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A Robust and Novel Approach to Identify the Nudity of a Person

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***Abstract*:** The nude image is an important part in adult images spreading on the Internet. As the development of the Internet, children are easily exposed on the pornography through web browsers. To block adult images, content-based image retrieval technique is employed for nude image identification. In this paper a novel algorithm to detect explicit content or pornographic images is proposed using the transformation from the RGB model color to the YCbCr. First, the background is removed to obtain the rectangular region of interesting based on the detection of skin-like pixels. For each input image, color feature is used to retrieve 900 most similar images from the image database which contains both nude and non-nude images. However, if the retrieved images contains more than threshold nude pixels, then the input one is identified as a nude image. Otherwise, it is identified as a non-nude image. Experiment results have shown the effectiveness of the proposed method.

Keywords: Explicit content, Gabor filter, Nude image identification, Skin-pixel, YCbCr.

I. INTRODUCTION

With the ever-growing Web, The Internet is one of the greatest inventions of all time, but has also become a playground for pornographers. Aggressive marketing tactics and tricks are used to target the pornography is the most harmful one affecting children safety and causing many destructive side effects .Therefore, a filtering system is necessary for blocking nude images. Typically, current adult contents filtering approaches can be classified into three categories: IP-based black-list blocking, textual content-based filtering, and visual content-based filtering. The IP-based black-list filtering approach is inefficient and impractical however it is hard to keep the black-list of all objectionable web sites up to date, since content in the internet is highly dynamic. The textual content-based filtering approach attempts to block adult web sites based on the analysis of the textual contents Access to a requested web page is prohibited if a lot of offensive keywords or phrases occur in the requested web page. However, the textual content-based filtering approach suffers from the well known ‘‘over-blocking’’ phenomenon which blocks access to educational web sites such as health or sexology. In addition, many adult web sites with text incorporated in elaborate images cannot be blocked by textual content analysis. Therefore, many researchers investigate visual content-based filtering approach to analyze the image contents in a web page. Adult image identification is an challenging issue. In general, the skin regions are first segmented by color. The features extracted from the detected skin regions, including color, texture, and shape features, are then used to discriminate benign images from adult images and also it is possible to employ content-based image retrieval approach for identifying adult images. Given an image, a number of similar images are retrieved from an image database consisting of both adult and non-adult images. If most of the retrieved images are adult images, the input image is identified as an adult image. Otherwise, it is regarded as a non-adult image.

Hung-Ming Sun.[1] developed a method a new approach for detecting skin in a single image. Approach uses a local skin model to shift a globally trained skin model to adapt the final skin model to the current image. However generating a local skin color model requires more computation than the original method. The pioneer work of recognizing nude images was proposed by Fleck et al. They used a skin filter and a human figure grouper to find naked people in an image [2]. Nevertheless, the recognizing accuracy and speed can’t satisfy the practical need. Arentz et al. [3] classified the image content by investigating probable skin-regions, and extracting their features based on color, texture, contour, placement, and relative size-information for a given region. Hu et al. [4] partitioned the image plane into any number of rectangular blocks to compose the contour of nude person. Deselaers et al. [5] applied the bag-of-visual-words models to nude image recognizing system in which an image was represented by an unsorted set of discrete visual words obtained by discretization of local descriptors. Choi et al. [6] classified an image to nude image or close-up face image by the feature of color, texture and shape. Xiaoyin Wang, Changzhen Hu, Shuping Yao. [7] Developed an effective nude image recognizing algorithm based on the navel and body feature. Semantic feature has been successfully used in the areas of scene image classification [8-9]. The semantic feature based classification technique has used the information of semantic concepts existing in image [8].However nude image recognition can be realized from statistical features of skin pixel distribution. The algorithms above can settle the problem in some degree, but they still have to face some disadvantages. The statistical features of some algorithms didn’t express the characteristic of naked body completely, and the algorithms extracting the shape feature of body make huge computing quantity. Therefore, we proposed an effective and simple nude image identifying algorithm based on the skin color in this paper. The paper is organized as follows. Section 2 describes the process of the developed nude image recognizing algorithm. Section 3

discusses the experimental results of the algorithm. Section 4 draws the conclusions and further work.

II. DESCRIPTION OF THE PROPOSED ALGORITHM

The flowchart of our proposed system is shown in Fig. 1.

