Point Cloud Filtering on UAV Based Point Cloud

Mustafa Zeybek, İsmail Şanlıoğlu

PII: S0263-2241(18)30935-7
DOI: https://doi.org/10.1016/j.measurement.2018.10.013
Reference: MEASUR 5953

To appear in: *Measurement*

Received Date: 5 October 2017
Revised Date: 1 October 2018
Accepted Date: 5 October 2018

Please cite this article as: M. Zeybek, I. Şanlıoğlu, Point Cloud Filtering on UAV Based Point Cloud, *Measurement* (2018), doi: https://doi.org/10.1016/j.measurement.2018.10.013

Point Cloud Filtering on UAV Based Point Cloud

Mustafa Zeybek[1,2*], İsmail Şanlıoğlu [2]

[1]Artvin Coruh University, Engineering Faculty, Geomatics Engineering, Artvin, Turkey

[2]Selçuk University, Engineering Faculty, Department of Surveying Engineering, Turkey

[1,2]mzeybek@artvin.edu.tr,

[2]sanlioglu@selcuk.edu.tr

**Corresponding Author: mzeybek@artvin.edu.tr*

Abstract

Nowadays, Unmanned Aerial Vehicles (UAVs) have been attracted wide attentions such as a new measurement equipment and mapping, which are capable of the high-resolution point cloud data collection. In addition, a massive point cloud data has brought about the data filtering and irregular data organization for the generation of digital terrain models. Filtering of point clouds contains vegetations and artificial objects play a crucial role for bare earth terrain modelling. Topographical maps rely on the data structures which are built on bare ground terrain points. The bare earth surface extraction is not the only crucial to the topographical maps but also decision-making processes such as natural hazards management, deformation analysis and interpretation.

In order to filter a UAV-based 3D raw point cloud data, in this paper, filtering performance of four different algorithms using open source and commercial software's have been investigated, (1) curvature based (Multiscale Curvature Classification-MCC), (2) surface-based filtering (FUSION), (3) progressive TIN based (LasTool-LasGround module-commercial) and (4) physical simulation processing (Cloth Simulation Filtering-CSF). The applied filtering results were validated with the reference data set classified by operator. Although different filtering methodologies implemented on point clouds, these methods demonstrated similar results to extract ground on distinctive terrain feature such as dense vegetated, flat surface, rough and complex landscapes. The filtering algorithms' results revealed that UAV-generated data suitable for extraction of bare earth surface feature on the different type of a terrain. Accuracy of the filtered point cloud reached the 93% true classification on flat surfaces from CSF filtering method.

Keywords: *UAV, Point Cloud, Filtering, Bare earth, Extraction.*

1. Introduction

Over the past decade, Unmanned Aerial Vehicle (UAV) platforms have been using for various purposes with significant developments of communication systems, autopilot systems, geospatial global navigational satellite systems (GPS/GNSS). The UAV system's great potential for various mapping applications which grows rapidly [1]. Using a UAV to obtain spatial data is highly beneficial for the users in terms of time, cost and accuracy[2].

The UAV systems are preferred as its low cost and a small number of requirements for operation to take-off and landing sites. Furthermore, UAV platforms payload capacity have been increased due to technological improvements on sensors weights. Thus, different sensors can integrate to the platform such as camera and light detection and ranging (LiDAR). The autonomous flying UAV platforms which is able to determine flight direction and surveying area from web based map servers and continuously communicated with GNSS receivers on the platform that made possible to capture image data [3]. Briefly, UAV and remote sensors have giving great contribution to a survey grade mapping for users and research community. UAV's are used wide range of applications such as natural disasters, topographic mapping, volumetric calculations, building and highway engineering, precision agriculture and forestry [4-11]. Some work demonstrated the potential of UAVs or the other call Unmanned Aerial System (UAS) platforms and photogrammetry as a usable technology for surveying fluvial submerged topography areas at the mesoscale [12].

UAV platforms are increasingly used to generate of high-resolution maps for geosciences studies which require unreachable areas instead of time-consuming ground-based traditional measurement techniques [13, 14]. Also, various investigations were completed for generation point cloud such as effect of different ground height and camera angles on accuracy of orthomosaics [15]. Precise applications of UAVs such as in volume calculations have been investigated in previous studies [16-18]. In these studies, 3D point clouds have been produced through photogrammetrically work flow or also called as Structure from Motion (SfM) and Multiview-Stereo (MVS) techniques[19]. SfM includes basic traditional photogrammetry techniques. However, it does not require any regular or parallel captured images to process. Because, these techniques automatically extract and matches image features. Furthermore, it implements the bundle block adjustment procedures [20]. In this study, SfM algorithm has been implemented to generate millions of points clouds with images taken from the UAV platform.

Topographical maps and DTM productions are well-suited high resolution point cloud data to obtain various sensor and techniques [21]. LiDAR data filtering is challenging task for earth science research and being focused on many cases in the literature [22, 23]. Mostly used point cloud filtering algorithms are applied into the