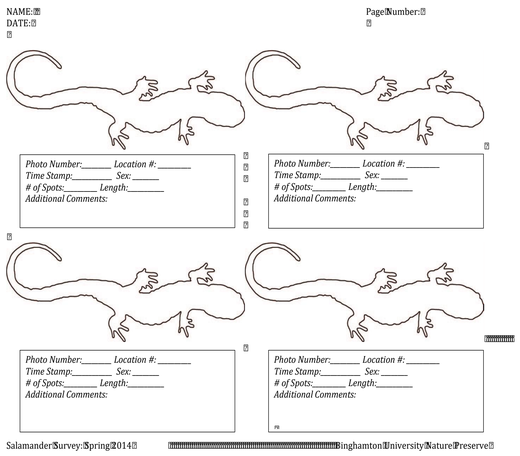
Spotting Salamanders: Discerning Salamanders Through Image Processing

Christian Tejera | Jonathan Milongo | Douglas Summerville, Ph.D.
Binghamton University and LSAMP

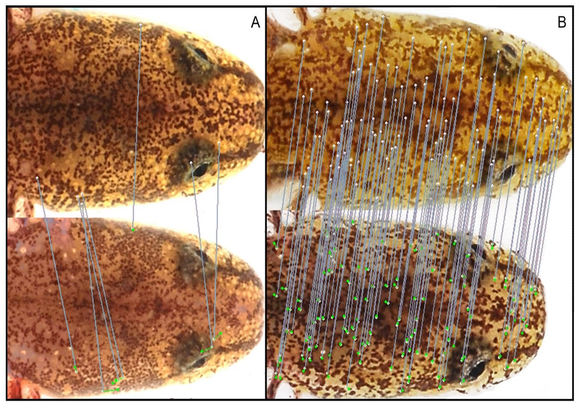
Premise

Dylan Horvath is the Steward of Natural Areas at Binghamton University. He is studying the salamanders that inhabit the university's nature preserve. Currently, he manually **identifies the salamanders based on their spots**. This is done by visually comparing the salamanders or by drawing the spots and **comparing each drawing**. With over 50 pictures taken each year, this process is time consuming and consequently, is stalling his research. He wants a computer program that will compare the spots and identify the salamanders for him.



The Goal

Currently, there exists a program, called Wild ID, that can do exactly what Dylan wants. However, the program requires the salamander be photographed with a solid color background. In order for this to be done, he would have to jeopardize the authenticity of his work by intervening with the salamander's daily habits. The goal of our research is to **prove that a program can identify these salamanders without a solid background** through the use of image processing. Generally, image processing is used to either enhance or extract information in an image.



Research Questions

How should the computer program mathematically compare the salamanders?

How should images of the salamanders be positioned?

Will the images need to be transformed?

What program will allow us to manipulate the salamander?

Does information need to be extracted in order to produce the best results?

Method-First Steps

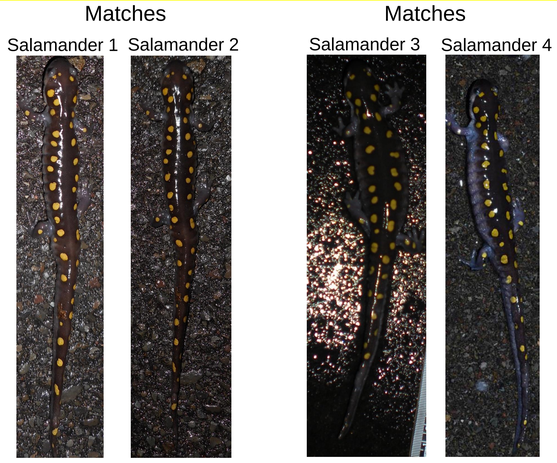
We used Adobe Photoshop as our test program in order to freely manipulate the images. Only images from a top-down perspective were used due to the other angles not capturing all of the spots on the salamander. These images still greatly differed due to the curves of the salamander's pose.

