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Theoretical Solution for Identifying and Creating Digital Camouflage Images by Two Scale Decomposition

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ABSTRACT
Camouflage is the mixture of resources, design or information for camouflage, either by making animals or objects tough to see or by hiding them. Camouflage follows human perception instinct to create digital camouflage images and complies with the physical creation procedure of the artist. The very first job of proposed system is creation of camouflaged image and then extraction of foreground object and background image from a created camouflaged image. After performing survey and analysis of various existing techniques for identification and creation of digital camouflaged image, a proposed solution is introduced for creation and identification of digital camouflage image by using two scale decomposition technique and threshold adjustment phenomenon for visually pleasing camouflage images and then extraction of foreground object and background image from a camouflaged image.

Keywords
Camouflage Images; Threshold Adjustment; Blending;

Human Visual System (HVS).

1. INTRODUCTION
The images observed in a fashion that diverges from objective reality are created by Optical illusions which are also called visual illusions. Camouflage images which are also called as visual images aim to determine the incredible capability of the visual system of human to transform visual input into interpretable shape. Foreground objects are smartly covered within the background scene through carefully placed objects, typescripts, glooms and coloring. People generally have difficulty in recognizing objects from their backgrounds immediately when they view a camouflage image. Camouflage images contain one or more hidden figures that remain unnoticed for a while. Camouflage image, also referred to as hidden image which is an instance of recreational art. This kind of image contains one or more hidden figure, or foregrounds which are embedded into background image, and these embedded figures remain unobserved for some time. Camouflage images are created by highly specialized skilled artists and this type of conception is exigent. An artist sketch background and foreground objects and draws them as a trustworthy image, and subsequently the particulars are carefully added to achieve a balance between hiding and acknowledging the object. This is very time consuming procedure and is also not precise for many users because it is a manual creation procedure. A recent work [1] has solved this problem. This work crafts camouflage images using natural photos and produces visually attractive results.

These approaches cannot promise the consistency of brightness between the foreground object and background object when the brightness contrast of the foreground object is moderately low. As a result, strong and long edges will occur and these edges give significant visual clues to the camouflaged objects.

Fig 1: Camouflage Image

While clearly representing the structural feature of the object shape many hidden objects have consistent textures and consistent colors with surroundings as shown in Fig.1 In many objects, important structural information is contained in edges present in an image. The contours representing the shape of the object are strong edges. To ensure that the structures of the objects are preserved through camouflage manipulations, the prominence of edges is considered using the Gaussian scale space analysis. Perception research [2] shows that long consistent-edges, even if indistinct, are salient to the Human Visual System (HVS). This system is motivated by law of closure of the theory of psychology by Gestalt. A theory states that humans recognize objects as a whole even when they are not complete. Important and long edges of the object are considered in this system and these edges are divided into shorter edges and remove some of them. The concealed object can still recognize by the viewer which is based on the remained shorter edges. This system proposes an alternative method to create camouflage images by considering the above observations. In this method a background image and a foreground object is given which is to be hidden in that background image. The camouflage image generating process is defined as an image blending problem, which is considerably an optimization problem. To preserve the structure of the foreground object in the blending region, the hidden object should contain consistent textures and consistent colors with the environments. In this system a two-scale computation mechanism is selected which is inspired by the physical creation procedure of artists. Such a scheme follows the instinct that the overall shape of an object is defined by its large features, and the details are defined by its small features[3]. The approach of this system starts by decomposition of the foreground object and the background image into the spatial structure layer and the detail layer respectively. These layers can be modified in various ways. The spatial location of edges can be preserved in the structure layers by adding weight in detail layers and therefore detail layers are weighted-added layers.

This system makes the following contributions:

1) An innovative technique for large-scale image blending: the large-scale spatial intensity is controlled over the result using an innovative edge-aware energy minimization.

2) A trend for managing spatial detail variation: the intensity and spatial variation of the high- frequency detail is manipulated while respecting the intensity of large-scale layers.

3) A constraint to evade halo artifacts: a gradient correction constraint is selected by this system to prevent halo artifacts.

The part of related work of camouflaged image is explained in next section.

