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Innovative Digital Twin and Machine Vision Approaches for Molluscan Phenotyping

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Abstract

Accurately quantifying the shell geometrics is perhaps the most crucial process for breeding northern quahogs, *Mercenaria mercenaria* (also known as hard clams). However, manual measurements of these dimensions using a caliper are time-consuming and prone to human errors. Overcoming this challenge requires an automated and accurate technique. Through a preliminary study, we created 3D point cloud-based, digital twin models of 95 market-sized northern quahogs. The imaging platform primarily comprises a green screen environment, a round turntable, and two DSLR cameras. Each 3D point cloud for an individual hard clam was generated via photogrammetry processing, using approximately 240 images. To validate the model's accuracy, we manually extracted the length, width, and height values from 20 randomly selected point cloud models and compared them with the ground truth values measured by a caliper. The RMSE for all three metrics were within 0.5mm, providing sufficient accuracy for breeding selection. This study conceptually demonstrates the feasibility of the proposed methodology to accurately quantify hard clam geometrics. Through developing computational pipelines to automatically extract geometric values in the future, the selection process for northern quahogs can be significantly optimized and expedited.

Keyword: photogrammetry, machine learning, point cloud, application of point cloud