Zebrafish Skeleton Measurements using Image Analysis and Machine Learning Methods

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Context: Traditionally, biologists evaluate effects of experiments on zebrafish embryos through microscopic obsevations. However, visual inspection by experts is a limiting factor in large-scale studies. It brings us to consider supervised machine learning methods to automate the extraction of useful, quantitative, information from these images.

Problem: We focus on morphometric measuring of the cartilage skeleton. To this end, we address two subproblems : (i) quantifying the surface of the cartilage skeleton and (ii) detecting several points of interest in zebrafish images. We propose to tackle these two tasks by exploiting expert annotations with extremely randomized tree methods combined with extraction of subwindows within images [1,2].

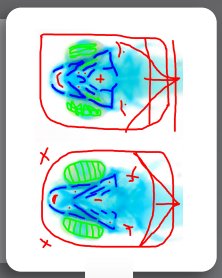
Results: They are visually coherent despite the difficulty to assess our model in the absence of a complete ground truth annotation.

Segmentation of cartilage skeleton

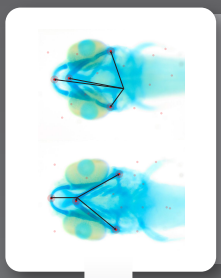
Partial annotation into three classes: Eye, Skeleton and Others

Extraction of subwindows of size ***w*** x ***h*** centered on the annotated pixels (input), and tagged by their label (output)

Classification model built using extremely randomized trees



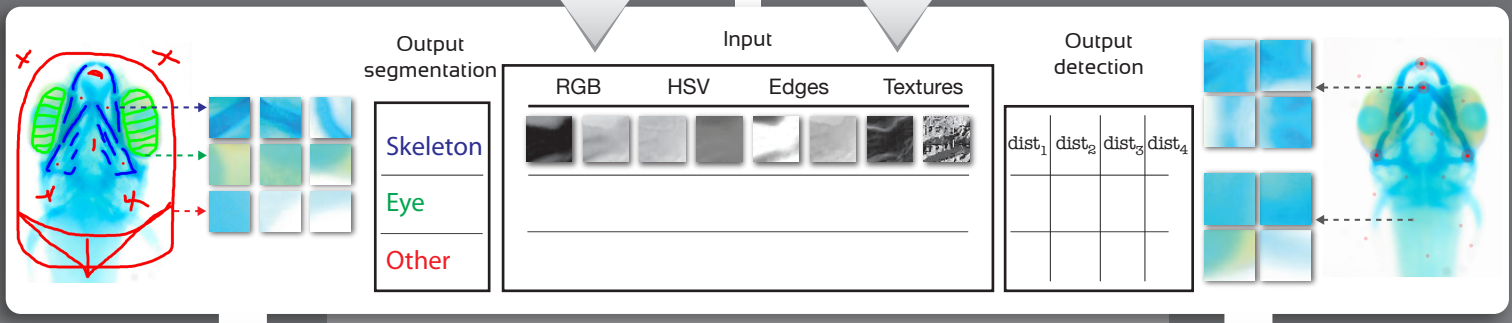
Detection of points of interest



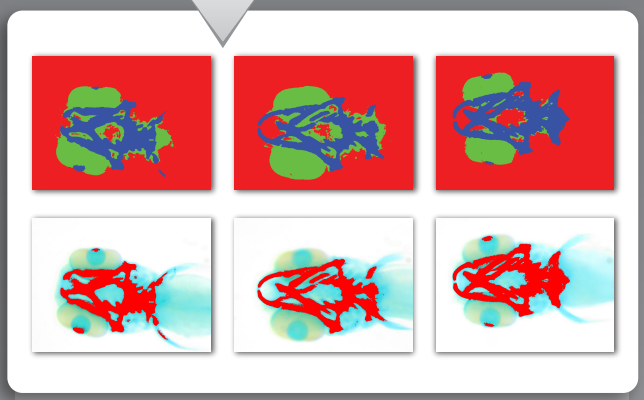
Indication of points of interest in all training images

Extraction of subwindows of size ***w*** x ***h*** centered on pixels in a radius ***r*** around the points of interest and on pixels taken randomly (input), and tagged by the distances of their central pixels to the points of interest (output)

Multiple output regression model built to jointly detect multiple points of interests within images

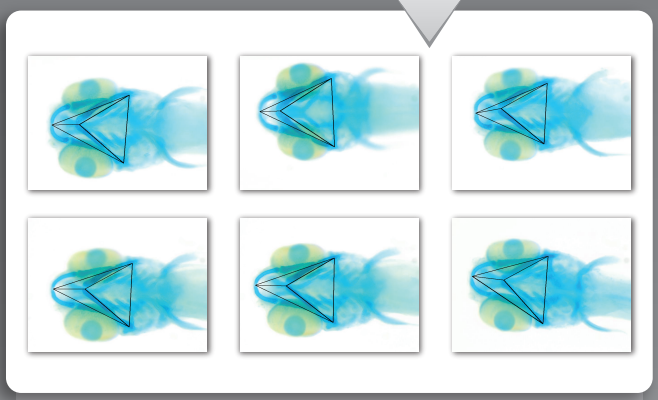


We describe each object by the color (i.e. the values in HSV and RGB color spaces), the edges (i.e. the gradient of the Sobel operator) and the texture (i.e. the histogram of local binary patterns [3]) of all the pixels in the subwindow.



3 images out of 15 manually and partially labelled

The 12 remaining images were automatically annotated: we extracted subwindows centered on each pixel of every test images and the tree ensemble model predicted their class



4 points manually identified in all images

Leave-one-out performed to assess the multiple regression model: we predicted the distances of every subwindow centered on the pixels of the test images and we took the coordinates of the nearest points to the points of interest as final coordinates

Conclusions and perspectives

We present two methods able to automatically segment new, unseen, zebrafish images into a finite set of predefined classes, and to detect points of interest in it. Nevertheless, we worked on a small set of control images. The next step in this research is to apply these techniques on larger sets of new images of zebrafish presenting deformations to better assess their performances.

We will also further investigate new ways to interpret the distances predicted and, in particular, use the geometrical information to provide a more robust detection.

References

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[3] Ojala et al., A Comparative Study of Texture Measures with Classification Based on Feature Distributions. Pattern Recognition, vol. 29, pages 51-59, 1996.

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