World Academy of Science, Engineering and Technology
International Journal of Computer and Systems Engineering
Vol:15, No:09, 2021

Comparing Two Unmanned Aerial Systems in Determining Elevation at the Field Scale

Authors : Brock Buckingham, Zhe Lin, Wenxuan Guo

Abstract : Accurate elevation data is critical in deriving topographic attributes for the precision management of crop inputs, especially water and nutrients. Traditional ground-based elevation data acquisition is time consuming, labor intensive, and often inconvenient at the field scale. Various unmanned aerial systems (UAS) provide the capability of generating digital elevation data from high-resolution images. The objective of this study was to compare the performance of two UAS with different global positioning system (GPS) receivers in determining elevation at the field scale. A DJI Phantom 4 Pro and a DJI Phantom 4 RTK(real-time kinematic) were applied to acquire images at three heights, including 40m, 80m, and 120m above ground. Forty ground control panels were placed in the field, and their geographic coordinates were determined using an RTK GPS survey unit. For each image acquisition using a UAS at a particular height, two elevation datasets were generated using the Pix4D stitching software: a calibrated dataset using the surveyed coordinates of the ground control panels and an uncalibrated dataset without using the surveyed coordinates of the ground control panels. Elevation values for each panel derived from the elevation model of each dataset were compared to the corresponding coordinates of the ground control panels. The coefficient of the determination (R^2) and the root mean squared error (RMSE) were used as evaluation metrics to assess the performance of each image acquisition scenario. RMSE values for the uncalibrated elevation dataset were 26.613 m, 31.141 m, and 25.135 m for images acquired at 120 m, 80 m, and 40 m, respectively, using the Phantom 4 Pro UAS. With calibration for the same UAS, the accuracies were significantly improved with RMSE values of 0.161 m, 0.165, and 0.030 m, respectively. The best results showed an RMSE of 0.032 m and an R^2 of 0.998 for calibrated dataset generated using the Phantom 4 RTK UAS at 40m height. The accuracy of elevation determination decreased as the flight height increased for both UAS, with RMSE values greater than 0.160 m for the datasets acquired at 80 m and 160 m. The results of this study show that calibration with ground control panels improves the accuracy of elevation determination, especially for the UAS with a regular GPS receiver. The Phantom 4 Pro provides accurate elevation data with substantial surveyed ground control panels for the 40 m dataset. The Phantom 4 Pro RTK UAS provides accurate elevation at 40 m without calibration for practical precision agriculture applications. This study provides valuable information on selecting appropriate UAS and flight heights in determining elevation for precision agriculture applications.

Keywords : unmanned aerial system, elevation, precision agriculture, real-time kinematic (RTK)
Conference Title : ICADTDDFCM 2021 : International Conference on Agricultural Drone Technology, Data-Driven Farming and Crop Monitoring
Conference Location : San Francisco, United States
Conference Dates : September 27-28, 2021