Oblique photogrammetry system for real-time monitoring of volcanic activity

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Volcanic eruptions often cause topographic changes, such as the destruction of an edifice due to an explosive eruption. For volcanic hazard mitigation, it is important to quickly measure these topographic changes. When a volcano erupts explosively, an airplane cannot fly directly over a crater to carry out aerial photography and LiDAR measurements. In order to obtain information regarding topographic changes, we can take many oblique aerial photos from an airplane and a helicopter, but it is difficult to obtain spatial information such as the spread area of pyroclastic flow deposits from oblique aerial photos. Therefore, we have developed an oblique photogrammetry system for real-time monitoring of volcanic activity. This system is capable of analyzing a single oblique aerial or terrestrial photo image using digital elevation model (DEM). There are three characteristics to this system: 1) making an orthophoto image from an oblique aerial or terrestrial photo; 2) measurement of position, distance, and square; and 3) generation of GIS data such as shape format. This system is also able to link to a video camera monitoring volcanic eruptions. Analysis of the monitoring video camera images enables prompt measurement of the distance ejecta travel from the crater. In addition, this system can generate a three-dimensional model from many oblique photos. The three-dimensional models are generated by an image correlation method. From this data, we can estimate the volume of ejecta and analyze topographic changes. We analyzed a lava dome from the 2011 eruption of Shinmoedake volcano, Kirishima volcanic group, Japan. We measured the elevation of the summit of the lava dome and the distance of the lava spread area, and estimated lava thickness from cross sections generated from the three-dimensional data. Our measurements were consistent with results of airborne synthetic aperture radar (SAR) and photographic surveying using oblique aerial photographs. The accuracy of this system is sufficient for real-time volcano monitoring. This system is also less expensive than airborne SAR and LiDAR. The oblique photogrammetry system enables a quantitative measure of the change in topography. For example, this system can be used to conduct a time series analysis of the formation and movement of craters or growth of lava dome.