2. RELATED WORK

Automatic design and creation of optical illusion images is addressed by most of the previous work and it is done using computational tools present in the computer graphics community. A texture synthesis technique is used by Chu et al [1] for creation of camouflage images that have natural form. The approach of these kinds of images leaves an appropriate amount of evidences of human to detect in the final result by bearing in mind object slices and their topological relations. This system also uses an image blending approach to create camouflage results. However, this system introduces a data term for measuring the background information to the original Poisson blending and develops the problem as a new optimization equation. To provide an appropriate degree of hints for recognizing the object while producing similar effects of subject contours, this system uses fewer non consistent edges and less shadow information by considering the structural importance of the object. The work of this system is also related with blending of an image that embeds an object from source image to the destination image. The classical method for image blending is Alpha blending method. This blending method is useful to obtain high quality bending results. Static hybrid images can be produced by blending various frequency images. For the creation of genuine image mosaics a method is proposed by Pavic et al [3]. In input image is spliced into a set of tiles and each tile is replaced by another image from a large database. This method is also useful for washing of the image database by eliminating all unwanted images with no meaningful content. This technique is developed by Oliva et al [4]. Different images can be identified as the viewing distance changes. Puzzle image mosaic is proposed by Kim et al [5]. In this method image slates of indiscriminate shape are used to compose the final picture. This system defines a mosaic as the tile structure which reduces a mosaicing energy function. A hidden picture puzzle generator is proposed by Yoon et al [6]. This system converts objects and image of the background into the line drawing and after that it finds a place in which to hide changed varieties of the objects using rotation-invariant shape context matching. Mitra et al [7] present a synthesis technique to generate emerging images from a given scene. Emergence denotes the distinctive human ability to aggregate information from clearly worthless pieces, and to identify a whole that is meaningful. This is a special skill of human which is used to tell humans and machines apart. Creation of an infinite number of images with emerging figures is possible using this technique. For modeling and translating dreadful figures, an optimization approach is generated by Wu et al [8]. There is a set of 3D locally possible parts of a figure whose approach enhances a view-dependent 3D model and translates new views of impossible figures at the desired pioneering vantage point. When various illumination conditions present between source and destination images then there are chances of arrival of artifacts. Perez et al [9] introduces gradient-based image blending methods. This method contains a variety of pioneering tools which are introduced for smooth editing of regions of an image. The first set of tools permits the smooth access of both blurred and transparent source image regions into a region of destination. The second set is established on similar mathematical concepts and allows the user to modify the presence of the image smoothly, within a selected region. The method of gradient domain is improved by optimizing the region boundary is proposed by Jia et al [10]. This system presents a user-friendly system for smooth image composition, which is called drag-and-drop pasting. This system introduced a new impartial function to calculate an optimized boundary condition to make Poisson image editing more practical and easy to use. To combine Poisson blending with alpha blending a hybrid image compositing method is introduced by Chen et al [11]. This system founds a realistic picture from a simple freehand sketch defined by text labels. The constituted picture is generated by smoother stitching many photographs in agreement with the sketch and text labels. This system selects appropriate photographs automatically from Internet to generate a high quality alignment, using a filtering scheme to exclude detrimental images. Alike result to the original Poisson blending is obtained by using the mean value cloning proposed by Farbman et al [12]. This approach uses mean value coordinates instead of solving Poisson equations for cloning of image. The usage of coordinates is helpful in terms of speed and implementation. To preclude color bleeding artifacts without changing the boundary location an error-tolerant cloning approach is proposed by Tao et al [13]. The approach of this system improves standard gradient- domain compositing in two ways. Define the boundary gradients first, so the produced gradient field is nearly integral. Secondly, control the process of integration to distillate residuals where they are fewer noticeable. This system increases the visual quality and run-time complexity of an image. A method of multi-scale image harmonization is introduced by Sunkavalli et al [14]. This system presents a framework that explicitly matches the visual appearance of images through a process called image harmonization, before blending them. To transmit the presence of one image to another, a multi-scale technique is used in this system. A content-aware image blending method is presented by Ding et al [15] in which alpha matting is combined with Poisson system. In this technique, the process of diffusion is reformed which is used in the gradient-based approach for the usage of alpha dark for the replicated area as a mass function to control intensity interpolation. A system for creation of hidden images is proposed by Tong et al [16]. This method uses a shape matching technique for object embedding in the background scene by considering edge information and object contour. This method uses a modified Poisson blending technique to create resultant hidden images. The workflow of this system is shown in Fig.2. In this workflow a user first chooses a region by painting strokes or using the Lazy Snapping method to obtain the object in the source image. The selected area is then inevitably entrenched into the background image using the algorithm. In this block diagram, Δ denotes large scale non-linear blending and + denotes weighted addition. Two images are considered, first the source image as an object for embedding and a background image as a scene.