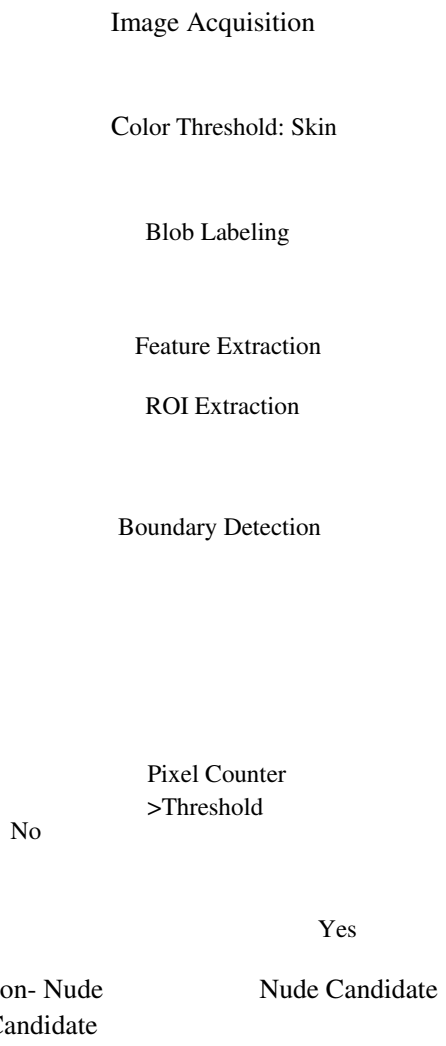

Figure.1 The architecture of the proposed system.

A. Background Removal

Candidate blobs are extracted from the input image by thresholding using YCbCr color space for nude body. To obtain the region of interest (ROI), the background region which contains definitely non-skin-like pixels will be first removed. In this paper, color information is employed to detect skin-like pixels. Garcia and Tziritas have shown that skin-like pixels are more correlated with Cr and Cb components than Y component. Therefore, the input image is first transformed from the RGB color model to the YCbCr color space. A pixel is considered to be skin-like if its Cb and Cr components meet the following constraints,

$$C_r \geq max\{-2(C_b+24), -(C_b+17), -4(C_b+32), 2.5(C_b+\theta_1), \theta_3, 0.5(\theta_4 - C_b)\}$$

and,

$$C_r \leq min\{(220 - C_b)/6, 4(\theta_2 - C_b)/3\}$$

Where $\theta_1, \theta_2, \theta_3$ *and* θ_4 are the constants given by,

$$\theta_1 = \begin{cases} -2 + \dfrac{256 - Y}{16} & if \quad Y > 128, \\ 6 & otherwise, \end{cases}$$

$$\theta_2 = \begin{cases} 20 - \dfrac{256 - Y}{16} & if \quad Y > 128, \\ 12 & otherwise, \end{cases}$$

$$\theta_3 = \begin{cases} 6 & if \quad Y > 128, \\ 20 - \dfrac{256 - Y}{16} & otherwise, \end{cases}$$

and,

$$\theta_4 = \begin{cases} -8 & if \quad Y > 128, \\ -16 + \dfrac{Y}{16} & otherwise. \end{cases}$$

As a result, a binary image can be used to indicate whether a pixel is skin-like or not (see Fig. 2) where the skin-like pixels be represented as white pixels and non-skin-like pixels are represented as black pixels.

Figure.2 a) The original image b) Image after skin-like detection.

B. Feature Extraction

First the image is filtered to reduce noise and enhance the visual quality of the input image. Filtering constitutes an important part of any image processing pipeline where the final image is utilized for visual inspection or for automatic analysis [10]. This preprocessing helps increase the performance of the subsequent stages. The image is then viewed in colour spaces and the sensitivity is tested. here our system use gray color image. After testing the sensitivity, a suitable threshold value T is taken for formulating the binary images. There are different set of values for detecting the foreground and differentiating it with the background colour. After the implementation of the specified values, the image can finally be converted into a binary form. All those pixels that have their values in this specified range(within the threshold valve) are given a value of 0, i.e. white and rest all the other pixels are given a value of 1, i.e. black (see Fig.3).

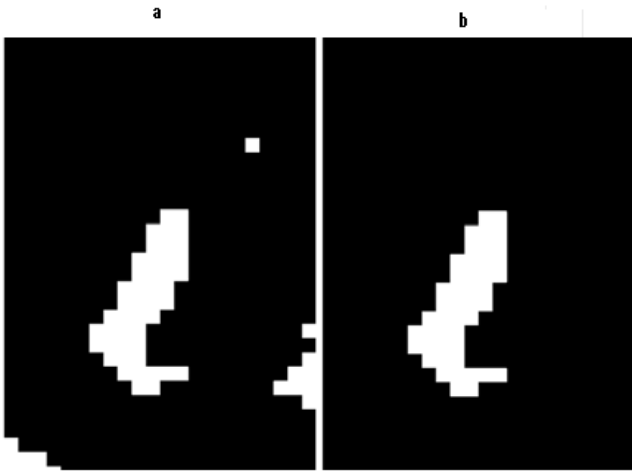

Figure.3 a) the skin-like blocks, b) After binarization.

