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An Enhanced invisible Digital Watermarking Method for Image Authentication

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Abstract

Watermark is pattern of bits inserted into a digital image that identified the file's copyright information. The name watermarking is derived from the faintly visible marks imprinted on organizational stationery. In this work a robust and novel strategic in-visible approach for insertion-extraction of a digital watermark in color images are presented. Unlike printed watermarks, which are intended to be somewhat visible; the digital watermarks are designed to be completely invisible: Invisible insertion of the watermark is performed in the most significant region of the host image such that tampering of that portion with an intention to remove or destroy will degrade the esthetic quality and value of the image. One feature of the algorithm is that this user defined characters are used as a region of interest for the water marking process and eliminates the changes of watermark removal. Specifically dithering techniques are developed and intended to embed color water marking into color image. A new technique is proposed and implemented using dithering techniques in various color spaces like RGB, HSV, and CMY. An attempt is made to develop full color water marking scheme using those techniques.

Key words: - Watermarking; RGB; HSV; CMY; Dither.

INTRODUCTION

Many researchers over the past decade have enables digital water marking to establish itself as a potential solution for the n protection of ownership rights and policing information piracy of images .Water marking techniques developed for images are mainly classified into visible and invisible approaches [20] .while the visible methods provide means for overt assertion of ownership with logos, the invisible methods provide covert protection of these rights .Images with visible watermarks cannot securely protect the intellectual property because it is easy to process any image in popular graphic software suites .Digital water marking emerged as a tool for protecting the multimedia data from copyright infringement[8]. This water mark will contain information about the owner and thus protect it against illegal use. Since a secret key is used to embed the watermark, nobody but the owner will be able to detect this watermark.

In the modern era, providing authenticity is becoming increasingly important as more of the worlds information is stored as readily transferable bits .Digital watermarking has been widely applied to solve copyright protection problems of digital media relating to illegal use or distribution .In the past few years , several gray level image water marking schemes have been proposed [19], but the use of full color watermarks is still not well studied and a major weakness of water marking techniques is that they do not work if the image needs printing .No invisible watermark survives the distortions introduced by printers and any subsequent scanning does not allow recovery of originally embedded watermark. Hence the color image watermarking in printed images is focused here. In the present work, we explore the techniques to embed invisible watermark in color images that can survive printed distortions. Printers use a technique called dithering to render images on paper [1]. Dithering involves printing pure color dots on paper in specific patterns determined by the algorithms and the dither masks used .Specifically we investigate dithering techniques to embed color watermark into color image. Here the dithering techniques are proposed and implemented in RGB, HSV, and CMY color spaces.

DITHERING IN RGB AND HSV COLOR SPACES

In RGB color space dithering is performed by mapping the colors in the source image to colors in RGB set i.e. Red, Green and Blue. A dither mask is issued to map the colors to RGB color sets .The mask is constructed by randomly distributed red, green and blue colors and the threshold values are taken by dividing the color range based on the number of tiles for each color inside the mask .This mask is tiled for each color inside the mask .This mask is tiled over the image and dither algorithm is applied .If the image patch value exceeds the threshold value, then the primary color of that particular tile (mask) is retained , otherwise the pixel is made white .The following is the dither mask containing RGB colors .We have chosen 4X4 mask containing 7 red tiles , 5 green and 4 blue. To avoid patterns in the dithered image, all the three colors tiles are randomly dispersed in the mask. The threshold values in the mask are generated by dividing the color range(0-255) separately for each color channel .Since there are 7 red tiles in the mask, the color range (0 to 255) is divided into 7 part ie. (37,74,110,150,185,220,255) and are randomly placed in the red cells , similarly the color range (0-255) is divided into 5 parts (50,100,150,200,250) for green and 4 parts for blue (64,128,190,255) according to the figure 1.