CIELAB color space is almost unchanging and superior to dispersed lightness from color than other color spaces. After decomposition the background images the channels of lightness of the object are decomposed to the large- scale and detail layers by applying an edge- preserving filter operator [18]. The large features which carries low

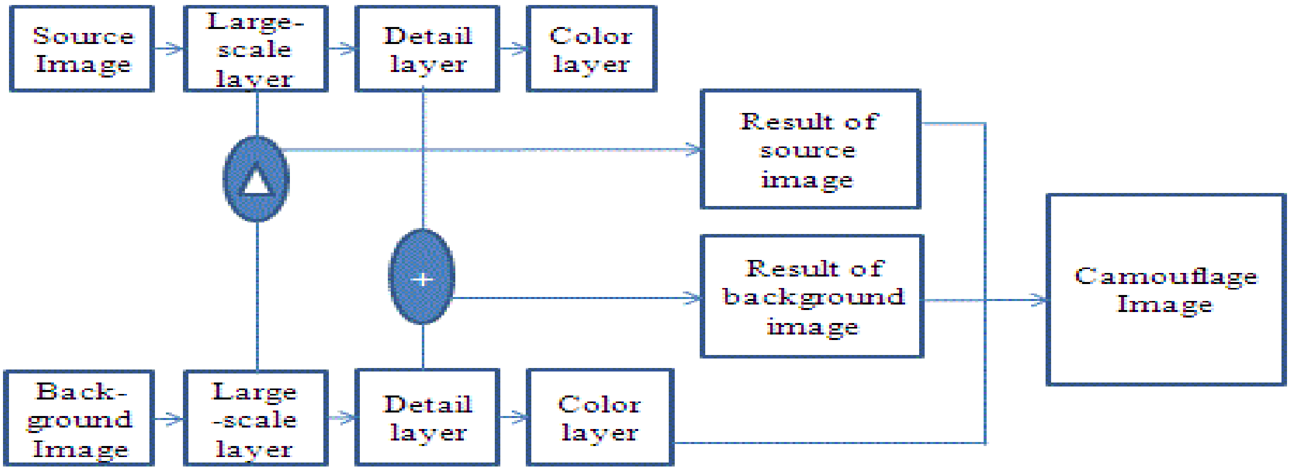

Fig 2: Block Diagram of Existing System

Firstly, this algorithm decomposes background scene and foreground object into lightness and Chroma channels. Background image and lightness channels are then decomposed into large-scale layer and the detail layer by using edge-preserving filter operator [18]. Large-scale layer gives the large features of the image which carries low frequency information while the detail layer shows the small features of the image which carries high frequency information. The detail layer is generated by subtraction of large scale layer from lightness channel. Different color patterns are required in creation of camouflage image. Therefore, to obtain a color pattern from background image and foreground object, a color layer is required.

3. METHODOLOGY

3.1 Synthesis of Camouflage Images

To identify the objects of a scene, the brightness of an image provides sufficient visual clues which shows by the vision science research. Thus the focus of this system is on the process of the brightness channel of the image. The camouflage image generating algorithm of this system is explained in detail. The effect of Camouflage has two goals:

1) Keeping the components of the original section of the background image

2) Introducing the feature of foreground object into the final result

The approach of this system compromises between applying the texture from the source image which consist the foreground object and retaining texture information from the background image to reach the aim. The system ponders the preservation of the structure of foreground object and the texture of background image to achieve a probable result.

