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Skin Detection Based Cryptography in Steganography (SDBCS)

[1] Mr. R.Surendiran [2] Dr. K. Alagarsamy

[1][2] Madurai Kamaraj University, Madurai

[1] surenconference@gmail.com [2]alagarsamymku@gmail.com.

Abstract

As the popularity of digital cameras increases, some limitations of digital technology are becoming apparent and on the other hand it has become imperative to ensure security of information. Looking ahead towards the authentication scheme with a view to optimize it. Skin detection [1] is a very popular and useful technique for detecting and tracking human-body parts. It receives much attention mainly because of its wide range of applications such as, face detection and tracking, naked people detection, hand detection and tracking, people retrieval in databases and Internet, etc.

With this view we proposed a novel method in steganography using skin color detection scheme. In this method we introduced a *Two Way* security mechanism in steganography using skin color detection scheme as well as cryptography. To ensure the strength of cryptography we used JCA (Java Cryptography Architecture).

Keywords: *Color Detection, Skin Detection, Color Tracking, Cryptography in Skin Detection.*

1. Introduction

Color detection and tracking has been the topics of an extensive research for the several past decades. Many heuristic and pattern recognition based strategies have been proposed for achieving robust and accurate solution. Among feature-based face detection methods, the ones using skin color as a detection cue have gained strong popularity. Color allows fast processing and is highly robust to color variations of the skin pattern. Also, the experience suggests that human skin has a characteristic color, which is easily recognized by humans. So trying to employ skin color modeling for face detection was an idea suggested both by task properties and common sense. When building a system, that uses skin color as a feature for face detection, the researcher usually faces three main problems. First, what color space to choose, second, how exactly the skin color distribution should be modeled, and finally, what will be the way of processing of color segmentation results for face detection. This paper covers the first questions and implements it on cryptography leaving the second and third (an equally important one) for another discussion. In this paper we discuss color space transformation for *pixel-based* skin detection methods that classify each pixel as skin or non-skin individually, independently from its neighbors.

1.1 Cryptography

Cryptography is the science of using mathematics to encrypt and decrypt data. Cryptography enables you to store sensitive information or transmit it across insecure networks (like the Internet) so that it cannot be read by anyone except the intended recipient.

While cryptography is the science of securing data, *cryptanalysis* is the science of analyzing and breaking secure communication. Classical cryptanalysis involves an interesting combination of analytical reasoning, application of mathematical tools, pattern finding, patience, determination, and luck. Cryptanalysts are also called *attackers.* .The study of techniques related to all aspects of data security. The word "cryptography" is derived from the ancient Greek words "kryptos" (hidden) and "graphia" (writing).

Some aspects of data security:

- Confidentiality - Keeping data secret.
- Data Integrity - Ensuring data has not been altered.
- Entity Authentication - Identifying parties involved.
- Data Origin Authentication - Identifying the data origin.

Cryptanalysis - The study of techniques to defeat cryptographic techniques.

1.2 Steganography:

Steganography is the science of *hiding* information. Whereas the goal of cryptography is to make data unreadable by a third party, the goal of steganography is to hide the data from a third party. In this article, I will discuss what steganography is, what purposes it serves, and will provide an example using available software.

There are a large number of steganographic methods that most of us are familiar with (especially if you watch a lot of spy movies!), ranging from invisible ink and microdots to secreting a hidden message in the second letter of each word of a large body of text and spread spectrum radio communication. With computers and networks, there are many other ways of hiding information, such as:

- Covert channels (e.g., Loki and some distributed denial-of-service tools use the Internet Control Message Protocol, or ICMP, as the communications channel between the "bad guy" and a compromised system)

- Hidden text within Web pages
- Hiding files in "plain sight" (e.g., what better place to "hide" a file than with an important sounding name in the *c:\winnt\system32* directory?)
- Null ciphers (e.g., using the first letter of each word to form a hidden message in an otherwise innocuous text)

Steganography today, however, is significantly more sophisticated than the examples above suggest, allowing a user to hide large amounts of information within image and audio files. These forms of steganography often are used in conjunction with cryptography so that the information is doubly protected; first it is encrypted and then hidden so that an adversary has to first find the information (an often difficult task in and of itself) and *then* decrypt it. In this paper we introduced novel method in steganography to hide the data using skin detection scheme.

2. Color spaces used for skin color detection

Colorimetric, computer graphics and video signal transmission standards have given birth to many color spaces with different properties. A wide variety of them have been applied to the problem of skin color modeling. Identifying skin colored pixels involves finding the range of values for which most skin pixels would fall in a given color space. In general, a good skin color model must have a high detection rate and a low false positive rate. That is, it must detect most skin pixels while minimizing the amount of non-skin pixels classified as skin. Commonly used skin detection algorithms can detect skin regions accurately. Skin color has proven to be a useful and robust cue for face detection, localization and tracking. Image content filtering, content aware video compression and image color balancing applications can also benefit from automatic detection of skin in images. Numerous techniques for skin color modeling and recognition have been proposed during several past years [2]. We will briefly review the most popular color spaces and their properties.

