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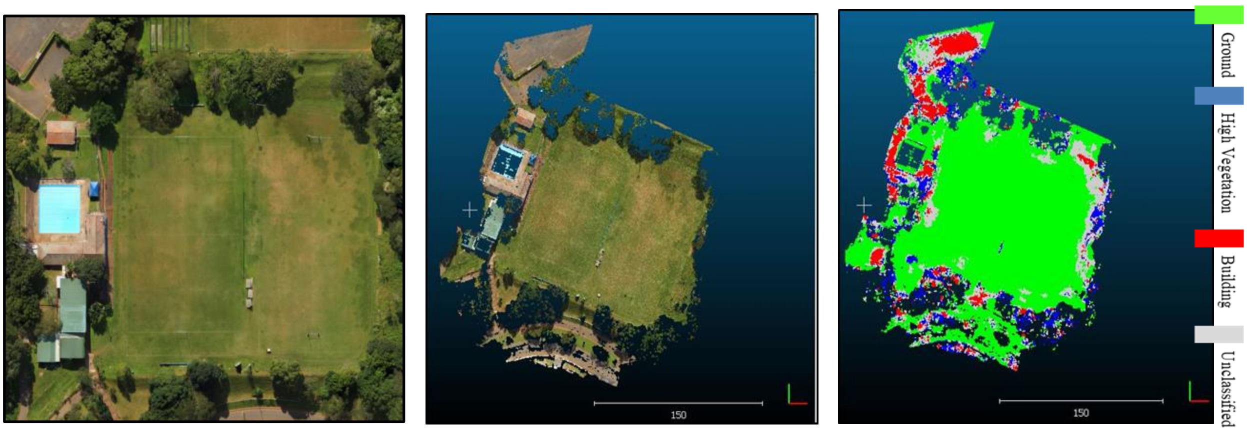
Abstract:

The use of lidar technologies for point cloud acquisition is financially costly. However, photogrammetry using unmanned aerial systems (UAS) imagery and structure-from-motion (SfM) techniques have proven a practical and cost-effective way to collect point cloud data (Liu and Boehm, 2015). SfM uses two-dimensional (2D) images to produce high-quality three-dimensional (3D) point clouds. Classified point cloud data is useful in environmental modelling, cultural heritage preservation and navigation applications (Grilli *et al*., 2017; Roynard *et al*., 2018; Croce *et al*., 2021). This study focuses on classifying a 3D UAS-SfM point cloud of a heterogeneous urban environment into three land cover categories: ground, high vegetation and buildings.

A sports field situated in the University of KwaZulu-Natal, Howard College Campus, was selected as the study area. Figure 1 (a) shows an orthophotograph of the study. Aerial imagery was acquired using a DJI Phantom 3 Pro UAS (drone) equipped with a digital charged-coupled device (CCD) camera. The Web Open Drone Map (WebODM) open-source API (Application Program Interface), which uses the SfM technique, was used to generate a 3D point cloud (figure 1 (b)) and other photogrammetric products. It was noted that the water body (swimming pool) was not reconstructed to a point cloud. The CANUPO (*CAractérisation de NUages de POints*) suite developed by Brodu and Lague (2012) and incorporated in Cloud Compare software was used for supervised classification. CANUPO uses a point cloud's local dimensionality properties to classify points. An independent point cloud with properties similar to the study area was used to sample the training data. The first classifier separated ground from non-ground points, while the second classifier separated buildings and high vegetation. The classification results are shown in figure 1 (c) below.



(a) (b) (c)

Figure 1. Study area: (a) An orthophotograph of the study area. (b) A 3D point cloud before classification. (c) A 3D point cloud after CANUPO classification

Experiments revealed that using the training samples from the same point cloud subject to classification improved the classification results. The accuracy of classification depended on the robustness of classifiers and the classification threshold. Random ground truth sites were generated over the orthophotograph for validation of classification. In addition, site visits were conducted. Adopting the error matrix for classification accuracy assessment, the overall accuracy of 81.3% and the corresponding Kappa Statistic of 0.70 were obtained. These results indicated satisfactory classification with few events of misclassifications. This study has indicated the potential use of the classification of cost-effective 3D UAS-SfM point clouds in mapping, monitoring and other applications. Future research expands to point cloud classification in underwater environments.

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