Comparison of camouflage detection performance between trained military personnel and civilians

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Evaluating the effectiveness of camouflage patterns

Current methods

Image Analysis
Fast – relies entirely on computation
Lacks ecological validity

Field trials
Realistic – relies on human visual system
Slow
Expensive
Subjective
Computation and human vision in combination to provide new methods for efficient testing of camouflage?

Vision scientists – psychophysics

Computer scientists - object recognition systems based on human visual system
High Throughput Psychophysical Evaluation of Camouflage in the Visual Domain
Olivia Matthews

A Biologically Motivated Visual Recognition System
An artificial surrogate for a human observer: Face Recognition and Camouflage assessment
Tim Volonakis
Target was a replica PASGT helmet on to which one of five camouflage covers were fitted.
Psychophysics – Field Photography

Leigh Woods (Purple Route, Leigh Woods, N. Somerset, UK)
Mixed deciduous woodland environment
Images taken every 20 paces along route
Psychophysics – Field Photography

Targets were placed 3.5m, 5m & 7.5m from tripod Positioned in left, middle and right of visual field Orientation was randomised in 45° increments

Background image with no target
Background image with 24 colour Gretag-Macbeth Colorchecker

Images calibrated for display system
Psychophysics Experiment

Within subjects design
5 patterns (DPM, MTP, MarPat, Olive, UN PKB)
2 colour levels (colour, greyscale)
2 cueing levels (cued, uncued)

20 blocks with 27 trials per block
Camouflage pattern randomised

2-Alternative-forced-choice
Psychophysics – Results

Participants: N = 15 (Males = 7, mean age of 19.14 years, SD = 2.03)
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Psychophysics – Conclusions

MarPat had the lowest detection accuracy

Most effective pattern

UN PKB had the highest detection

Easiest to find – least effective
Psychophysics – Conclusions

Psychophysics can be used to test effectiveness of camouflage

Detection is still based on human visual system – increases validity

Faster than field trials (more so if utilising existing database of images)

Further experiments (not presented here) show that other patterns can be tested by digitally altering image of target – new photographs are not required
Building a visual recognition system

Desirable Properties:

Ideal Observer - flexible to variety of environments and objects

Fast – automated

Biologically inspired - based upon low level vision
Stage 1: Filter images

Convolve with a log Gabor filter bank
Captures the early linear properties of the visual system

Stage 2: Process Filtered Output

Compute Local Energy & Phase
Accounts for the non-linear properties
Stage 3: Sample
Sample with a Hexagon Lattice
Optimal Sampling
Physiologically sensible

Stage 4: Recognition Decision
Make mixture models
Compute likelihood features came from object
Find points of highest concentration
Evaluate maximum posterior probability using Bayes' rule
Benchmark on existing databases to test that it works
Try it out on camouflage

Equivalent to the cued trials of the psychophysics experiment

Model is shown a pair of images

Bayes’ rule evaluates the maximum posterior probability for which image is the helmet
Compare results to those generated by human participants.
Colour

Model human colour opponency using the Macleod and Boynton colour space

Images are Gaussian blurred to model colour in the periphery

Luminance channel excluded

Texture heat map is multiplied with colour heatmap
Heatmap Example Under Illumination
Human versus final visual recognition system

Human vs Model: Texture + Colour
Leigh Woods

Human Accuracy

Model Summed Log Probability
Visual Recognition System - Conclusions

A surrogate human observer has been designed using low-level vision principles

State of the art face recognition

The model assesses camouflage consistent with human observers
BUT……

Human participants were all Bristol undergraduates

e.g. Participants: N = 15 (Males = 7, mean age of 19.14 years, SD = 2.03)

and recognition system has only been compared to data from these participants

What if military observers produce different data for this detection task?
Comparison of camouflage detection performance between trained military personnel and civilians

Within subjects
4 patterns (MTP, MarPat, Olive, UN PKB)

Between subjects
2 observer levels (military, civilian)

5 blocks with 27 trials per block
Camouflage presentation randomised

2-Alternative-forced-choice
Military observers vs Civilians – Results

14 Military personnel from ATDU, 13 Civilians from QinetIQ and DSTL

Effect of experience & camo–pattern

- Significant effect of pattern (p<2.2e-16)
- No effect of observer group (p=0.3529)
- Interaction not significant (p=0.05432)
Military observers vs Civilians – Conclusions

No difference between military observers and civilians

UN PKB easiest to detect – least effective
MarPat hardest to detect – most effective

Camouflage pattern results are very similar to those reported in the original experiments using undergraduates.
Final Conclusions – potential methods for evaluating camouflage patterns

Psychophysics
- Reliable
- Efficient
- For detection task, participants do not need to be trained observers

Visual recognition systems
- Automated
- Based on human visual system
- Not necessary to model trained observers