2.1 RGB

RGB is a color space originated from CRT (or similar) display applications, when it was convenient to describe color as a combination of three colored rays (red, green and blue). It is one of the most widely used color spaces for processing and storing of digital image data. However, high correlation between channels, significant perceptual non-uniformity), mixing of chrominance and luminance data make RGB not a very favorable choice for color analysis and color based recognition algorithms. This color space was used in [Brand and Mason 2000], [Jones and Rehg 1999].

2.2 RGB Color Value Normalization

RGB color representation that is easily obtained from the RGB [1] values by a simple normalization procedure:

$$r = R/R+G+B \tag{1}$$

$$g = G/R+G+B \tag{2}$$

$$b = B/R+G+B \tag{3}$$

As the sum of the three color components is known ($r + g + b = 1$), the third component does not hold any significant information and can be omitted, reducing the space dimensionality. The remaining components are often called ”pure colors”, for the dependence of r and g on the brightness of the source RGB color is diminished by the normalization. A remarkable property of this representation is that for matte surfaces, while ignoring ambient light, normalized RGB is invariant (under certain assumptions) to changes of surface orientation relatively to the light source [Skarbek and Koschan 1994]. This, together with the transformation simplicity helped this colorspace to gain popularity among the researchers [Brown et al. 2001].

2.3□ HSI,□ HSV,□ HSL□ -□ Hue□ Saturation□ Intensity□

Hue-saturation based color spaces were introduced when there was a need for the user to specify color properties numerically. They describe color with intuitive values, based on the artist’s idea of tint, saturation and tone. *Hue* defines the dominant color (such as red, green, purple and yellow) of an area; *saturation* measures the colorfulness of an area in proportion to its brightness [Poynton 1995]. The”intensity”,”lightness” or”value” is related to the color luminance.

The intuitiveness of the color space components and explicit discrimination between luminance and chrominance properties made these color spaces popular in the works on skin color segmentation

Several interesting properties of Hue were noted in [Skarbek and Koschan 1994]: it is invariant to highlights at white light sources, and also, for matte surfaces, to ambient light and surface orientation relative to the light source. However, [Poynton 1995], points out several undesirable features of these color spaces, including hue discontinuities and the computation of”brightness” (lightness, value), which conflicts badly with the properties of color vision.

$$\begin{aligned} H &= \arccos \frac{\frac{1}{2}((R-G)+(R-B))}{\sqrt{((R-G)^2+(R-B)(G-B))}} \\ S &= 1-3\frac{\min(R,G,B)}{R+G+B} \\ V &= \frac{1}{3}(R+G+B) \end{aligned} \tag{4}$$

A different representation of Hue-Saturation using Cartesian coordinates can be used

$$X = S\cos H,\ Y = S\sin H \qquad (5)$$

2.4□□YCr□Cb□Color□Intensity

YCrCb is an encoded nonlinear RGB signal, commonly used by European television studios and for image compression work. Color is represented by luma (which is luminance, computed from nonlinear RGB [4], constructed as a weighted sum of the RGB values, and two color difference values Cr and Cb that are formed by subtracting luma from RGB red and blue components.

$$Y = 0.299\ R + 0.587\ G + 0.114\ B \qquad (6)$$

$$Cr = R - Y \qquad (7)$$

$$Cb = B - Y \qquad (8)$$

YCrCb was developed as part of the ITU-R Recommendation B.T. 601 for digital video standards and television transmissions. It is a scaled and offset version of the Y UV color space. In YCrCb, the RGB components are separated into luminance (Y), chrominance blue (Cb) and chrominance red (Cr). The Y component has 220 levels ranging from 16 to 235, while the Cr, Cb components have 225 levels ranging from 16 to 240:

$$\begin{bmatrix} Y \\ C_r \\ C_b \end{bmatrix} = \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} + \begin{bmatrix} 65.4810 & 128.5530 & 24.9660 \\ -37.7745 & -74.1592 & 111.9337 \\ 111.9581 & -93.7509 & -18.2072 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

(9)

Where the R, G, B values are Weighted to [0, 1].

In contrast to RGB, the YCbCr color space is lumaindependent, resulting in a better performance. The corresponding skin cluster is given as [9]:

$$Y > 80$$
$$85 < Cb < 135$$
$$135 < Cr < 180,$$

Where Y,Cb,Cr = [0,255] .

Chai and Ngan [4] have developed an algorithm that exploits the spatial characteristics of human skin color. A skin color map is derived and used on the chrominance components of the input image to detect pixels that appear to be skin. The algorithm then employs a set of regularization processes to reinforce those regions of skin – color pixels that are more likely to belong to the facial regions. Working in the YCrCb space Chai and Ngan have found that the range of Cb and Cr most representatives for the skin – color reference map were:

$$77 <= Cb <= 127 \text{ and } 133 <= Cr <= 173$$

2.5 Image Resampling

Image resizing (or resampling) is one of the most common functions of every raster image processing tool. Graphics Device Interface GDI+ is an improved 2D graphics environment, adding advanced features such as anti-aliased 2D graphics, floating point coordinates, gradient shading, more complex path management, intrinsic support for modern graphics-file formats like JPEG and PNG (which were conspicuously absent in GDI). If you've decided for GDI+ to resize your images, you can choose from variety of filters. Libor Tinka [10] implemented a collection of different resampling filters. Some of them provide even better results than filters in professional imaging applications. He used C#.net to implement the Resampling Service.

