Using Interactive Evolution to Discover Camouflage Patterns

Craig Reynolds
Sony Computer Entertainment, US R&D

Figure 1: camouflaged circular "prey" overlaid on the background image for which they were evolved
(a) tree bark, (b) twisty wire, (c) flowers and leaves, (d) serpentine, (e) lentils

1 Introduction

This poster describes an abstract computation model of the evolution of camouflage in nature. Evolution is represented by *genetic programming*. Camouflage patterns are represented by *procedural texture synthesis*. A 2D *environment* is represented by a supplied photo. A *predator* is represented by a human's visual perception, interacting through a graphical user interface.

In the natural world, many predators hunt using vision. Prey that are harder to see have a survival advantage. Over time this can lead to the type of camouflage known as *cryptic coloration*. As prey become more cryptic, predator vision must improve to detect the prey. That coevolutionary system leads to well-camouflaged prey and sharp-eyed predators.

This work is a first step toward simulating that natural system. It defers the difficulty of building a simulated predator by taking a hybrid approach, using a "human in the loop" to play the role of predator along with texture synthesis and evolutionary computation. This poster will describe and illustrate the procedures used, show examples of evolved camouflage and discuss future work.

2 Experimental Procedure

Natural morphogenesis is represented by a C++ library for texture synthesis (purely procedural, not example-based). This was connected to the genetic programming facility of Open BEAGLE, an open source library for evolutionary computation. This combination could be used to evolve textures with a traditional objective fitness function. However in these experiments, the fitness measure is subjective, based on human perception and judgement.

In each round of the "camouflage game" a cohort of 10 camouflaged prey are displayed to the user overlaid on a given background image. The user searches for the most conspicuous prey and clicks to "eat" it, causing it to be removed from the display and from the evolutionary population. This is repeated until 5 prey remain which are allowed to survive. 5 new camouflaged prey are bred from parents in the surviving population. In this way the effectiveness of each prey's camouflage is judged relative to the others in its randomly selected cohort. Over time this process removes the most conspicuous prey from the population, allowing it to converge on and refine more cryptic textures.

3 DIscussion and Future Work

Not all runs produce good results, although many do and some are strikingly effective. This interactive procedure is time consuming and mind numbing but served its purpose to prototype camouflage evolution and demonstrate its feasibility. In these runs the user makes about 5000 mouse clicks over several hours. Future work will include larger hybrid systems using distributed human computation, using *crowd sourcing* or *games with a purpose*.

The eventual goal of this work is to "close the loop" and model the coevolutionary dynamics of camouflage and predator vision. The hope is to create an *artificial predator* using techniques from machine learning and machine vision. This would allow running much larger simulations. More importantly it would provide a complete computational model of the natural system that may be useful to biologists for experiments and teaching. Other applications of evolutionary texture synthesis will also be investigated.

References

REYNOLDS, C. 2010. Interactive Evolution of Camouflage. To appear in the proceedings of the *12th International Conference on the Synthesis and Simulation of Living Systems* (ALife XII), August 2010. URL=http://www.red3d.com/cwr/iec/

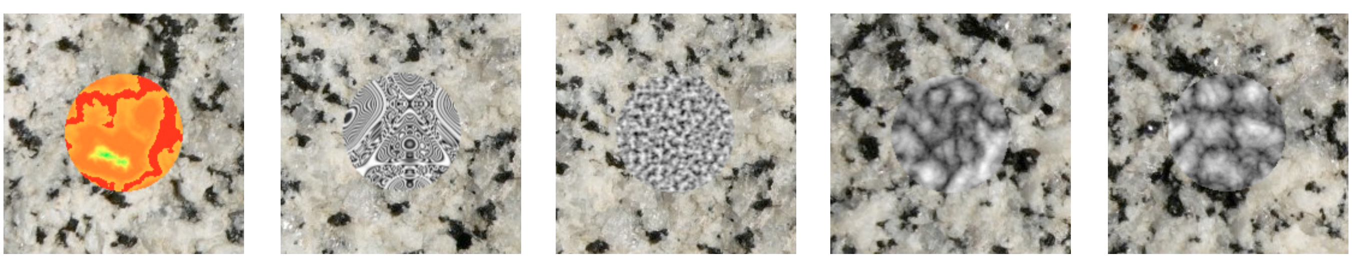

Figure 2: progression of camouflage patterns during a run with the granite environment

SIGGRAPH 2010, Los Angeles, California, July 25 – 29, 2010.
ISBN 978-1-4503-0210-4/10/0007