysis of the models, offering increased usability and versatility in applications. For instance, after multiple ground sills experience cracking due to debris flow impact, smartphones can instantly quantify the cross-section of the streambed using the 3D model and determine the dimensions of the cracks. Additionally, regarding the stones in the stream, smartphones can instantly measure the size of the rock particles using the 3D models. Moreover, the pile of sediment covering the gas station can be assessed in real-time for its volume using the 3D model. Visual representation modes such as walkthrough mode and AR mode can be employed to showcase the scenario, allowing users to immerse themselves and understand the current situation of the disaster site. Ultimately, the 3D models can be exported into various formats for further value-added applications using computer software.

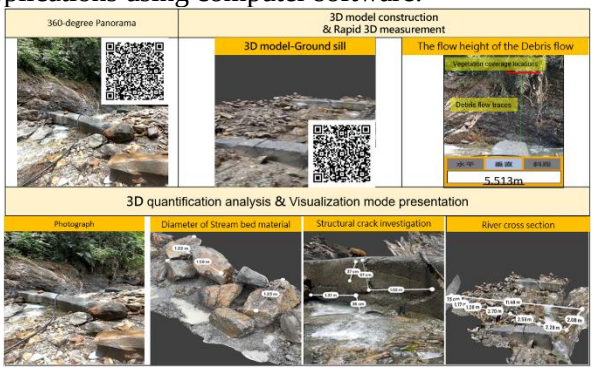

Fig. 4 The 360-degree panoramic and 3D model in stream

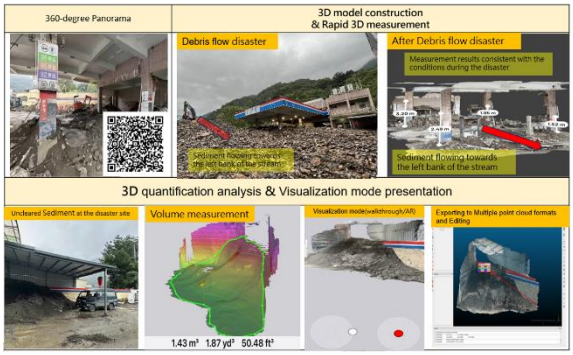

Fig. 5 The 360-degree panoramic and 3D model in gas station

References

1) Che-Yu Li, Chen-Yu Chen, Kuo-Wei Chen (2023) Exploring the Application of Establishing 3D Models of Sediment-Related Disasters Using Smartphones. 2023 Conference of Chinese Soil and Water Conservation.(in Chinese)
2) 岩間輝(2021). iPhone LiDAR× CloudCompare で体積算出しようぜ, https://note.com/iwamah1/n/n018247e7dbb5
3) 岩間輝(2022). 徹底解説！iPhone 3D スキャンの撮り方全て教えます,https://note.com/iwamah1/n/n1419056b7445

Keywords: Smartphone, Photogrammetry, LIDAR, Debris flow.