3.2 Layer Decomposition

The algorithm of this system first decomposes the foreground object and background image into lightness and Chroma channels by transforming them into CIELAB color space. The frequency information of the image are denoted by the large scale layer which is also called as structure layer. The trivial features which carry high frequency information are denoted by detail layer. The generation of detail layer is performed by subtracting the large-scale layer from the lightness channel.

3.3 Large-Scale Layer Blending

Foreground objects are blending with surrounding for creation of camouflage images. It specifies that while preserving some structural information of foreground image for human recognition and hence the result of camouflage must be much similar to the background image on texture and color. This system uses an innovative blending approach for the large scale layer for preserving an important structure of the foreground object. A blending algorithm for large-scale layer is considered as an optimization problem by minimizing an energy function in terms of least-squared error:

$$\sum_{p\in\Omega} \omega\big(F(p) - T(p)\big)^2 \; (1-\omega)|\nabla F(p) - \mu.g(p)|^2$$

$$\text{with } F|_{\partial\Omega} = T|_{\partial\Omega} \quad (1)$$

where F and T represent the large-scale layer of the resulting image and the background image, respectively. Ω is the hidden region specified by the user and δΩ is the boundary of the region. ∇ denotes a gradient operator. Ω is used to control the hidden level of the foreground object. The resulting F is more similar to the background T when we increase the value of Ω, which leads to more difficulties in recognizing the object. µ is a gradient constraint which is used to prevent halo artifacts. Here g is a gradient field defined as:

$$\begin{cases} \nabla T, & if|\nabla T| > |\nabla S| \\ \nabla S, & otherwise \end{cases} \quad (2)$$

This system adds a data function term to the optimization functional which is similar to the standard mixing gradient problem of cloning. Conferring to the Euler- Lagrange equation, we can rewrite equation 1 so that the minimization problem can be defined as the solution of the following linear system:

$$\omega - (1-\omega)\Delta F = \omega T - (1-\omega)\mu\nabla.g \quad (3)$$

where Δ is the Laplacian operator.

3.4 Structural Edge Constraint

To achieve the unified hidden level of an object, here the same Ω is setting for all the pixels. In the outcome of camouflage, some structural contours of the object must be preserved to see the foreground object. The approach of this system identifies the relevant image structure represented by a hierarchy of edges in the Gaussian scale space. Computer vision community developed this Gaussian scale space [17] to deal with structure identification in images with no theoretical information. The edges of the object are found out by using Canny edge detector. These detected edges have no concept of edge importance. Therefore this system calculate the lifetime of each edge pixel in the Gaussian scale space and use the lifetime as a measure of structural importance. The other thing is to deal with edge lengths. The conceptual studies [2] show that long consistent-edges are conceptually impressive to the HVS even they are faint. Long edges may reveal the important information about the object. The process for long edges should be considered to hide the foreground object. The main idea behind this is to divide important and long edges of the object into smaller parts and remove some of the parts. A law of closure of Gestalt psychology's grouping theory states that an observer can fill in the gaps between distinct edges and evaluate sections as a complete instead of as a set of unconnected features. Specifically, the algorithm first collects the edges longer than a certain threshold according to the mask M. In this system 30 pixels are used as threshold. After this, the algorithm opens these collected edges using a 50 * 50 window, casts some sample points on the collected long edges randomly and divides amplified long edge patches into shorter edges patches Ei in terms of the sample points. Hence an algorithm randomly wins the percentage (specified by the user, default 20 percent) of shorter edges. The value of Ω changes smoothly over each successful edge.

3.5 Gradient Constraint

By applying the mixing gradient of the object and background image on the optimization leads to halo artifacts near strong edges. To avoid the artifact, this system uses a gradient constraint to reduce the coefficient μ according to the magnitudes of the gradients to avoid halo artifacts. Removing the halo artifacts can be demonstrated as a Gaussian distribution formula:

$$\mu(p) = exp\frac{-\beta(1-\omega(p))||\nabla S||^2}{2\sigma_2^2} \qquad (4)$$

$$\sigma_2^2 = mean\left(||S||^2\right)\Omega \qquad (5)$$

where mean(.) denotes the mean value over the hidden domain Ω. 0.3 is the default value for β. The weighting μ is low when the gradient is very high to reduce artifacts.