The texture information in the image features are emphasized using Gabor filters. Gabor filters are preferred for texture analysis because they have been used to describe the response of the receptive fields of cells in the visual cortex [12], and they have been found to be appropriate for extracting texture information and for texture discrimination [11]. Gabor filters have been successfully used for texture analysis in other related recognition processes-iris and fingerprint recognition [11]. A 2-D Gabor filter is given by :

$$h(x,y) = exp\left\{-\Pi\left[\frac{(x-x_o)^2}{\alpha^2}+\frac{(y-y_o)^2}{\beta^2}\right]\right\} \otimes exp\{-2\Pi[u_o(x-x_o)+v_o(y-y_o)]\} \quad (1)$$

where x_o and y_o give the position in the image, α and β specify the width and length. u_o and v_o specify the modulation with spatial frequency f given by:

$$f = ({u_o}^2 + {v_o}^2)^{\frac{1}{2}} \quad (2)$$

and direction given by:

$$\phi = \tan^{-1}\left(\frac{v_o}{u_o}\right) \quad (3)$$


Figure.4 Boundary box image

Using translation operation the coordinates are obtained. If the resulting coordinates are entirely inside the said envelope, then the edge is said to be matching. If the match is not yet found, the chain code of the corresponding edge is transformed accordingly. If no match is found, then the next possibility is tried for. This is continued till a match is found or until the ordered set of distances, gets exhausted. Figure.4 shows the minimum bounding box for the detected skin region. After all these procedure the process of extracting the features of naked body is as following:

Step 1: Boundary Detection

Stage 1.1 Read the image using imread function.
Stage 1.2 Convert the image into binary image
(Pixels with the value 0 are displayed as black; pixels with the value 1 are displayed as white).

Step 2: Plotting Boundary Values:
Stage 2.1 Choose a appropriate scale to plot boundary values on to a graph.
Stage 2.2 The boundary values are plotted using the function; plot(Y) plots the columns of Y versus their index if Y is a real number.
Stage 2.3 If Y is complex, plot(Y) is equivalent to plot(real(Y),image(Y)). (The scale considered for each plot is based on the width and length of the image fragments from the top-left corner of the scanned image).
Note: The extraction of the plotted boundary values and bifurcating these values as uniform boundary and non-uniform boundary values is very difficult because while scanning the fragments, even if placed with at most care on the scanner bed since, skew problem occurs.

Stage 3: Bounding box
Stage 3.1 The scanned input image is first converted into a binary image using:
Stage 3.2 Producing binary images from indexed, intensity, or RGB images.
(The output binary image BW has values of 0 (black) for all pixels in the input image with luminance less than LEVEL and 1 (white) for all other pixels).

Stage 4: Crop image
Stage 4.1 Working area that is selected within the bounding box
Stage 4.2 IMCROP ( ); imcrop crops an image to a specified rectangle.
(It displays the input image and waits for you to specify the crop rectangle with the mouse).

Stage 5: Boundary detection
Stage 5.1 Apply Gabor filter
Stage 5.2 Detect the boundaries of the fragments.
Stage 5.2 Tracing the exterior boundaries of objects, as well as boundaries of holes inside these objects, in the binary image BW.
(BW must be a binary image where nonzero pixels belong to an object and 0 pixels constitute the backgrounds).

Stage 6: Nude detection
Stage 6.1 Calculate the percentage of the nude using tracking method.
Stage 6.2 If nude percentage is greater than the threshold value, output as nude or non-nude.

III. RESULT

Images were collected from the Internet. There are 500 human nude images and 400 non-nude images. The nude set comprises Caucasians, Blacks and Asians. The non-nude set comprises clothed people, nature scenes, buildings, wood, foods, rock, desert sand, and animals. For the results of the test images, the false positive is 11% and the false negative is 16%. The overall detection rate is 87%.

IV. CONCLUSION AND FUTURE SCOPE

This paper proposed an algorithm to detect explicit content or pornographic in color images, using the YCbCr color model and a method of skin detection which works effectively although in some images it could find some errors, due to the image lighting conditions when was taken. Even so the proposed system achieved a 87% to the YCbCr color model, for explicit images detection. However, some improvements remain as tasks for the future.

- We must detect and recognize the nipples in adult nude image effectively.
- We must identify the erotogenic parts in image.
- We must classify the nude image(men or women).

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