Figure 1: Dither Mask

Algorithm

1. Compute RGB values of each pixel in the image.
2. Construct a Dither mask (4X4 block) containing randomly distributed RGB values.
3. The Dither mask is tiled over the image and one to one comparison of the corresponding points is done i.e. the pixel values are compared with the threshold values of the mask .
4. If the image pixel value exceeds threshold value retain the primary color of the otherwise make the pixel white.
5. This process is applied selectively on the channels ie. the threshold values in red tiles are applied on red channels only. Repeat the step 3 till whole image is dithered. The sample images are as shown below in figure 2,3and 4

Figure 2: Image

Figure 3: Dithered image

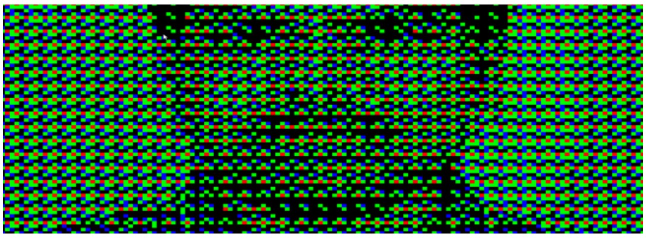

Figure 4: Dithered image zoomed

A. Dithering on Maximum Values of RGB

In each pixel of the image, the maximum value of RGB is computed and is compared with threshold value in the mask .If that value is greater than the threshold of the maximum color then the component of that cell is retained. If we consider an example with pixels as Pixel (30, 50,220), Threshold = 150 then the Max (R, G, B) =blue (220) is calculated and Max (RGB)>threshold. Hence blue is retained in the output image as shown in figure 5

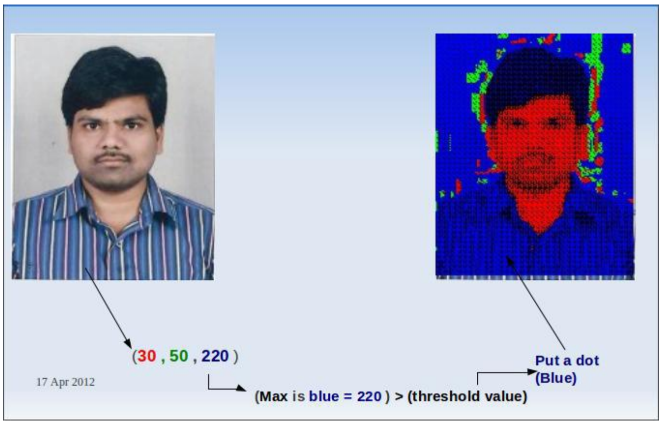

Figure 5: Dithered to maximum value from primary colors

B .Dithering in HSV space

Dithering on Hue

Hue is one of the important property of color .It refers to dominant wavelength of a specific color. By dithering the image based on 'hue' parameter, the color content of the image can be changed [22].

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Algorithm

1) Consider an image .Convert each pixel in RGB image into an HSV.
2) Construct a dither mask (4X4) containing randomly distributed hue values.
3) Tile the mask over the image.
4) Perform one of the comparisons of threshold value with hue value of each pixel of the image.
5) If hue value of the image exceeds the threshold value then hue is set as 120 degrees .Otherwise it is taken as '0'.
6) Repeat step 3 till the whole image is dithered.
7) Convert HSV values into RGB primary colors.

Sample images dithered based on hue are shown below in figure 6,7, and 8

Figure 6: Image

Figure 7: Dithered image

Figure 8: Dithered image containing red (hue=0) and green (hue=120)

In the above figure, hue values are either '0' or '120'. The colors appeared in the dithered image are red and green .The sample image to hue at 120 and 240 are shown below in figure 9, 10 and 11

Figure 9: Image

Figure 10: Dithered image

Figure 11: Zoomed blue (hue=240) and green (hue=120)

C. Dithering on Dispersion

Dithering on Saturation refers to the purity of color. By dithering on saturation the purity of the color can be varied .Here by considering a dither mask containing random values of saturation 16 parameters, dithering is performed on saturation parameter only. The sample images are as shown below in figure 12 and 13.