2.6 Skin Color Detection

The skin color detection with resizing technique can be summarized as follows:

Step1: Extract the images from web pages.

Step2: Determine the used filter for resizing.

Step3: Apply the resizing method with the extracted image, image width/2, and image height/2 as arguments.

Step4: Apply the skin color detection on the output image after resizing.

Step 5.Record the CPU time of the detection process for both the classic and resized techniques.

Commonly used skin detection algorithms can extract skin regions from images accurately and reliably, but they often take a long CPU time to finish the detection process. As described in section 3, the resizing algorithm can be considered as fast skin region detector technique.

3. The Proposed Method

In Our Paper, to optimized the value for Color space techniques we had invoked to algorithm for Skin Color Detection as follows.(1) Skipping Algorithm and (2) Hybrid Algorithm. The Steps involved in the proposed method (Skipping) are as follows

Step1: Extract the images from web pages.

Step2: Apply the skipping method on the extracted images.

Step3: Apply the skin color detection on the input image with skipping a predetermined number of pixels.

Step4: Record the CPU time of the detection process for both the classic and skipping techniques.

We can combine the proposed method with the resizing method to obtain better results. This hybrid technique takes the advantages of both methods. In this technique, we first resize the extracted image, then we apply the skipping technique in the skin color detection step. The hybrid algorithm can be described as follows:

Step1: Extract the images from web pages.
Step2: Determine the used filter for resizing.
Step3: Apply the resizing method with the extracted image, image width/2, and image height/2 as arguments.
Step4: Apply the skin color detection on the resized image.
Step5: Apply the skipping method on the resized image.
Step6: Record the CPU time of the detection process for both the classic and hybrid techniques.

By using the above two algorithm results samples were as follows:

Original image

Proposed Method

Hybrid Method

By using proposed techniques, the Skin Color Detection was made. After ensuring with the color values based on skin color the art of cryptography were implemented.

3.1 Implementation of Cryptography in Proposed Method

3.1.1 Encryption

After reading the Color values using the algorithms which mentioned above, the steps followed in encryption is as follows:
Step1: Encrypt the text based on Tkey
Step2: Embed the Tkey in the image.
Step3: Now Apply Color Space based on Fkey.
Step4: Substitude the Fkey in the Image Last Pixel.
The Formulation of the process

Tkey=Total ASCII + Total Position
FKey=Total Position.

3.12 Decryption

Step1: Retrive Fkey from its Last Position
Step2: Retrive Color Space Based on Color Key (Original Color Space)
Step3: Apply Color space based on the Color Retrieved from the previous step.
Step4: Retrive Tkey from the image along with the color value (Position).
Step5: Retrive Encrypted text based on the Tkey right from the first pixel position of the image.

4. JCA framework extension for SDBCS

JCA [5] and the Common Data Security Architecture (CDSA) are two cryptographic frameworks [6] for conventional public key cryptography. Neither of them supports group-oriented cryptography. Recently JCA has been extended to support RSA based group-oriented cryptography [7]. The present work extends the JCA architecture to integrate the Color Space Transformation based cryptography, one of the most important types of group-base public key cryptography. The UML class diagram of Color Space based Cryptography framework extension is depicted in fig 1. Under this extension, various Cryptography providers can be plugged into a security application at runtime. The extension also makes it easy for those JCA-based applications to easily be migrated to use threshold cryptography to enhance system security. It is our belief that this integration would speed up the adoption of cryptography by implementing Color Space.

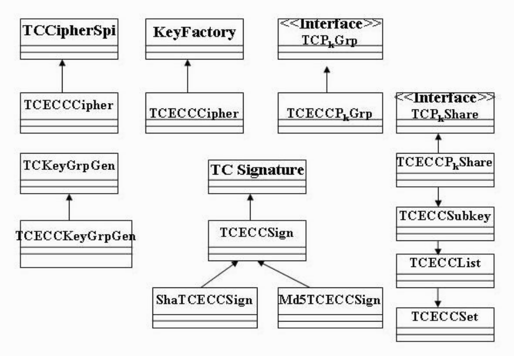

Figure 1: UML class diagram of CSC framework

To test the above framework extension, we have implemented an example provider based on the Color Space Cryptography (CSC), which can be used for Encryption and Decryption.

5. Conclusion:

In this paper, we have provided an application for Steganography using Color Space Transformations based on popular methods for skin color detection. Parametric skin modeling methods are better suited for constructing classifiers in case of limited training and expected target data set. The generalization and interpolation ability of these methods makes it possible to construct a classifier with acceptable performance from complete training data. The paper has endeavored to integrate the features of Cryptography and Color Space Transformation to provide the best of both worlds in information security. To bridge gap between the state-of-the-art security research community and the state-of-the-art security practice.

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