Evolving a Non-Cooperative Robot: Designing Camouflage from Optic Flow Algorithms

Serena Booth, Jacob Peters, Jonathan Bobrow

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1 Project Description

We plan to evolve a form of new-age camouflage to disguise motion from optical flow algorithms.

Visual deception has long been an area of interest for a multitude of reasons, including but not limited to applications of privacy, protection, and fun. Modern day surveillance suggests that privacy is a limited resource and biological systems have evolved unique and robust visual deception techniques. Most of the research and experimentation in this form of crypsis has dealt with static objects and human perception, with the ideal being an invisible cloak (much in the vain of Frodo's); our project, too, will explore solutions for static patterns. However, we aim to conceal motion from optic flow cameras rather than human perception. Because we see examples of counterintuitive camouflage patterns in nature (e.g. a zebra's stripes), we use an evolutionary approach to design static camouflage.

The question of sensor and algorithm deception has many potential applications. We imagine our system being used to constrain a robots area of motion, using a mechanism similar to that of a virtual cattle guard. We aim to provide evidence of optical flow being a flawed system for use in traffic navigation by autonomous vehicles. Lastly, we know insects to use optical flow to compute information about flight altitude, amongst other navigation computations, and so we expect our project to equip us with a method of exploiting insect behavior. One example of this may be to design a picnic table which deters insects through a pattern which disrupts optical flow computation.

2 Related Prior Work

3 Plan of Execution

4 One sentence summary

Using a genetic algorithm, we will evolve a form of new-age camouflage which disguises motion as computed by current optic flow algorithms.

References

Date	Goals
Tue, 3/31	• Project Proposal hand in
Sat, 4/11	• Prototype of camouflage pattern generation through evolutionary algorithm verified against a fitness function using optic flow calculations. • Construct scenarios which we can hand-design; aim to evolve expected results. • Full frame pattern to mitigate concerns with regard to edge detection in optic flow computation. Run computation of camouflage pattern on these scenarios. • Create GUI for result verification. • Authors should be comfortable with all tools to be used in project: DEAP evolutionary algorithm package, OpenCV for optic flow calculation and image manipulation. • Serena lead on using DEAP, Jonathan lead on using OpenCV. Jacob participates in both, preps for hardware testing. • Following weeks assume success criterion.
Sat, 4/25	• Introduce the dilemma of edge detection: instead of having our pattern work only when full-frame, hope to generalize to (a) random backgrounds or (b) selected real-world applicable backgrounds e.g. desert sand, traffic camera. • Run simultaneous computations using AWS or SEAS computing cluster for a variety of scenarios to test the robustness of camouflage pattern generation. • Serena and Jonathan break up cases, iterations, and work on this. • Assuming success criterion, set up a physical testing station using a webcam in place of a camera simulation. • Test for robustness against aliasing and motion blur. • Jacob lead on hardware testing. • Prepare class presentation of results so far.
Wed, 5/6	• Prepare final results, write final paper.