3.6 Detail Management

This system now obtained the large-scale layer F of the result by solving the linear system. The detail information of the foreground object and the background image should also be integrated into the final result. Otherwise, the result will not be realistic due to the lack of the detail. Here the resulting detail layer DR is defined as a weighted sum of the object detail DS and the background detail DT, i.e.

$$D_R(p) = D_T(p) + t(p)D_S(p) \qquad (6)$$

where $0 \leq t(p) \leq \alpha$. $\alpha \in [0,1]$ is a user given constant for controlling the contribution of the foreground object detail. Here the expectations are the value of t should vary depending upon the value of Ω. That is, the detail of the object should not appear in the result where the parts of the foreground object are hidden completely. Thus, we define t as

$$t(p) = \begin{cases} \propto, & \omega(p) = \kappa \\ (1-\omega(p))\propto, & otherwise \end{cases} \qquad (7)$$

For different pixels, different values of t are used. Pixels with large Ω values imply small t values, and the resulting pixels are much closer to the background pixels.

In this system, author has proposed methodology to produce camouflage image, but there are some cases in which this technique doesn't provide appropriate results such as:

1) If background image has sharp edges then this technique fails to produce appropriate result.

2) If background image has dense object then the results of this technique are not proper.

3) If background and foreground images has same pattern then also this technique is not capable to produce a good camouflage image.

4. PROPOSED WORK

A threshold adjustment phenomenon is introduced in a proposed system for identification of camouflaged image. This system will provide better results even if the background images have sharp edges or dense objects. Threshold values of both foreground object and background images are adjusted and then two scale decomposition technique is applied. After this addition of both foreground object and background image is performed to get a resultant camouflaged image.

The proposed system also provides a theoretical solution for extraction of images from camouflaged image. After detection of camouflaged image, a two scale decomposition technique is applied for identification of foreground object and background image. Again a layer separation technique is applied on both the images and after adding these layers finally a separate background and foreground images are occurred.

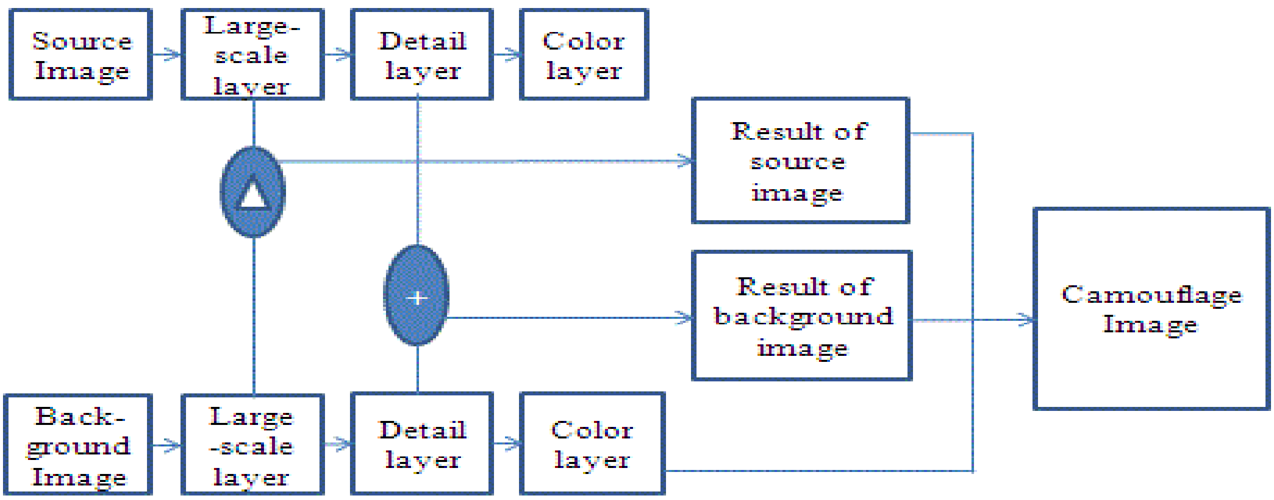

Fig. 3(a): Phase-I of Proposed System for Creation of Camouflage Image Using Threshold Adjustment Phenomenon

