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PSO-based integration navigation and LiDAR-based remote sensing algorithms for 3D agriculture digital modeling with light multi-rotor UAV

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ABSTRACT

Traditional remote sensing methods have short revisiting cycles and poor timeliness, it is difficult to apply in agriculture because of its high cost. In order to solve the above problems and meet the requirements of digital agricultural development. This paper focuses on the optimization of integrated navigation algorithms and the establishment of a three-dimensional digital model of a ground specific target for multi-rotor unmanned aerial vehicle remote sensing at low altitude. Firstly, aiming at the poor positioning accuracy of the traditional small airborne integrated navigation systems, a linear decreasing particle swarm optimization (PSO) algorithm is used to set the optimal noise covariance matrix Q and R. The global optimization characteristics of PSO algorithm is used to optimize Q and R jointly. Secondly, a set of filtering and interpolation algorithms for processing point cloud data of airborne LiDAR remote sensing systems are integrated. The method of extracting irrigation canal characteristic lines is proposed; a new threshold selection method is used to improve the accuracy of irrigation canal characteristic line extraction. Finally, the experiment shows that the convergence curve of the iteration reaches the global optimum after 100 iterations, the integrated navigation algorithm optimized by linear decreasing PSO has a strong robust ability. The variance of longitude error and latitude error is 0.00076 and 0.00041. The three-dimensional digital model of wheat in two different periods, *Euonymus japonicus* and *Anemone* was established in MATLAB. The height error of the three-dimensional digital model of the above crops is 4.78%, 4.46%, 5.72%, and 7.31%. An irrigation canal was successfully extracted and its three-dimensional digital model was established. The errors of average depth and width between the three-dimensional model and the true value are 4.42% and 4.56%.

Keywords: LiDAR remote sensing; Multi-rotor unmanned aerial vehicle; Particle swarm optimization; Ecological irrigation canal; Ground crop; Point cloud data

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