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Survey of Object Detection Methods in Camouflaged Image

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Abstract

Camouflage is an attempt to conceal the signature of a target object into the background image. Camouflage detection methods or Decamouflaging method is basically used to detect foreground object hidden in the background image. In this research paper authors presented survey of camouflage detection methods for different applications and areas.

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Key words: Camouflaged Detection, Decamouflage, object detection Method

1. Introduction

Camouflage is an attempt to obscure the signature of a target and also to match its background (Ariel Tankus and Yehezkel 2000).The word camouflage has come from the ancient days of animal kingdom in those days animals used to hide themselves from predators by changing their body pattern, texture, coloration as per environment `s texture. In war, camouflage is a technique for military to conceal them in the background texture so that enemies could not identify them and Decamouflage is a technique to reveal the enemies those are camouflaged in the image texture. Camouflage related work can be divided in to two areas first camouflage assessment and design second camouflage detection. Here the authors shall discuss about camouflage detection.

Camouflage Identification System or Decamouflaging is use to reveal the target object from its background, means discriminating foreground object from camouflaged image. There are many potential application of Camouflage Identification System like discriminating enemies in war field, Detecting defects in product during manufacturing, Identifying duplicate products during logistics etc. So concept of Decamouflaging is how to detect specific texture to identify from the provided background. Some models have been proposed in literature to identify camouflaged region, however, most of them normally either consider recognizing motion camouflage that is detect an object which tries to get camouflaged during movement or in static image in contrast to motion camouflaged problem if the Decamouflaging is carried out in sort of supervised environment.

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2. Camouflaged Defined

Likely origin of the word camouflage is camoufler a French term (Jiri F. Urbanek, et al., 2010). Camouflaging is the process of concealment of an object to blend it with its surrounding (P. Sengottuvelan and Amitabh Wahi, 2008). In other term also we can express camouflage as, it is the process of masking the foreground to appear as though it is background.

The definition of camouflage involves concealment and the obscurity, whether applied to the natural coloration of animals, or artificial camouflaged image. Natural or artificial camouflaged images are basically from wide variety of applications like

- Natural camouflage of predator. Like insects hide themselves from their predators fig 1.
- Motion camouflaged means hiding object in the visual background. In visual surveillance applications camouflaged occurred when texture and color of moving object is same as the background.
- Camouflage texture pattern used in battle field to hide soldiers and weapons. Means first camouflage textures are evaluated from the environment and then camouflaged textures are used to design coloration of cloth, weapons etc. In fig 2 one soldier is having close texture appearance as the background.
- Mixing up duplicate product in to original in such way that duplicate product is get camouflage in to original. In set of match boxes (fig 3) one of match box is defective but it is difficult to identify which one is defective.
- The disguising of defects in the product at the time of manufacturing is also a type camouflage.

Fig 1

Fig. 2

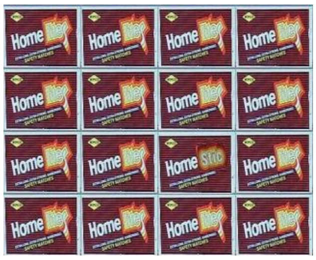

Fig .3

3. Review of Decamouflaging techniques

Decamouflaging techniques in the literature are summarized in following sections for different kind of applications.

In the year 1995 Srinivasan & Davey first suggested Motion camouflage that would allow one moving body (a shadower) to camouflage its motion from another moving body (the prey). The thesis submitted by Andrew James Anderson Department of Computer Science University of London has provided the first artificial motion camouflage control systems known to the authors in the year 2003. The origin of motion camouflage is that the shadower maintains a trajectory such that its image projected on to the prey's retina emulates that of a distant stationary object (a fixed point). This trajectory requires the shadower to always remain directly in between the fixed point and the prey i.e. on the straight line connecting the position of the fixed point to the present position of the prey (Anderson, et al., 2003).

Camouflaged detection methods are summarized as follows.

3.1. Visual Camouflage Breaking (Ariel Tankus and Yehezkel, 2000)

Ariel Tankus and Yehezkel have introduced Convexity based Visual Camouflage Breaking and suggested a mathematical model which describes a possible explanation of visual camouflage breaking. In this paper, they discuss the issue of visual camouflage breaking. Some animals use counter-shading in order to prevent their detection by predators. Counter-shading means that the albedo of the animal is such that its image has a flat intensity function rather than a convex intensity function. Thayer's counter-shading prevents detection based on the convexity of the gray level function (Darg). The effectiveness of camouflage breaking by convexity detection (for subjects which are not counter-shaded according to Thayer's principle) is demonstrated using Darg. The operator Darg is basically intended for detection of image domains emanating from smooth convex or concave 3D objects. This method does not extract the object completely and some threshold must be determined, which can change the results. In this paper author also compare and explain edge-based detection is not enough, because the input to the detector is almost similar to background and subject domains and how this Darg operator used to break camouflage with some example.

