INTEGRASI *COMPUTER VISION* BERBASIS *DEEP LEARNING* DAN *ACOUSTICAL DATA PROCESSING* UNTUK PEMANTAUAN PEMBENTUKAN SELULOSA BAKTERI PADA NATA DE COCO

INTISARI

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Pemantauan pembentukan selulosa bakteri (BC) pada *nata de coco* menggunakan *image processing* memiliki keterbatasan fleksibilitas pengambilan gambar dan ketergantungan parameter ketebalan. Penelitian ini bertujuan mengintegrasikan *computer vision* berbasis *deep learning* dengan *acoustical data acquisition tool* untuk penambahan parameter pemantauan non-destruktif.

Pembuatan model menggunakan 400 data untuk *training, validating, dan testing* dengan algoritma *you only look once* (YOLO) dan *segment anything model* (SAM) untuk deteksi dan segmentasi area transparan (*window*) dan BC (*object*). Integrasi data akustik menerapkan deteksi dan isolasi sinyal dengan pendekatan *energy detection* diujikan pada 30 data perekaman. Perolehan dan pengolahan data menggunakan bahasa pemrograman *python*.

Hasil menunjukkan model mendeteksi *window* dengan akurasi 92%, presisi 90,91%, *recall* 100%, dan F1-Score 95,24%, serta *object* dengan metrik 100%. Segmentasi *window* mencapai mIoU 84,02% dan *dice score* 91,01%, sedangkan *object* mencapai mIoU 91,86% dan *dice score* 95,68%. Kalkulasi ketebalan memiliki MAE 0,2663 mm. Isolasi sinyal pengetukan meningkatkan SNR rata-rata sebesar 9,147% dibandingkan dengan rentang durasi sinyal 1 detik. Pendekatan ini memungkinkan pemantauan BC berbasis data visual dan akustik menghasilkan sistem perolehan dan pengolahan data dengan keluaran ketebalan, frekuensi, magnitudo, *short-term energy*, *zero moment power*.

Kata kunci: *bacterial cellulose*, *nata de coco*, *computer vision*, *deep learning*, *acoustical acquisition.*

INTEGRATION OF DEEP LEARNING-BASED COMPUTER VISION AND ACOUSTICAL DATA PROCESSING FOR MONITORING BACTERIAL CELLULOSE FORMATION IN NATA DE COCO

ABSTRACT

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Monitoring bacterial cellulose (BC) formation in nata de coco using image processing is limited by inflexible image acquisition and reliance on thickness parameters. This study aims to integrate computer vision based on deep learning with an acoustical data acquisition tool as with additional parameters for enhanced non-destructive monitoring .

The model was developed using 400 data samples for training, validating, and testing, employing You Only Look Once (YOLO) algorithms and Segment Anything Model (SAM) for detection and segmentation of the transparent area (window) and BC (object). Acoustic data integration applied signal detection and isolation using an energy detection approach, tested on 30 recordings. Data acquisition and processing were conducted using Python.

Results showed the model detected window with 92% accuracy, 90.91% precision, 100% recall, and 95.24% F1-Score, and object with 100% across all metrics. Segmentation of window achieved an mIoU of 84.02% and Dice score of 91.01%, while object reached an mIoU of 91.86% and Dice score of 95.68%. Thickness calculation yielded an MAE of 0.2663 mm. Signal isolation improved SNR by 9.147% compared to the 1-second signal duration range. This approach enables visual and acoustic-based BC monitoring, producing a data acquisition and processing system with outputs of thickness, frequency, magnitude, short-term energy, and zero moment power.

Keywords: bacterial cellulose, nata de coco, computer vision, deep learning, acoustical acquisition.