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Application of UAV Photogrammetry and 3D Modeling in Mine Geological Environment Monitoring

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Abstract: UAV low-altitude remote sensing technology enables fast and accurate real-time monitoring of mines within a specific range. The method of UAV photogrammetry and Structure from Motion (SfM) are utilized in the process of the establishment of the mine three-dimensional model. In this study, the mine of Yangjiazhangzi Village in Xingcheng City, Liaoning Province, China, was selected as the research area to carry out mine geological environment monitoring, validating the method's feasibility. A total of 661 mine images were acquired, and the lateral overlap was over 57%. Agisoft Photoscan software was used for data processing. After the automatic aerial triangulation, the digital surface model (DSM) is extracted to obtain high-precision DSM data of the entire mining area, and the high-precision digital elevation model (DEM) of the mining area is obtained by DSM filtering or manual editing. The mining area and volume can be accurately calculated on the basis of orthophoto and DEM image.Finally, DEM image processor is used for rapid monolithic correction, radiation processing, and orthophoto stitching to generate an orthophoto of the entire mine area. (Fig. 1) Photo-based 3D reconstruction refers to the use of photo images to recover a three-dimensional geometric model of an object. Two core technology of 3D geological modeling are Structure from Motion (SfM) and Multi-View Stereo (MVS). This technology mainly includes steps such as feature point detection and matching, point cloud sparse reconstruction, camera self-calibration, and point cloud dense reconstruction. (Fig. 2) According to the remote sensing image interpretation statistics, the mining area of the pit is 267,600 m^2, and the mining volume is 18.55 million m^3, occupying cultivated land and forest land. The accumulation area of gangue hill around the mining area is 1,147,600 m^2, and its volume is 1670.08 million m^3. A large amount of tailings slag in the tailings pond buries the original surface vegetation. The generated high-precision real-scene 3D model can accurately reflect the environmental problems of the surface. Geological hazards and hidden dangers such as collapse, landslides, mudslides and unstable slopes can be identified on the image, which can guide humans to repair the mine environment in a targeted manner.The landslide has a fan-shaped or arc-like structure on the image, and the texture is rough. The new landslide is mostly light gray while the old landslide is mostly khaki and its back wall is covered with plants. According to the interpretation, three landslides were identified in the study area. Some areas in

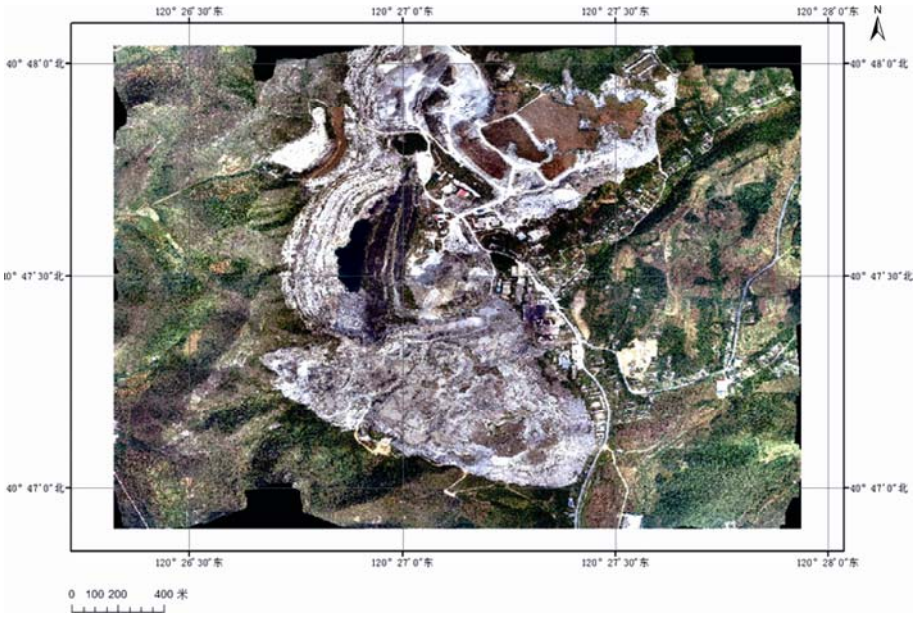

Fig. 1. Orthophoto of research area.

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http://www.geojournals.cn/dzxbcn/ch/index.aspx; https://onlinelibrary.wiley.com/journal/17556724

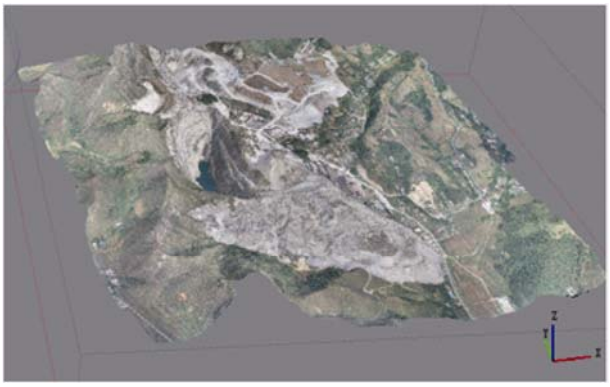

Fig. 2. Three dimensional geological model of mine.

the study area have steep slopes and almost no vegetation cover. Combined with the slope map, six unstable slopes with slopes greater than 40° and less vegetation coverage are interpreted. Most of these slopes are close to the roadside and residential areas, which is a potential hazard. In summary, UAV technology can be used to acquire high-precision low-altitude remote sensing images of mines. Researchers can conduct mine environment monitoring based on orthophotos, digital elevation models and real-world 3D models. In addition, the low-altitude remote sensing technology of UAV is highly feasible in the actual project and the data accuracy is reliable. As a new type of remote sensing means, it can be widely applied to the monitoring of mine geological environment.

Key words: UAV photogrammetry, 3D modeling, environment monitoring

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