*3.2. Texture Segmentation by Multiscale Aggregation of Filter Responses and Shape Elements (*Meirav Galun, et al., 2003*)*

Meirav Galun et al. in their paper Texture Segmentation by Multiscale Aggregation of Filter Responses and Shape Elements they discuss texture segmentation problem using a framework that combines structural characteristics of texture components with filter responses. These processes adaptively identifies the shape of texture components and characterize them by their size, aspect ratio, orientation, brightness, etc., and then uses various statistics of these properties to distinguish between different textures. Segmentations produced by this approach are hierarchical, and with their associated statistics they can be used directly for recognition and retrieval, Problem with this is how to combine the various statistics into a single weight.

*3.3. Co-occurrence matrix and invariant central moments (*Nagappa U. Bhajantri and P Nagabhusan, 2006**)***:*

Nagappa U. Bhajantri et al. have described Camouflage Defect Identification and used Co-Occurrence matrix based texture elements within the small block of region of an image. Here first they divide the entire image into LXL disjoint blocks and compute invariant central moments up to Kth order (10^{th} order is sufficient) for each block. Finally camouflaged parts of an image are detected by cluster analysis and identified through Watershed Segmentation method. This technique gives good result, if camouflaged portion is present in a close neighbourhood of the blocks of image and total percentage of camouflage should not be more than 4%.This technique would not be feasible when large amount of camouflaged image present in input image frame or when the normal texture itself is irregular. Further more it is also not able to discriminate defective part if more than one type of defect is present in one image frame.

*3.4. Color and Intensity based camouflaged detection (*I. Huerta, et al., 2007*)*

I. Huerta et al. proposed segmentation procedure that is based on colour and intensity information. Consequently, the intensity model enhances segmentation when the use of color is not feasible. Here authors faced the problem of camouflaged when the foreground pixel has the same brightness as the background model and they discussed two types of camouflaged namely dark and light. A Dark Camouflage is considered when the pixel has less brightness and it cannot be distinguished from a shadow. Next, Light Camouflage happens when the pixel is brighter than the background model. Foreground detection is thus achieved by using the normalized brightness and normalized chromaticity measures from color model and the statistics from the intensity model for every new image, and then applying the pixel classification technique. Extended work suggested by the author needs to address new cues, like edges or corners because the intensity model can not work with intense shadows and highlights.

3.5. Use of GLCM and Dendrogram in camouflage detection **(**P. Sengottuvelan*, et al., 2008)*

P. Sengottuvelan et al. in their research paper Performance of Decamouflaging through Exploratory Image Analysis have proposed a system to detect the camouflaged object from a given image and to take out that from the background efficiently. According to them normally, decamouflaging is carried out in unsupervised way, which means we do not have any knowledge about either the camouflaged part in image or features of normal background. The camouflaged parts of an image are surface objects which are induced with hiding characteristics by merging their features with the nature of background. Firstly they have converted input image in to gray scale image then divide image into LXL equal blocks and calculate GLCM value for each block.

Finally the mean value is computed for each GLCM values, then dendrogram is plotted for mean values and from dendrogram find out the largest individual block and combine the adjacent blocks. This method is not feasible for an image which contains shadow effect and for images with non-uniform background and the success rate is 70%.

*3.6. Bayes classification of background and foreground image and Gaussian mixtures model for background observation (*Hongxing Guo, et al., 2008*)*

Hongxing Guo et al. have proposed a method to separate foreground from Background accurately in visual surveillances application by using Bayes classification of background and foreground with the help of Gaussian mixture model for background observation, however a challenge for this approach is that it is difficult to choose a threshold to separate foreground from background because of camouflage. Camouflage problem appears when the color elements of a pixel of new foreground object are so close to the background models of an image. So they propose averaging the video frames in sequences temporally, that reduces the variances of background models. Thus the background model is squeezed to a very narrow region and the probability of camouflage is reduced.

*3.7. Background subtraction technique based on color statistics and edge information (*P. Siricharon, et al., 2010*)*

P. Siricharon et al. have introduced the Statistical Background subtraction and shadow detection algorithm (SBDG), in this paper they presented a robust outdoor background subtraction technique based on color statistics and edge information. This paper basically focused on foreground subtraction from background in visual surveillances. Whenever color of foreground and background are same, camouflage problem occurs, to solve this problem author used three background model the color based, edge based and intensity background model. This technique SBGS color model detects shadow image and low contrast image to discriminate foreground and background. This algorithm overcomes the problem of shadow effect in identifying camouflaged image of P. Sengottuvelan method Performance of Decamouflaging through Exploratory Image Analysis.

