The Fourth Australasian Ground Control in Mining Conference 2018

Paper Number: 50

Evaluation of a UAV-LiDAR system for mapping geological structures in an open pit highwall

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ABSTRACT

Structural mapping of pit walls can be performed using digital images and photogrammetry software, but the performance is limited by weather and environmental conditions including dust, rain and light. On the other hand, active sensors such as terrestrial laser scanners (TLS) and total stations suffer from vertical orientation bias and occlusions when persistent discontinuities dip at the same angle as the scanner line-of-sight. The recent development of the compact light detection and ranging (LiDAR) systems has made it possible to mount these sensors on unmanned aerial vehicles (UAVs) or drones which offer the potential to overcome limitations that are inherent in existing monitoring systems. This study details the research involving integration and application of an advanced UAV-LiDAR system for structural mapping of a highwall. A state-of-the art laser scanner with an inertial measurement unit (IMU) and real-time kinematic global positioning system (GPS) was integrated on to a UAV. The system was first tested in a laboratory condition. Then the UAV-LiDAR system was employed to map a highwall of a coal mine. The planned flight trajectories tested the system at variable distances from the highwall face and at variable speeds. The raw data collected from individual sensors were fused, filtered to remove noise, and segmented to produce a surface scan model. Finally, the point density, surface roughness, and surface coverage were measured using the surface scan model of the highwall. The parameters were compared with equivalent measurements computed from a reference TLS data. The study demonstrates the capabilities of a UAV-LiDAR system to generate accurate and occlusion free data for mapping highwall geological structure with a very quick and efficient flights in the field.