

DETEKSI INDIVIDU POHON BERBASIS LIDAR UDARA PADA HUTAN HUJAN TROPIS DI SUMATRA SELATAN INDONESIA

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INTISARI

Deteksi individu pohon berbasis LiDAR udara merupakan metode yang digunakan untuk mengekstraksi informasi pohon secara individual dalam suatu tegakan hutan. Pemanfaatan teknologi *Light Detection and Ranging* (LiDAR) melalui *Airborne Laser Scanning* (ALS) memungkinkan analisis struktur tegakan secara tiga dimensi. Meskipun berbagai metode deteksi individu pohon berbasis LiDAR telah dikembangkan, sebagian besar penelitian masih dilakukan pada hutan beriklim sedang, sementara evaluasi metode tersebut pada kondisi hutan hujan tropis, khususnya Indonesia masih relatif terbatas. Penelitian ini bertujuan untuk mengevaluasi kinerja metode deteksi individu pohon berbasis data LiDAR menggunakan menggunakan algoritma Silva et al. (2016) pada kondisi hutan hujan tropis di Sumatra Selatan, Indonesia. Penelitian dilakukan pada koridor *right-of-way* (ROW) di Suaka Margasatwa Dangku dengan panjang 2 km dan lebar 100 m. Data yang digunakan berupa data LiDAR udara dengan kerapatan titik rata-rata 122,26 titik/m² serta data sensus pohon dengan diameter setinggi dada (DBH) ≥ 20 cm sebagai data referensi. Deteksi individu pohon dilakukan menggunakan algoritma Silva berbasis *Canopy Height Model* (CHM) dengan optimasi parameter ukuran jendela pencarian dan ambang tinggi minimum. Evaluasi akurasi dilakukan melalui pendekatan *Mutual Nearest Neighbor* (MNN) yang dikombinasikan dengan logika *point-in-polygon*. Hasil penelitian menunjukkan nilai *recall* sebesar 0,53, *precision* sebesar 0,51, dan *F1-score* sebesar 0,52 yang menunjukkan kinerja algoritma pada tingkat sedang. Analisis kesalahan segmentasi menunjukkan dominasi *under-segmentation* sebesar 49,79%, diikuti segmentasi tepat (*one-to-one*) sebesar 28,76%, *over-segmentation* sebesar 4,33%, serta *omission error* sebesar 17,12%. Hasil penelitian menunjukkan bahwa metode berbasis CHM dengan algoritma Silva mampu merepresentasikan individu pohon pada kanopi dominan, namun kinerjanya masih dipengaruhi oleh kompleksitas struktur kanopi hutan hujan tropis. Penelitian ini memberikan kontribusi dalam mengevaluasi kinerja algoritma deteksi individu pohon berbasis LiDAR pada kondisi hutan hujan tropis di Indonesia serta memberikan informasi mengenai pola kesalahan segmentasi tajuk pada struktur kanopi tropis.

Kata Kunci: Deteksi individu pohon, LiDAR udara, *Canopy Height Model*, algoritma Silva, hutan hujan tropis

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INDIVIDUAL TREE DETECTION BASED ON AIRBORNE LIDAR IN A TROPICAL RAINFOREST OF SOUTH SUMATRA INDONESIA

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ABSTRACT

Individual Tree Detection (ITD) is a method used to extract tree-level information within a forest stand. The use of Light Detection and Ranging (LiDAR) through Airborne Laser Scanning (ALS) enables detailed three-dimensional analysis of forest structure with high spatial resolution. Although numerous LiDAR-based ITD methods have been developed, most studies have been conducted in temperate forests, while evaluations under tropical rainforest conditions, particularly in Indonesia, remain limited. This study aims to evaluate the performance of a LiDAR-based individual tree detection method using the algorithm developed by Silva et al. (2016) under tropical rainforest conditions in South Sumatra, Indonesia. The study was conducted along a 2 km long and 100 m wide right-of-way (ROW) corridor located within the Dangku Wildlife Reserve. The dataset consisted of airborne LiDAR point cloud data with an average point density of 122.26 points/m² and field census data of trees with a diameter at breast height (DBH) ≥ 20 cm used as reference data. Individual tree detection was performed using the Silva algorithm based on a Canopy Height Model (CHM), with parameter optimization for the search window size and minimum height threshold. Accuracy assessment was conducted using a Mutual Nearest Neighbor (MNN) matching approach combined with a point-in-polygon rule. The results showed a recall of 0.53, precision of 0.51, and an F1-score of 0.52, indicating moderate detection performance. Segmentation error analysis revealed that under-segmentation was the dominant error type (49.79%), followed by correct segmentation (one-to-one) at 28.76%, over-segmentation at 4.33%, and omission error at 17.12%. These findings indicate that the CHM-based Silva algorithm is capable of representing dominant canopy trees spatially; however, its performance is still influenced by the structural complexity and overlapping canopy structure typical of tropical rainforests. This study contributes to the evaluation of LiDAR-based individual tree detection methods in tropical forest ecosystems in Indonesia and provides insights into canopy segmentation error patterns under complex tropical canopy conditions.

Keywords: *Individual tree detection, Airborne LiDAR, Canopy Height Model, Silva algorithm, Tropical rainforest*

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