

Measuring European Seabass (*Dicentrarchus labrax*) in the Rearing Environment using Cameras Above RAS Tanks



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I4F Project Motivation

Aquaculture is the fastest-growing food-production sector, essential for meeting rising global food demand. European seabass (*Dicentrarchus labrax*) is a key species in Mediterranean aquaculture. A primary challenge is maintaining uniform fish weight in rearing units throughout production. This uniformity is critical to reduce aggression and cannibalism, improve feed efficiency and growth, ensure predictable harvests, and support sustainability. Current physical sampling and grading, which involve redistributing fish, rely on traditional methods that are labor-intensive and costly, reducing economic efficiency in fish farming.

I4F Project Objective

The I4F project aims to develop an integrated set of tools and models to monitor and predict weight dispersion based on rearing conditions and fish characteristics. These models will be incorporated into a methodology designed to optimize the grading process, minimize costs, reduce weight dispersion, enhance animal welfare, and support business sustainability.

I4F Project Impact

The framework developed through this project's research and development represents a significant advancement for European seabass aquaculture in the European Union.

I4F Phases

1. developing a fish weighing model using imaging,
2. predicting growth and weight dispersion throughout the rearing cycle,
3. creating a grading and resource utilization model.

Experimental data collection took place at CIIMAR's laboratory, equipped with three RAS tanks, as shown in fig. 1. During the first project phase, a data acquisition and control system was established. This poster pertains to phase 1, focusing on initial setup and the development of data acquisition tools.

Measuring European seabass by stereo imaging above RAS tanks

Measuring fish using overhead cameras requires two key developments. The first is a stereo vision model that converts paired 2D images into 3D spatial coordinates (fig. 2-3). The second involves a pipeline of models (fig. 4-10) for fish image instance segmentation, identifying the fish's contour in both 2D images and correlating those contours between left and right photos. A 14-point skeleton characterizes the 3D contour, recovering five distances along the silhouette. These measurements are used to estimate fish weight based on species-specific allometric relationships.

Challenging environment for measuring by RGB imaging:

- Address lighting, reflections, fish movement, and fish color mimicking tank environments.
- Manage water turbidity in European seabass rearing tanks.
- Ensure high accuracy in measuring size distribution, not just the mean size.
- Develop affordable solutions for European seabass aquaculture SMEs.

Stereo imaging model development

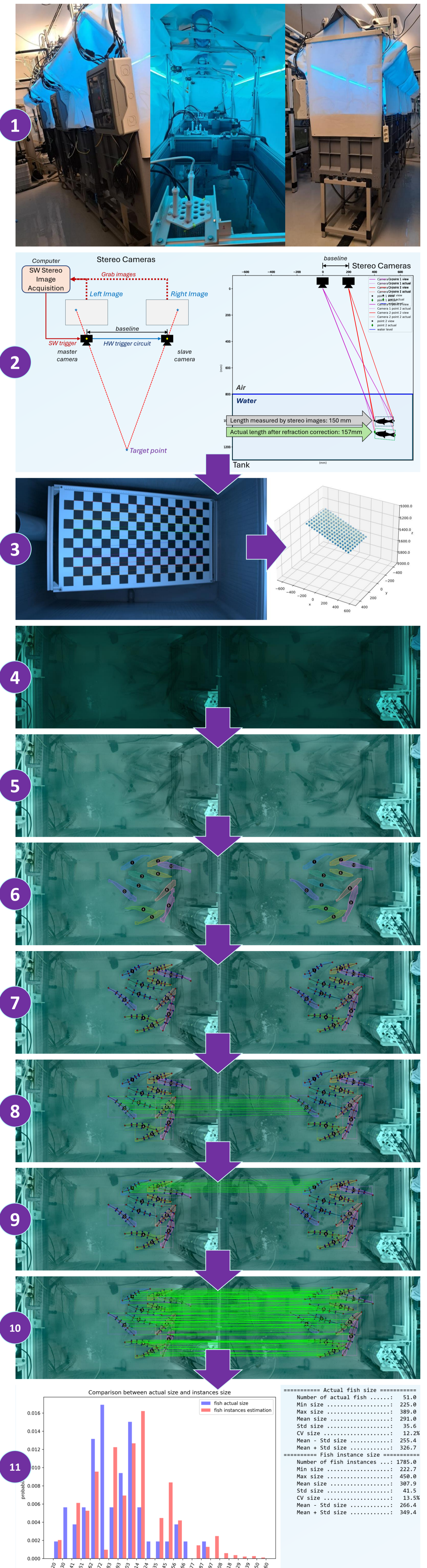
Achieving the required accuracy for weight distribution measurement needs an additional step for parameter optimization, constrained by calibration panel relationships. A machine learning regressor was developed and trained using data augmentation from the computer vision model and water reflection optics. This approach enabled significantly faster conversion of stereo 2D images into 3D points.

Imaging processing for fish measurement and weighing

The initial step in image processing involves applying filters to the original image to enhance contrast (fig. 4-5). The next step is identifying fish contours within the image, a task efficiently handled by YOLO v8, which was trained using European seabass images, yielding high segmentation accuracy and fish instance identification (fig. 6). To simplify correlation and measurement, a 14-point contour descriptor (skeleton) was defined, with six points along the midline and four on each side, utilizing the Voronoi algorithm (fig. 7). This descriptor effectively measures fish in various positions and bending patterns. Stereo matching presents additional challenges due to fish silhouette characteristics, overlapping fish, and environmental factors. A bipartite graph-based algorithm was employed for final matching (fig. 8-10).

Preliminary Results

Preliminary results at this stage are promising (fig. 11), and multiple improvements aimed at enhancing the accuracy of the models in the pipeline are currently under development and testing.



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