VannameiVision: A Novel End-to-End Pipeline for Stock Quality Assessment With a Case Study in Shrimp Post-larvae Screening From Robust Data Acquisition to Autonomous Segmentation and Systematic Characterization of Count, Size, and Vitality

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In a world where nearly 800 million people face hunger, aquaculture, especially shrimp farming, emerges as a vital solution to bolster food security and sustainably meet the nutritional needs of the growing global population. Ensuring health and quality of post-larval shrimp is crucial, as it directly influences yields and efficacies of aquaculture operations. However, traditional methods are labor-intensive, susceptible to human error, and lacking consistency, leading to imprecise stock management and potential economic losses at both farm and industry levels. VannameiVision is designed to revolutionize these processes through automation and advanced machine learning algorithms. Our pipeline features robust data acquisition, autonomous segmentation, and systematic characterization of count, size, and vitality. The first step introduces a novel standardized shrimp imaging system using ArUco markers for enhanced capture. The second step automates annotation, integrating GPT-4 for caption generation and Grounded-SAM for zero-shot segmentation, speeding up the process by 3,061 times. The third step uses YOLOv8 trained on synthetic data for shrimp isolation, achieving over 98% mAP50 and improving count accuracy. The fourth step uses Elastic Net for body length estimation from segmentation masks with less than 0.1 mm error margin. The final step addresses health condition screening by leveraging sampling statistics, shared encoder and reparameterization, achieving a remarkable accuracy of 99.4%, distinguishing healthy individuals even in batches with high trait heterogeneity. VannameiVision not only pioneers a sustainable future in aquaculture but embodies a beacon of innovation, casting light on paths to conquer global hunger with precision and perseverance.

Awards Won:
Third Award of $1,000
Association for Computing Machinery: First Award of $4,000