Figure 12: Image

Figure 13: Dithered image on 'S'parameters

D. Dithering on 'Value'

In each geometry, the central vertical axis is called value and is comprises the neutral ,achromatic, or gray colors, ranging from black at value 0, the bottom , to white at value 1, to the top. Figure 14 and 15

Figure 14: Image

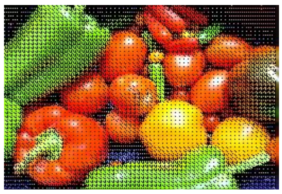

Figure 15: Dithered image on 'V' parameter

E. Dithering in CMYK color space

Printing presses and some ink jets printers use 4 colors of ink(cyan, magenta, yellow and black).Dithering is the most common means of reducing the color range of images .It is one of the principles behind printing technology. The colors are printed by mapping the colors in the source image to CMYK.

C 32	Y 51	M 240	C 200
M 85	C 1	Y 160	M 63
Y 130	Y 196	C 150	Y 164
M 245	C 255	M 94	C 100

Figure 16 : CMYK mask

The color palette contains CMY colors .The figure ….above shows the mask that is designed by using 6 cyan tiles, 5 magenta and 5 yellow. The threshold values for cyan are taken by splitting the color range into 6 parts (1,32,100,150,200,255) as shown in figure 16 .Similarly the color range is divided into 5 parts each for yellow and magenta .To map the colors to the CMYK mask , the mask is tiled over the color image and one to one comparison of pixel values of corresponding cells is performed .If the pixel value exceed threshold value, then the color of the corresponding cell is retained .Otherwise white color is retained.

RESULTS

Image

Dithered image

Color image

Dithered to CMY

F. Embedding Secret Information

Invisible Watermarking

The proposed algorithm embeds watermark into color image and uses dithering technique to embed watermark in color image .To make the watermark survive against the distortion created by printers, the image is dithered in CMYK color space .To embed secret information two different types of dither masks are used by dithering the image in CMYK color space. For this, a secret code can be embedded in the image.

EMBEDDING WATERMARKING INTO IMAGE

Algorithm

1. For an image convert the primary RGB values of each pixel into subtractive primary CMY colors.
2. Generate two different types of masks (mask-1, mask containing randomly distributed CMY colors.
3. The characters that are to be embedded are converted into ASCII equivalents, the ASCII values are further computed to its bit equivalent.
4. The region where secret information is embedded is dithered using two kinds of masks (mask-1 to encode bit 0 , mask-2 to encode bit 1.The remaining region of image is dithered using single mask.
5. If bit value is '0' mask-1 is tiled over the image .The image is dither with other masks if the bit value is '1'.

Dither Masks

In embedding secret code in the image two kinds of masks are used .These masks contain randomly distributed CMY colors and the threshold values are generated by dividing the color range separately for each color channel .The following are the dither masks that contains the threshold values of three colors cyan, magenta and yellow The whole image is dithered with single mask, the place where secret information as to be inserted is dithered using two kinds of masks as shown in the figure17 and 18.

C 32	Y 51	M 240	C 200
M 85	C 1	Y 160	M 63
Y 130	Y 196	C 150	Y 164
M 245	C 255	M 94	C 100

Figure17: Mask-1

M 20	Y 51	C 252	M 70
C 42	Y 255	M 120	Y 102
Y 153	C 125	M 230	C 168
C 210	M 170	C 83	Y 204

Figure 18: Mask-2

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Experimental Results:

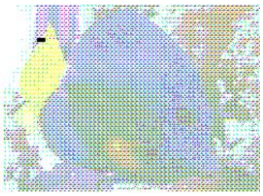



Figure 18: Cover image **Figure19:**Watermarked image

The black spot in the watermarked image in the above figure 19 is calibrated mark. A secret message is embedded just after the calibrated mark.

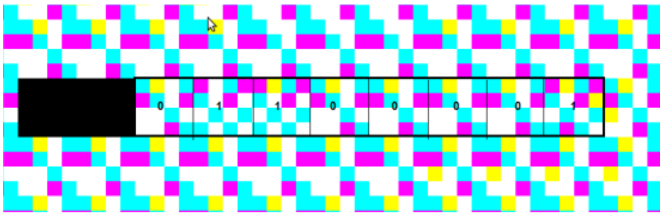


Figure 20: Encoded bits in watermarked image (zoomed)

The figure 20 above shows the embedded bits of character ‘a’. The image is calibrated to find the encoded region. A single character ‘a’ is embedded in the image .The ASCII equivalent of ‘a’ is computed which is ‘97’ and is further converted into bit equivalent i.e. 01100001.These bits encoded in the image using two kinds of masks as shown in figures 20.

