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United States Department of Agriculture
Project Initiation

Project Data for Accession Number 1031813

Project Title

Advanced imaging transforms RAS via individualized tracking of salmon growth and welfare

Project Details

Sponsoring Institution National Institute of Food and Agriculture	**Project Status** COMPLETE
Funding Source NIFA Non Formula	**Grant Year** 2024
Grant No. 2024-33530-41913	**Cumulative Award Amt.** $175,000.00
Proposal No. 2024-00152	**Multistate No.** (N/A)
Project Start Date Jul 01, 2024	**Project End Date** Aug 31, 2025
Program Code [8.7] Aquaculture	

Project Director

Huber, R.

Recipient Organization

RADMANTIS LLC
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Performing Department

(N/A)

Non Technical Summary

This project aligns with NIFA research priorities for better integrated aquatic animal health, more efficient production, and reduced environmental impacts. It leverages leadership in AI-based phenotyping (Radmantis), with expertise in commercial RAS (LocalCoho), to advance a new generation of biometrically-enabled fish assessment for bluehouse salmon farming. Effective operational practice in aquaculture requires access to timely and accurate information on growth trajectories, injury, and emergence of production-related pathologies. Whereas aggregated population parameters are of some value, a far superior monitoring system would be one with the ability to track phenotypic presentation of individual fish, both reliably and continuously over time. To achieve this goal, we are partnering with AMD's AI/Robotics division to bring cutting edge, hardware-accelerated imaging capabilities to bear on use cases in uncrewed aquaculture management. This proposal outlines a set of aims that examine to what extent a system integrating high-resolution imaging, hyperspectral visualization, and biometric identifiers, can recognize unique

individuals within a large population of unmarked and freely moving animals. The first stage of technology testing will be carried out in collaboration with the Freshwater Institute, a USDA-funded research facility for precision aquaculture. Following successful proof of concept at research scale, the technological innovation will be translationally tested at enterprise scale. A successful product would launch into a rapidly expanding market for domestic seafood production. The contribution of such next-gen aquaculture to a climate neutral, circular, and sustainable food system, is of an economic and social value that can hardly be overstated in an increasingly hungry world.

Animal Health Component

Animal Health Component: 100%

Research Effort Categories

Basic	5%
Applied	80%
Developmental	15%

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
307	3712	1020	100%

Knowledge Area

[307] Animal Management Systems

Subject Of Investigation

[3712] Salmon

Field Of Science

[1020] Physiology

Keywords

Health, Advanced Population Assessment, Individualization, Precision Aquaculture, Visual Processing

Goals / Objectives

By critically examining whether individual animal identities and their overall physiological state can be gleaned from rapid and comprehensive capture of biometric descriptors, we advance stated USDA research priorities. As we apply our expertise in hardware-accelerated computer vision, we will generate real time data that far exceeds the current status of aggregated population metrics. The ability to confirm identities in repeated encounters, track individual growth, behavioral engagement, and visual markers of stress or disease, should prove invaluable for optimizing the sustainability, resilience, and efficiency of production processes. Importantly, this data-driven approach will also provide managers an early warning system for detecting emerging stressors and biosecurity threats. We propose to complete three specific aims:Aim I. Identify individual animals using real-time biometric data. Recognizing individual animals without tagging is an enduring challenge that is exacerbated in aquatic environments because of the difficulty

of obtaining detailed morphometrics from freely moving fish in densely populated aquaculture. First we derive a set of imaging and lighting conditions to significantly improve image quality over existing approaches. The initial research phase will situate our biometric scanner in a defined population of electronically tagged salmon for ground truthed verification of individual identities. For each fish transit we (1) capture a high-resolution image, (2) derive a comprehensive set of morphometrics, (3) cluster similarity in metrics across repeat transits, (4) construct a library with a set of individual identities, and (5) assess success of the derived classification against known identities (confirmed with PIT-tag data).Aim II. Visualize injury, health and stress in individuals using multispectral imaging. When humans blush, changes in blood flow result in noticeable changes in skin tone. A wide range of physiological, psychological, and mechanical stressors are known to affect color of the outermost integument of the animal. As a conservative first experimental approach, here we assess to what extent increased blood flow associated with minor skin injury can be detected with a ratiometric comparison across color bands, as a prelude to ultimately associating unique spectral signatures with particular pathologies and stress conditions.Aim III. Evaluate research outcomes of aims I and II at enterprise scale. Commercial RAS 'bluehouse' farms are complex environments with large populations of anonymous individuals. The ability to assign key parameters like growth, health, and wellbeing in real time to individual fish will offer a degree of insight that is currently unavailable to managers who seek to optimize operational outcomes. We will explore to what extent the solutions emerging in aims I and II can be implemented and contribute to decision making in a full-scale, commercial fish farm.

Project Methods

The ability to visually recognize individual animals based on unique skin patterns and a wide range of biometric markers requires the use of high-quality images obtained underwater. We continue developing a dedicated underwater imaging solution that allowed us to use ML-inferencing to guide fish towards one specific exit. This tubular structure for fish management offers a suitable physical stage for the advanced imaging necessary to achieve this aim. Since many underwater imaging problems arise from inadequate lighting, the inside of this device offers artificial illumination. The essential computer vision tasks for acquiring, processing, and analyzing digital images are performed with a heavy reliance on OpenCV, a leading library of programming functions for real-time computer vision. With images of superior quality, our analyses are able to extract high-dimensional data from underwater assets, producing the numerical and symbolic information necessary to match complex sets of visual descriptors to individual identities. Visually derived individual classifications will be compared to the known identity of animals previously tagged with Passive Integrated Transponders (PIT). PIT tags (with FDX technology) are glass coated radio transponders that answer to the signal emitted from a scanner. Two ring antennae installed around the lumen of the device, read the true emitted ID signature of the fish as it transits the imaging platform.