Explainable AI for Histological Image Analysis in Aquatic Animal Health

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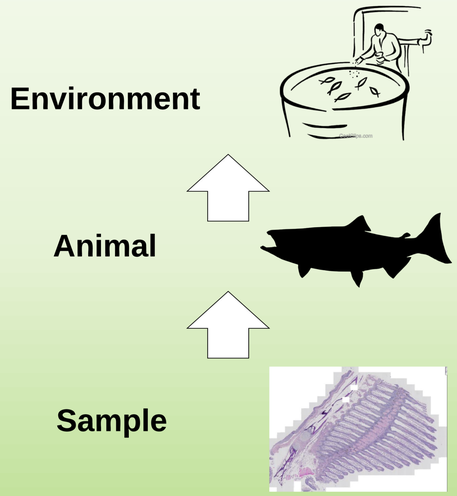
Project Overview

This project uses histology whole-slide images (WSIs) to further the understanding of an animal's condition at the point of death. In areas such as aquaculture, all data gathered during post-mortem analysis is of vital importance to help gain an epidemiological understanding of the health and wellbeing of a population, and relevant features within the environment. Given that manual analysis is time-consuming and expensive, an automated approach to detect and measure the severity of individual lesions, such as hyperplasia, is desirable. It is also imperative that any statistics generation should be based on explainable features to increase trust.



Hyperplasia in Salmon Gills

Hyperplasia (proliferation of cells) is a common pathological lesion present in gills. Expert pathologists consider a number of visual characteristics which can be measured to establish the severity of hyperplasia. The most prominent are:

- Increase in overall tissue area.
- Reduction in space between secondary lamellae (the comb-like formation).
- A shift in colour towards darker, more purple/blue tones.

Lesions such as Hyperplasia can give an insight into environemtal characteristics such as water quality.

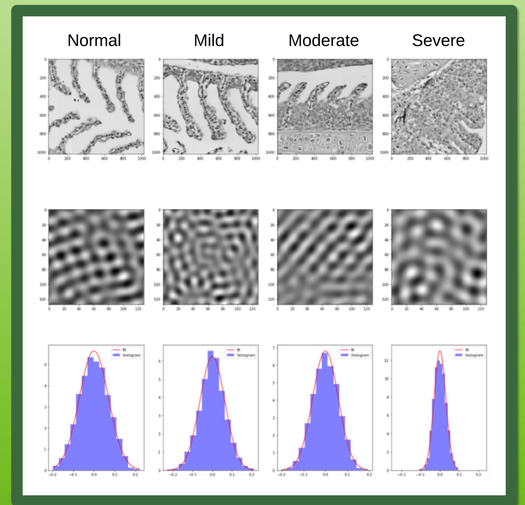


Figure 1. Columns from left to right: normal, mild moderate, severe cases of hyperplasia. Rows from top to bottom: Greyscale image, example subband image produced by EWT, best fit line fit from parameters on histogram of pixels.

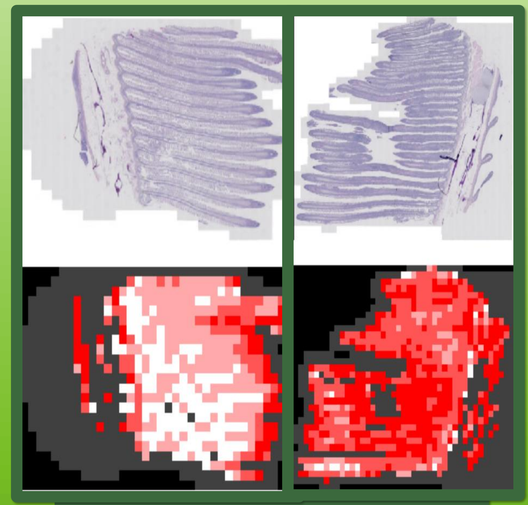


Figure 2. The approach applied to two whole slide images. Left is a predominantly healthy slide, right has severe hyperplasia. Red indicates predicted severe regions of hyperplasia, white is predicted healthy.

Empirical Wavelet Transform for Texture-Based Analysis

As statistics generation is a significant aim of this work, it is important that automated analysis can be performedand cross-checked by those without expertise in ML. The tile-based approach uses a **novel parametric feature generation** approach using the **Littlewood-Paley Empirical Wavelet Transform (EWT**) as a way to represent texture in separate colour channels and train machine learning models. These models classify tiles into classes based on the severity of hyperplasia. The dimensionality of the feature vector produced is significantly smaller than those produced by the convolution layers of popular CNNs. As such, model training is considerably faster and less computationally expensive. Furthermore, as the approach uses explainable area, texture, and colour-based features, classifications can be trusted as a reliable and understandable source for statistics generation for epidemiological analysis.

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