RESULTS


Cover image Single character encoded image

Image watermarked with 3 characters

Decoded information from scanned image

This Algorithm retrieves watermark from the scanned image .The basic idea of dithering is to reduce color range of image. The same concept is used in retrieving secret information .The embedded information can be decoded by dithering the scanned image to CMYK color set.

Printing and Scanning of Watermarked image

Calibration mark

Initially the watermarked image is calibrated with black mark near watermarked region, so that embedded information can be easily located .Here we used 4X8 block of black pixels that act as calibration mark .The watermarked image is printed at different resolutions and scanned at different dpi. The following decoding algorithm is applied on the scanned images to retrieve the secret information.

Algorithm

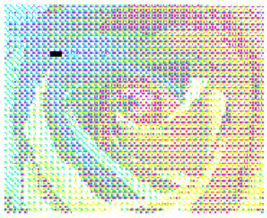
1. For every pixel in the scanned image compute mean square distance to each color in CMY color set.

2. Compute minimum distance of each pixel in the scanned image to the colors in CMYK color space.

3. The scanned image is dithered by replacing each pixel in the scanned image to closest color in the CMYK color set.

4. After mapping all colors to CMYK color space, the image is examined near the calibrated mark to find whether the embedded masks are retrieved.

Experimental Results



Watermarked image with calibrated mark

Mask -1 **Mask-2**

As shown in the figure above , Mask-1 is used to encode ‘0’ and mask-2 to encode ‘1’.Single character ‘a’ is encoded in the image ,its bits equivalent can be observed in the figure above.

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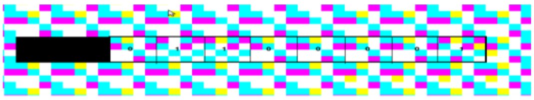
Step 1: Encoding the secret characters



Encoded bits (enlarged)

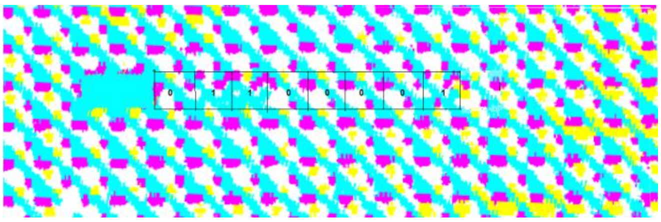
Step 2: Scanning the watermarked image

Scanned image at 600dpi

Step 3: The colors in the scanned image are mapped to colors in CMYK

Scanned image dithered to CMYK set

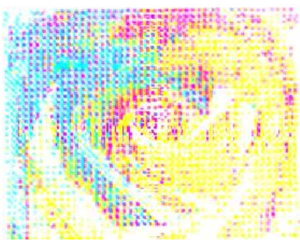
Step 4: Examine the region near calibration mark to decode secret bits



Retrieved watermark (decoded bits)

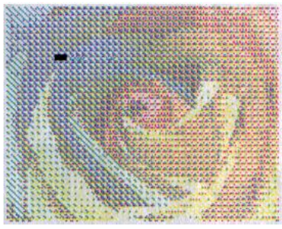
Image at 75 Dpi

Scanned image at 700 dpi



Dithered image

Image at 1200 Dpi



Scanned image at 1200 dpi

Dithered image

CONCLUSION

In this work, a new method was proposed for embedding secret information invisibly into an image printed on a page. the secret embedding is in the form of dither masks .The pattern of colors printed is unique to the mask and we showed that the pattern is recoverable if scanned at sufficiently high resolution .In our experiment we got the best results when the scanned resolution is more than four times the print resolution .This technique has the potential to greatly enhance our concept of secure documents.

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