World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:16, No:06, 2022

Satellite LiDAR-Based Digital Terrain Model Correction using Gaussian Process Regression

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Abstract : Forest height is an important parameter for forest biomass estimation, and precise elevation data is essential for accurate forest height estimation. There are several globally or nationally available digital elevation models (DEMs) like SRTM and ASTER. However, its accuracy is reported to be low particularly in mountainous areas where there are closed canopy or steep slope. Recently, space-borne LiDAR, such as the Global Ecosystem Dynamics Investigation (GEDI), have started to provide sparse but accurate ground elevation and canopy height estimates. Several studies have reported the high degree of accuracy in their elevation products on their exact footprints, while it is not clear how this sparse information can be used for wider area. In this study, we developed a digital terrain model correction algorithm by spatially interpolating the difference between existing DEMs and GEDI elevation products by using Gaussian Process (GP) regression model. The result shows that our GP-based methodology can reduce the mean bias of the elevation data from 3.7m to 0.3m when we use airborne LiDAR-derived elevation information as ground truth. Our algorithm is also capable of quantifying the elevation data uncertainty, which is critical requirement for biomass inventory. Upcoming satellite-LiDAR missions, like MOLI (Multi-footprint Observation Lidar and Imager), are expected to contribute to the more accurate digital terrain model generation.

Keywords : digital terrain model, satellite LiDAR, gaussian processes, uncertainty quantification
Conference Title : ICGRS 2022 : International Conference on Geomatics and Remote Sensing
Conference Location : Tokyo, Japan
Conference Dates : June 09-10, 2022