All the images were arranged with the salamanders' heads facing upwards. Our hope was to apply **mean squared error** (MSE) as a metric to assess the similarity of two salamanders. **MSE finds the average distance between like pixels.** These values are squared and summed. If two images of a salamander are the same, the spots should align, reducing the MSE. However, the curves within the salamander's pose greatly effects the results of MSE. In order to create a base case, we had to find two different images of the same salamander.

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(f_i - y_i)^2$$

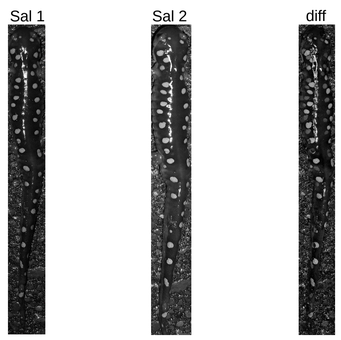
where N is the number of data points, f_i the value returned by the model and y_i the actual value for data point i.

Method-Matching The Salamanders



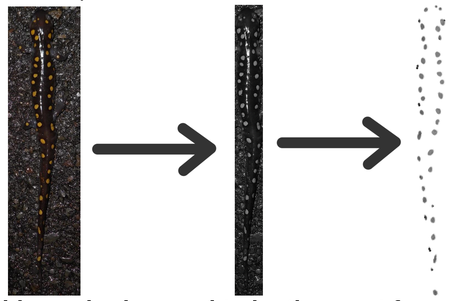
We were able to find two matching pairs. The first test was conducted without manipulating the images. Salamander 1 was compared with the above salamanders and two other salamanders. **In order to calculate MSE, we used a program called ImageMagick** which has a function that is able to calculate the difference. ImageMagick computes MSE as a sum of values and a percentage of difference. The program even provides a resulting difference image. We concluded that the initial test was not providing a substantial deviation in the percentage of difference. The differences were all between 10-12%.

The outcome seemed uncontrolled because images that look completely different resulted in a similar MSE as images that looked alike. In the second test, we cropped the images in order to reduce potential background noise. We also applied a grayscale because the MSE computation accounts for differences in color. Through Photoshop, we transformed (scaled) the images (as best as possible) to match salamander 1. The result, once again, was not conclusive (between 10-12% for all comparisons.)

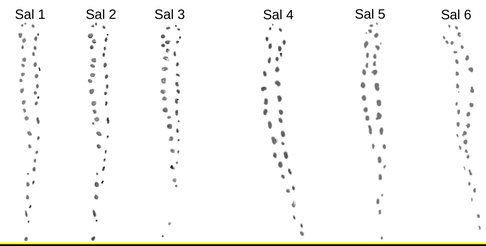


Method-Extracting The Spots

The body of the Salamander may be the reason for our poor results. In our third test, we completely extracted the spots from the salamanders. Photoshop has a function called "Select and mask" that allows us to manually pick out the spots.



This method proved to be the most favorable. We also transformed the images further. Photoshop has a function called puppet wrap that allows us to realign parts in the photo. We used this to straighten the body of the salamanders and improve the consistency between images. **The resulting difference for images of the same salamander were between 5-7%.** The difference between different salamanders were between 10-12%.



Conclusion

In conclusion, extracting the spots was the only method with results that could translate to a sound matching system. Furthermore, we were able to demonstrate that matching can be done without a solid background. Now, we move towards creating a program that can reproduce our methods. The program will use cross correlation (finds peak signals in the similarity of images) to recreate the transformations used in Photoshop. Our ultimate goal is to create an application with a database of images. Finally, our research was a success and is a stepping stone for solving Dylan's problem.

Image Sources

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0059424
https://www.researchgate.net/figure/Mean-Squared-Error-formula-used-to-evaluate-the-user-model_fig1_221515860
http://www.imagemagick.org/discourse-server/viewtopic.php?t=32362

Acknowledgements

Thank you to the LSAMP Research and NSF program for supporting my research. Thank you to my mentor Douglas Summerville and Scott Craver for advising me throughout my research and providing feedback. A special thank you to Dylan Horvath for giving me the opportunity to help you and your research.