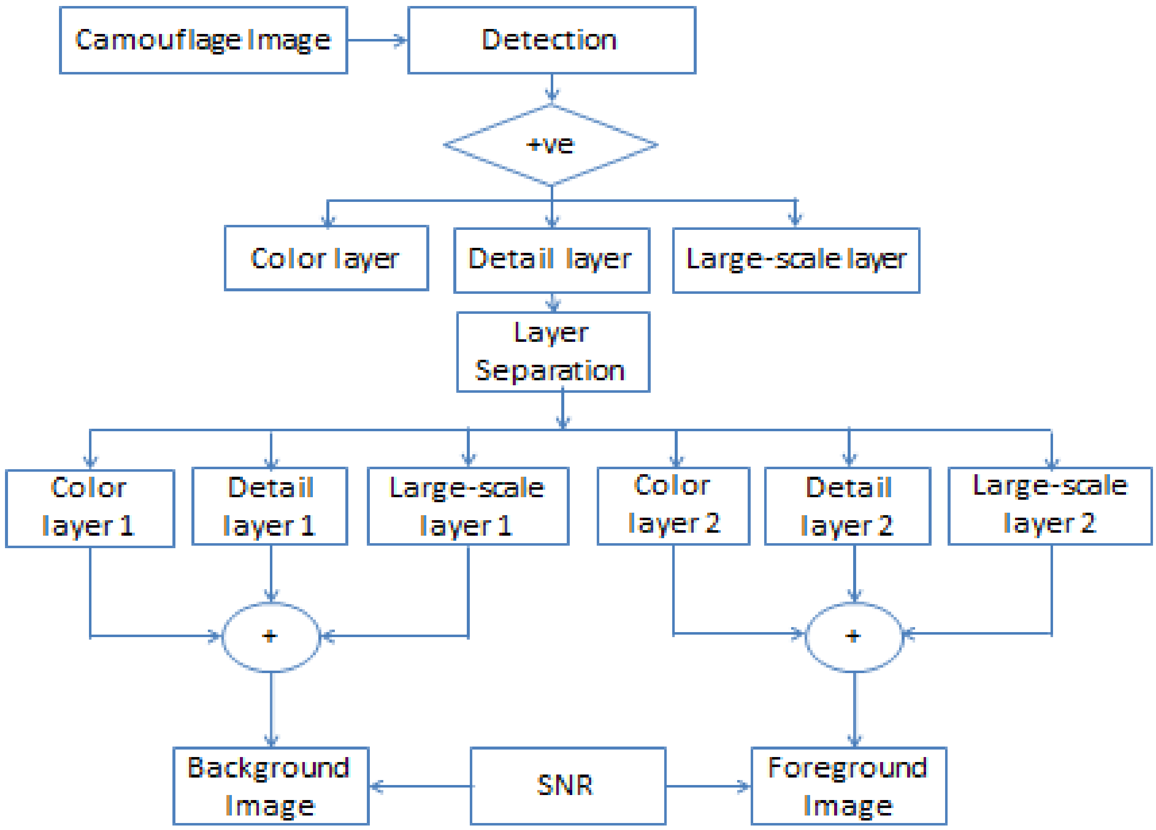

Fig. 3(b) Phase-II of Proposed System for Extraction of Foreground Object and Background Image from Camouflaged Image

5. CONCLUSION

The proposed system provides an approach for creation of camouflage images. This approach can control both large-scale layer structure and the detail layer structure of an image. This control is possible by the integration of edge-preserving decomposition. The non- linear analysis is performed on a large-scale and the linear analysis is performed on detail layer. The approach of this system hides the foreground object into the background image. This system enhances the degree of difficulty of camouflage image by finding the best hidden location for the foreground object. The proposed system gives visually pleasing camouflaged images by using threshold adjustment phenomenon. The proposed system also gives a theoretical solution for extraction of foreground object and background image from a camouflaged image.

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