

# Making Pixel Patterns Automatically for Camouflage – Using Color Information from Their Background

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**Abstract.** Camouflage is an attempt to obscure a target's outline and match its background for hiding the target. Detectability of a target depends on the features of the background and changes in the surrounding. Thus, we have to consider visual information from the background and apply them to the development of an effective camouflage pattern. As dynamic environments are essential for designing an adaptive pattern, controlling digital images and making patterns automatically by use of computer can be efficient alternatives through the designing process of development and evaluation. In this study, we made the automatic pixel patterns program for the camouflage assessment. For making patterns, color information derived from background was used and pixel-dot type of pattern was considered in view of the digital pattern. Automatic stimuli-pattern maker developed in this study follows several steps; load an image, select an area, extract colors, and create a pattern. This automatic implementation has some benefits for design processes for camouflage pattern development. Further studies are needed not only for program-upgrade but also for improvement of color strategy through analyzing camouflage features.

**Keywords:** camouflage pattern, camouflage assessment, photosimulation, adaptive pattern.

## 1 Introduction

Recently, we heard of the breaking news that British a Defense Company is developing the invisible tank. Using attached electric sensors on the surface of the tank it could process color, line and shape from surroundings, and then project them on a tanks' exterior. This invisible tank technology, so-called 'e-camouflage system' aims to merge target and background.

In the context of military, these demands for finding the adaptive camouflage strategy in dynamic environment conditions will grow as battle conditions vary. Detectability of a target depends on the features of the background and changes in the surrounding. Thus, we have to consider visual features like colors or patterns from

environments and apply them to the design process for an effective camouflage. In addition, empirical detectability data of developed patterns on dynamic surrounding conditions are required for effective camouflage pattern rather than designers' subjective point of view.

In this study, we developed the automatic pixel pattern program for photo-simulated camouflage assessment aimed to investigate how visual features from background could affect a target's ability of camouflage.

## **2 Camouflage Pattern Design and Assessment**

### **2.1 Camouflage Pattern Design**

Camouflage is an attempt to obscure the target's signature and match its background[1,2,6] in order to hide or disguise the identity of the target. In the same context, the purpose of camouflage pattern is to minimize the noticeability and maintain the visibility of pattern at the same time[2,5]. To satisfying the two contradicting purposes for camouflage, features of camouflage pattern have to be similar with the visual features of the targeted background as much as possible. Some features like color, shape, and size among others can be critical factors for designing patterns. Designers have to deal with these factors sufficiently and increase similarity with the targeted region for effective camouflage design.

So far, most camouflage patterns were generated by the subjective view of expert-designers who could deal carefully with characteristics of background conditions like color and pattern, and so on. But now, these traditional approaches can incur relatively high cost and time to create adaptive camouflage patterns as the military contexts are changed[3,5]. If dynamic environments are essential for designing adaptive patterns like the 'e-camouflage' system, controlling digital images and making patterns automatically by computer can be efficient alternatives through the design process of development and evaluation.

### **2.2 Camouflage Assessment by Photosimulation**

Evaluation of the camouflage effectiveness is also a fundamental step for optimal camouflage pattern. There are two camouflage assessment methods; one is field observation, the other is photosimulation[4].

The former performs the camouflage assessment on natural field conditions. While this field observation is able to obtain most practical evaluation data, it has some potential risk factors disturbing detection performance of camouflaged targets.

The latter, in contrast, photosimulation performs on the controlled experimental situation, so it is made possible to produce rich statistical data from different groups of observers with the same image sets. Moreover, it has some strengths in designing patterns in respect that we are able to collect images continuously under the identical conditions and spare the additional expense [4]. Photosimulation is used to design or evaluate the developed pattern for dynamic and various military contexts because it is implemented on digital environments [3,4]. Actually, it is usual to apply color information as quantitatively computable data to experimental settings. These

simulated results are applicable to real military environments, but potential influence factors in natural situations are not considered.

In this study, we designed the visual target search experiments applying photosimulation and developed the automatic program for making pattern-stimuli under a dynamic background for the purpose of comparing camouflage effectiveness of patterns easier.

### 3 Automatic Program for Making Camouflage Pattern Stimuli

Making patterns automatically from digital images is beneficial to camouflage assessment experiments using photo simulation. The reason is that generation of patterns is easier for various backgrounds and quantitative descriptions of background features.

#### 3.1 Overall Flow of Automatic Program

The automatic pattern-stimuli maker developed in this study follows several steps for generating patterns as the outcome.

(1) At first, load a photo used as a background image and (2) assign target area. After target area is selected, (3) this program extracts colors based on color information of the selected area, and (4) lastly creates a pixel pattern using extracted colors which are based on color features of the background.

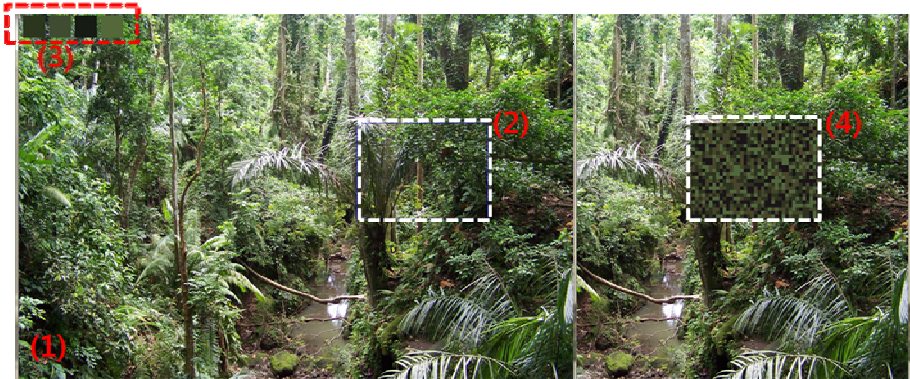


Fig. 1. Overall flow of developed program

#### 3.2 Use of Color Information and Generation of Pattern Stimuli

If the colors in the camouflage pattern are well extracted from the surroundings, they are used to allow the target to blend into the background and reduce any visual cues[2,3,5]. Several countries investigated color characteristics of different environments and applied different color schemes to development of patterns for dynamic surroundings[2]. In many ways, the use of color information derived from

background images plays an important role in detectability of camouflaged targets. Further, it is critical to extract the limited numbers of appropriate colors.

In this program, we used color information as a best feature for effective camouflage and pixel-dot type of pattern was considered in view of the digital pattern. This automatic pattern program derives selected numbers of colors based on color frequency information of the selected area and then replaces all pixels of the targeted area with extracted frequent-colors according to the similarity measure.

## 4 Discussions

In this study, we developed the automatic pixel pattern program for the camouflage pattern stimuli, which is aimed to investigate how visual features from background could affect detectability of camouflaged targets through photo-simulated camouflage assessment.

As a result of the developing and testing the automatic pattern stimuli program, it was determined that strategy used for color processing was less effective for considering color characteristics of a background in some conditions. Nevertheless, this implementation deserves to be considered continuously through the design process for camouflage pattern development. For better effectiveness, further studies are needed not only to upgrade the program but also to improve color strategy through analysis of camouflage features.

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