*3.8. HSV color and GLCM texture to identify camouflaged object (*R. E. Ch.Kavitha, et al., 2011*)*

Ch. Kavitha et al uses the local HSV color and Gray level co-occurrence matrix texture features to identify camouflaged object in an image. The input image is split into sub blocks of equal size then the texture features and color features of each sub-block are computed. Color of each sub-block is extracted by quantifying the HSV color space into non-equal intervals and cumulative color histogram is used to represent the color feature. Texture feature of each sub-block is taken by using gray level co-occurrence matrix and an integrated matching scheme based on Most Similar Highest Priority (MSHP) principle is used to compare the query and target image. Using the sub blocks of query and target image the adjacency matrix of a bipartite graph is formed. This matrix is used for matching the images. Here camouflaged portion retrieval is achieved using HSV color and GLCM texture features of a given image sub-blocks with one to one matching. This combination of color and texture can be used to identify camouflage.

*3.9. Object detection using top down information based on EM (Expectation maximization) Framework (*Zhou Liu, et al., 2011*)*

Zhou Liu et al. presented a new foreground object detection method that propose a generalized EM (Expectation maximization) framework to integrate spatial, spectral, top-down features for the foreground object detection based on background. In this Expectation maximization framework, the top-down information is incorporated in an object model, based on the object model and the state of each target, a foreground model is constructed. This foreground model can enhance the foreground detection for the camouflage problem. This method is basically for the visual surveillance application but they also describe how to handle camouflage problem. Limitation of the proposed method is if part of the object shape is obscure, the detection result around this part may not be very accurate.

*3.10. Weight structural similarity (WSSIM) to find the Camouflage texture (*Song Liming and Geng Weidong, 2010*)*

Song Liming et al. in their paper a new camouflage Texture Evaluation Method Based on WSSIM and Nature Image Features expressed method to evaluate and design of the camouflage texture. So in this paper they discuss about making a camouflage image with the help of weight structural similarity and nature image features, the same method we can use to discriminate the camouflage texture. Because structural features like average luminance, standard deviation, correlation, image entropy of natural images can be used to identify the camouflage texture.

*3.11. Camouflaged Target Detection Method Based on 3D Convexity (*Yuxin Pan, et al., 2011*)*

Yuxin Pan et al. in their research paper study on the Camouflaged Target Detection Method Based on 3D Convexity proposed detection of camouflaged target in the complex background with the help of Darg operator based on the convex structure to find out which is the convex points. Some problem in this method still has not been solved like selection of the threshold to remove noise that results due to of Darg operator for complex background that is mixture of flat image, tiny and local convex elements.

3.12. Optical Flow Model based on velocity to detect motion camouflage **(**Jianqin Yin, et al., 2011**)**

Jianqin Yin et al. have introduced optical flow model based on velocity to detect motion camouflage have discussed about detection of the moving object with camouflage color, means moving object is hiding in the background image. Common target motion detection algorithms like frame difference method, Gaussian Mixed Models, CodeBook Models work better but these algorithms do not work properly when the target image is with camouflage color. So in order to effectively segment the moving object with camouflage color the optical Flow Model based on velocity field characteristics was put forward. Demerit of this method is it is easily manipulated by noise impact.

4. Discussion

Camouflage is used from the ancient days of animal kingdom when predators hide themselves in surrounding by changing their body texture then after consequently this concept has been used by military and in many areas and applications. In this study we have found two different types of camouflage, natural and artificial camouflage. Natural camouflage is something which is generated automatically like i) image of tiger hidden in the background has been taken to discriminate tiger from background (P. Sengottuvelan et al.2008) and ii) camouflage problem also occurs when the color components of a pixel of new object are so close to the background (Hongxing Guo et al. 2008). Artificial camouflage is designed by critical texture assessment as discussed by (Song Liming et al. 2010) and (Nagappa U. Bhajantri et al. 2006). Many methods have been proposed in texture analysis to extract features from image statistics like co occurrence matrix or spatial frequency domain but they work in limitation. Invariant central moments up to kth order is used to analyze texture features but it does not work if more than one type camouflage is available or portion of camouflage is more (Nagappa U. Bhajantri et al. 2006). GLCM and statistics mean are used to extract feature of texture it returns 70% accuracy if background is uniform (P. Sengottuvelan et al. 2008). Background subtraction and shadow detection algorithm (SBDG) based on color statistics and edge information is also introduced, this techniques overcome the problem of shadow effect in Amitabh Wahi`s paper Performance of Decamouflaging Through Exploratory (P. Siricharon et al. 2010). In this way we have seen different techniques to identify camouflaged portion in camouflaged image all of them are having some constraint to find camouflaged portion. Texture analysis is useful in many applications of image processing for classification, segmentation, detection of images. So here authors are proposing texture analysis to reveal camouflaged portion of an image by using wavelet transform. Advantage of wavelet transform has been discussed over other previous methods available in the literature for texture analysis (S. Arivazhagan et al., 2003).

