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Influence of Drone Altitude, Image Overlap, and Optical Sensor Resolution on Multi-View Reconstruction of Forest Images

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摘要　　　　Recent technical advances in drones make them increasingly relevant and important tools for forest measurements. However, information on how to optimally set flight parameters and choose sensor resolution is lagging behind the technical developments. Our study aims to address this gap, exploring the effects of drone flight parameters (altitude, image overlap, and sensor resolution) on image reconstruction and successful 3D point extraction. This study was conducted using video footage obtained from flights at several altitudes, sampled for images at varying frequencies to obtain forward overlap ratios ranging between 91 and 99%. Artificial reduction of image resolution was used to simulate sensor resolutions between 0.3 and 8.3 Megapixels (Mpx). The resulting data matrix was analysed using commercial multi-view reconstruction (MVG) software to understand the effects of drone variables on (1) reconstruction detail and precision, (2) flight times of the drone, and (3) reconstruction times during data processing. The correlations between variables were statistically analysed with a multivariate generalised additive model (GAM), based on a tensor spline smoother to construct response surfaces. Flight time was linearly related to altitude, while processing time was mainly influenced by altitude and forward overlap, which in turn changed the number of images processed. Low flight altitudes yielded the highest reconstruction details and best precision, particularly in combination with high image overlaps. Interestingly, this effect was nonlinear and not directly related to increased sensor resolution at higher altitudes. We suggest that image geometry and high image frequency enable the MVG algorithm to identify more points on the silhouettes of tree crowns. Our results are some of the first estimates of reasonable value ranges for flight parameter selection for forestry applications.

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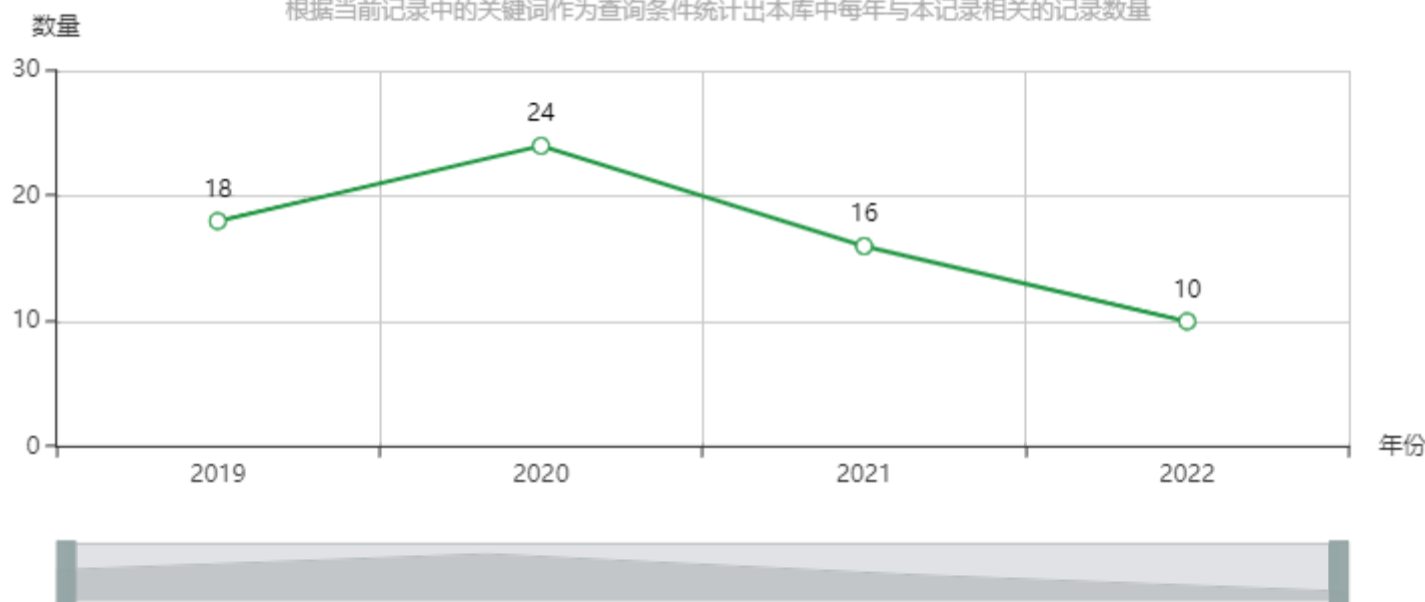
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