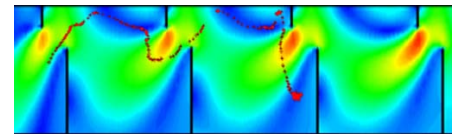


## Introduction



A vertical slot fishway is an hydraulic structure built in rivers to preserve fish biodiversity in places affected by the construction of engineering works, such as dams or weirs. These elements alter the ecosystem of rivers, causing changes in the fauna and flora and obstructing fish migration.

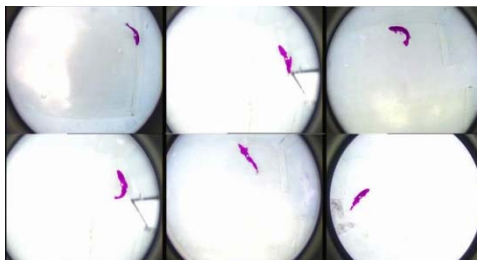
This paper analyses the automatic fish detection in turbulent waters. A SOM Artificial Neural Network is used to detect fishes in images from an underwater camera system built in a vertical slot fishway. This technique allows the study of real fish behavior and help to understand the swimming limitations of different fish species in high speed environments.



## Algorithm proposed

The input images were normalized and preprocessed to enhance the contrast of the image by using a contrast-limited adaptive histogram equalization (CLAHE). Once the image segmentation is obtained with the SOM Artificial Neural Network with a three-layer topology with 3 processing elements in each layer, the objective of the segmentation system is to determine the position of the detected fish in the image. Due to the characteristics of the image, where the fish is often partially hidden and where is the presence of shadows, bubbles and reflections, the algorithm should respond well to partial or abnormal detections.

It is based on obtaining the connected-body vector from the segmented image. Each body will be characterized by the vector of pixels that make it up and by a set of descriptive parameters: its area, its centroid and the minimum ellipse containing the body. The detected object is classified as a potential fish or noise, according to the size of the object and the minimum and major axis of the ellipse.



## Results

To measure the performance of the ANN SOM networks, a set of experiments were performed with living fishes of the salmo trutta specie in a 1:1 vertical slot fishway model located at CEH-CEDEX in Madrid.

A data set of 1000 images from 10 different cameras selected from different pool and fishway regions was defined. To establish a comparative, two classic techniques have been designed based on the conventional approaches in segmentation, edge-based classification by means of analyzing the discontinuities in the image and the region based classification by analyzing the similarity of pixels.

Results	Region	Edge	Proposed
Detections	2126	819	876
True Positives	631	716	809
False Positives	1495	103	67
True Negatives	12	47	50
False Negatives	705	270	187
Precision	0.30	0.87	0.92
Average Time	404	296	3566

## Conclusions

In this paper, a solution to detect fishes in vertical slot fishways based on SOM networks and an algorithm to filter anomalous detections is proposed. The accuracy and performance of the proposed technique has been tested, analyzing and comparing the obtained results with different segmentation techniques in dataset created with the help of experts. The results obtained with this system have been very promising, as they allowed us to obtain the fish position in the image with a low error rate.

## Agradecimientos

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