In Summary, camouflage detection may be improved with the help of image enhancement and good texture analysis technique. Thus we have seen in the literature that techniques used to detect camouflaged part in image is varying as per its application areas. The identification of defective Camouflaged Image is a tedious job, there is very less work is done in national and international area for identification of the natural and artificial camouflaged. So wavelet transform would be good approach in texture analysis and in identifying camouflaged image.

5. Conclusion

As available related work in the field of camouflaged detection we have found its origin the word camouflage and different areas in which it is applicable like motion camouflage in visual surveillance , identification of hidden enemies in the war field , Detection of disguising defects in the cotton wear , wood , tiles image that is basically unrecognized. Out of all available techniques either they are cost effective or they are not more efficient to identify the camouflaged portion in the given image. So authors are proposing new techniques to detect camouflage in image based on texture by wavelet Co occurrence features.

References

[1] Ariel Tankus and Yehezkel Yeshurun Convexity based Visual Camouflage Breaking Pattern Recognition Proceedings. 15th International Conference Page(s): 454 - 457 vol.1 2000 IEEE

[2] Anderson, A. J. & McOwan, P. W. Model of a predatory stealth behavior camouflaging motion. Proc. R. Soc. Lond.2003 B, 270, 489-495.

[3] Nagappa U. Bhajantri and P Nagabhusan Camouflage Defect Identification: A Novel Approach 9th International Conference on Information Technology (ICIT'06)0-7695-2635-7/06 2006 IEEE.

[4] I. Huerta, D. Rowe, M. Mozerov, and J. Gonzalez Improving Background Subtraction Based on a Casuistry of Color-Motion Segmentation Problems IbPRIA '07 Proceedings of the 3rd Iberian conference on Pattern Recognition and Image Analysis, Part II Pages 475 - 482 Springer-Verlag Berlin, Heidelberg 2007

[5] P. Sengottuvelan, Amitabh Wahi, A. Shanmugam Performance of Decamouflaging Through Exploratory Image Analysis ICETET 2008 IEEE.

[6] P. Siricharon, S. Aramvith, T.H. Chalidabhongse and S. Siddhichai . Robust Outdoor Human Segmentation based on Color- based Statistics Approach and Edge Combination 978-1-4244-6878-2/10 2010 IEEE.

[7] R. E. Ch.Kavitha, B.Prabhakara Rao, A.Govardhan An Efficient Content Based Image Retrieval Using Color and Texture Of Image Sub blocks International Journal of Engineering Science and Technology (IJEST) ISSN: 0975-5462 Vol. 3 No. 2 Feb 2011

[8] Zhou Liu, Kaiqi Huang and Tieniu Tan Foreground Object Detection Using Top-down Information Based on EM Framework IEEE Transactions on Image Processing 2011.

[9] Jiri F. Urbanek, Jiri Barta, Jozef Heretik, Josef Navratil and Jaroslav V Prucha Cybernetic camouflage on Human Recipient - Visual Illusion INTERFACE Recent Researches in Circuits, Systems, Electronics, Control & Signal Processing 9th WSEAS International Conference 2010.

[10] Hongxing Guo, Yaling Dou, Ting Tian, Jingli Zhou, Shegsheng Yu A Robust Foreground Segmentation Method by Temporal Averaging Multiple Video Frames ICALIP 2008 IEEE.

[11] Meirav Galun, Eitan Sharon, Ronen Basri, Achi Brandt Texture Segmentation by Multiscale Aggregation of Filter Responses and Shape Elements Proceedings of the Ninth IEEE International Conference on Computer Vision (ICCV'03) 2003 IEEE

[12] Yuxin Pan, Yiwang Chen, Qiang Fu, Ping Zhang, and Xin Xu Study on the Camouflaged Target Detection Method Based on 3D Convexity Modern Applied science Vol 5, No 4 2011 Canadian Center of science and education

[13] Song Liming and Geng Weidong A new camouflage Texture Evaluation Method Based on WSSIM and Nature Image Features Multimedia Technology (ICMT), International Conference Page(s): 1 – 4 Cited by 1 IEEE 2010.

[14] Jianqin Yin Yanbin Han Wendi Hou Jinping Li Detection of the Mobile Object with Camouflage Color under Dynamic Background Based on Optical Flow" Advanced in control Engineering and Information Science Elsevier 2011.

[15] S. Arivazhagan and l. Ganesan Texture segmentation using wavelet transform pattern Recognition letters 24 (2003)3197-3203 Elsevier.