SnappArt 360 E-SENSE: AI Model for Automated Egg Stage Detection to Support Modern Hatchery Management

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Introduction

Accurate assessment of spawned eggs number and embryonic development in fish eggs and larvae is a critical step in hatchery management, directly influencing survival rates, production efficiency, and decision-making throughout the early life cycle. Current assessment practices in hatcheries are predominantly based on rapid visual inspection and general stage estimation, often complemented by additional manual checks. While these methods are practical, they remain subjective, species-dependent, and limited in their ability to consistently evaluate developmental quality. This variability reduces comparability across hatcheries and increases reliance on expert interpretation.

To address these limitations, SnappArt 360 E-Sense has been introduced , a species-specific, automated imaging and analysis solution designed to accurately determine the number of the eggs spawned, the embryonic development from fertilization to the early larval stages, but also define the stage of eggs maturation in case of ovarian biopsy by cannulation. Integrated into the SnappArt 360 platform, the E-Sense tool combines high-resolution imaging with advanced image analysis algorithms to automatically identify developmental stages, quantify key morphological features, and generate standardized quality metrics. A species-specific approach ensures that algorithms and reference models are biologically relevant and tailored to distinct embryological patterns.

By replacing subjective evaluation with a consistent, data-driven methodology, SnappArt 360 E-Sense aims to improve accuracy, reduce labor dependency, and enable harmonized embryonic assessment across hatchery operations.

The aim of this study is explain how an AI model, trained on images labeled by experts, along with digital support systems that can recognize and track eggs stages of different species *as Sparus Aurata, Dicentrarchus labrax, Lates calcarifer,Solea Senegalensis,Scophthalmus maximus ex Psetta maxima, Gadus morhua*

In addition to the device, an integrated software platform processes the collected data and generates clear reports on periodic spawning events and corresponding hatching rates. This functionality supports hatchery managers in effectively monitoring broodstock egg production and maintaining operational control.

Materials and Methods

A known volume egg sample collected from the eggs collector was processed and prepared to be easily divided into a 3x4 cell culture plate, with 1ml per cell. Images of the wells are acquired using the SnappArt 360 device, a digital imaging system, consisting of a camera connected to a local edge-computer device based on the Nvidia Jetson Platform developed by Aris in collaboration with INVE. The captured images were transferred to CVAT (Computer vision annotation tool) for annotation by trained experts. The dataset consist of the following classes: viable eggs fertilized, viable eggs embryo (about 20h from fertilization), non viable eggs (degenerated eggs), healthy larvae, dead larvae, membranes, stage A-B-C-D depending on the maturation of the unfertilized eggs in the case of a preliminary maturation check of the oocyte in seabass. These expert annotated images were used to train and validate an AI model based on the YOLO (You Only Look Once) object detection architecture. Afterwards, this trained model was installed on the SnappArt to be tested in the field by technicians. After deployment on the SnappArt, it requires only basic input from the user, such as tank origin, tank volume, and sample volume. After a fast image capture of each separate well, the SnappArt delivers a comprehensive report detailing the number of viable eggs, the degenerated ones, and the number of eggs per stage (egg fertilized or embryo). An associated data management platform enables long-term tracking and analysis of broodstock production and quality of the spawn, keeping traceability of the hatching rate from fertilization to hatch.

Results

The accuracy of the Snappart AI system was evaluated by comparing automated counts with manual counts performed by an experienced technician using a stereomicroscope. Manual counting requires high operator expertise to correctly identify viable and degenerated eggs, avoid miscounting, and involves substantial time investment. The time required for manual counting is roughly double that of Snappart360.

In contrast, the Snappart AI system, based on the E-Sense model, allows result verification through real-time image recording and demonstrated 100% correct eggs detection for up to 200 items per well. Overall, the system achieved a total counting accuracy of 99%.

Discussion

The most advanced model is currently applied to fertilized seabream and seabass eggs and provides a broad overview of periodic spawning, supporting effective monitoring and planning of the hatchery.

The detection of the oocyte developmental stage before hormonal induction is another key capability of the system. Within a few minutes, the system provides the percentage distribution of the different egg developmental stages prior to spawning. This enables fast and informed decision-making regarding the most appropriate induction protocol to be applied to the selected breeders.

The automated approach eliminates the need for expert assessment of developmental stages, increasing process standardization and significantly reducing analysis time and accuracy with multiple replicates.