



Web Based Novel Technique for Watermarking Colour Images on Android Mobile Phones

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Abstract— *In this paper, a real time, ubiquitous and novel technique for automatically watermarking the color images for android mobile phone is discussed and demonstrated. The captured images are watermarked before it can be saved on memory or sd-card of mobile phone. No processing power of mobile phone is required for embedding or extraction processes. Hence, the proposed method consumes very less battery power for the embedding and extracting processes. With the proposed method, various watermarking algorithms can also be implemented with ease.*

Keywords—*Android, Copyright Protection, Discrete Cosine Transform (DCT), Digital Watermarking, Discrete Wavelet Transform (DWT), YCbCr.*

I. Introduction

In the recent time, mobile phones with android OS (operating system) are very popular and market leader. Android operating system is full, open and free and various android based applications are easily available in market and on Web servers. Multimedia data such as videos, audio and images are shared among the users in the hostile environment of mobile communication. Third party application (also called as apps) for android phone are available which can publish the images captured by the integrated digital camera of the mobile phone to social networks, images hosting services and so on. Before these images can be published to public domain, it may be required to protect the ownership of the images. By embedding watermark on such images provides a viable and classical solution for copyright protection or protects the ownership of the image. But, digital watermarking algorithms for embedding and extracting the watermark are very computationally complex and power consuming [1]. Directly implementing such algorithms on the power limited mobile phone having limited processing speed is not a feasible solution. Takao Nakamura *et al.* [2] proposed a fast and robust watermarking detection scheme for mobile phones but the limitation of the scheme is that it can only embed 16-bit watermark and show good results with images having maximum resolution of 288*352. A watermarking algorithm for mobile phone color images using BCH code was also proposed by J. Jeedella *et al.* [3] at Khalifa University of Science, Technology & Research. This algorithm show good robust level with high PSNR (peak-signal-to-noise-ratio) of watermarked image. But, only cell-phone numbers can be embedded as the watermark because their method requires that the watermark should be in the form of numbers. Raffaele Pizzolante, *et al.* [4], designs an android application tool for copyright protection for images on mobile devices. But image as well as watermark should already be saved on the memory of mobile phone before embedding. So watermark cannot be embedded before it can be stored in the memory of the mobile phones. The proposed technique demonstrated in this paper implements a client-server, Internet oriented watermarking technique on digital color images. In this method, the real time pictures using mobile digital camera are captured and watermark is automatically embedded in captured image before storing to sd-card of mobile phone for data integrity, copyright protection and authentication. The proposed design give emphasis on not to use the battery power of the android phone for the embedding and extraction process and make both the processes independent of the processing speed of mobile phone. The size of designed application is only 64KB due to which it can be easily stored and time taken for embedding or extracting the watermark is less than 60sec. The paper is organized as follows: In Section 2 some background information related to digital watermarking and client-server communication for android platform are discussed. In section 3 design and implementation of the proposed technique is elaborated. The Results and Analysis has been given in section 4 and section 5 describes the conclusion and future work.

II. Background Information

A. DIGITAL WATERMARKING

Digital watermarking is a method in which a watermark is embedded into the digital contents like images, audios, videos etc. [5]. This watermark may be any type of image or data which can prove the ownership of the watermarked contents and may be visible or invisible. After embedding the resulted digital content is called as Watermarked image.

Watermarking is used for copyright protection, authentication and ownership identification [5]. Two types of digital watermarking approaches are: visible watermarking methods and invisible or imperceptible watermarking methods. An ideal watermarked image should look similar as original image as possible. Moreover, watermarking scheme used should be robust so that it can tackle or resist any distortion or attacks which can be introduced during unintentional or deliberately attacked to remove or alter the watermark present in the digital content [6]. Various algorithms are available for watermarking embedding and detecting the watermark in a given image. Following are the three categories in which watermarking schemes can be classified:-

- a) Watermarking in Spatial domain.
- b) Watermarking in Spectral domain.
- c) Watermarking in Hybrid domain.

Least Significant Bit (LSB) method is best known Watermarking scheme in Spatial Domain. Discrete-Cosine Transformation (DCT) and Discrete Wavelet Transformations (DWT) are best known algorithms used in Transform Domain for embedding and extracting the watermark. Both algorithms have their own merits and demerits. Watermarking in transform domain shows good robustness against the attacks [5]. Hybrid scheme used combination of one or two stated algorithms for watermark embedding and extracting the watermark. A robust watermarking scheme is computationally complex also, and requires more resources for embedding and extraction processes. Mobile phones having limited battery power and computational processing speed. So, such watermarking algorithms cannot be directly implemented on mobile phones.

The concept of digital watermarking on images for mobile phone is very less studied and less researched field. Even mobile applications for watermarking the images are available, but these applications require processing speed of phone for embedding the watermark, and consume more battery power. Even some applications consume less battery power, only very limited information in the image can be embedded as watermark [1]. Moreover, both the watermark as well as the images to be watermarked must be saved in the memory of mobile phone before embedding. Watermark is not embedded automatically in the captured image before it can be stored in sd-card or memory of the mobile phone.

B. ANDROID PLATFORM

Android is an open-source operating system developed by Google and the Open Handset Alliance. Android also comes with an extension library of useful functions, including image manipulation, functions for user interface and camera control. Various devices such as tablets, smartphone and TV setup boxes are available in the market having preinstalled android platform [7].

C. CLIENT-SERVER COMMUNICATION FOR ANDROID PLATFORM

Stanford University, Stanford, USA explains the concepts and implementation procedure for Client-Server Communication for android Platform for image processing [8]. Their tutorials explain that since many image processing algorithms are highly computationally complex and power consuming, e.g. different watermarking techniques, running these algorithms directly on mobile client with responsive interaction is not feasible. One solution of this problem is to offload the work to a high-performance server over the network. Fig. 1 shows such scheme [8]. Following are the steps involved for client-server communication for android mobile phone are as follows:-

1. Captures an image using an android mobile phone called as client.
2. Captured image is automatically uploaded to Matlab Server via Internet.
3. A PHP script on the server runs a Matlab script.
4. Server-side Matlab program does the desired watermarking process (embedding or extraction).

After the completion of the desired function, server returns the watermarked image to the mobile client automatically for display. If the visual quality of the watermarked image is as per user requirement, image is stored automatically on the memory of the smartphone from where it can be shared to public domain. Make sure that while running the application, Internet connection must be active on mobile [8]. At the receiving side, application for extracting the watermark from the image received can be run and authenticity of the image can be verified by following same procedure/steps as given above.

III. Implementation

Setup a web server with HTTP software and PHP installed. WAMP server which is available free in public domain and easy to install is used. After installing and testing it, make it online. Android applications for embedding and extracting are installed on the mobile phone using JAVA with android Plug-In [7]. An android mobile phone with android system v2.3.5 and having its own browser is used. When application for embedding process is running, a camera preview will be displayed. User takes the image snapshot by pressing the camera key. Captured image is automatically uploaded to server. A watermarked image is displayed on the mobile screen after few seconds. The resulted image is also saved in memory of the phone. Fig. 1 illustrates the steps involved in the proposed technique. The following two flow charts summarize the process involved in the embedding as well as extracting process. Fig.2 (a) explains the steps followed in the embedding process. Fig. 2 (b) shows the steps required for extracting the watermark at the receiver side.

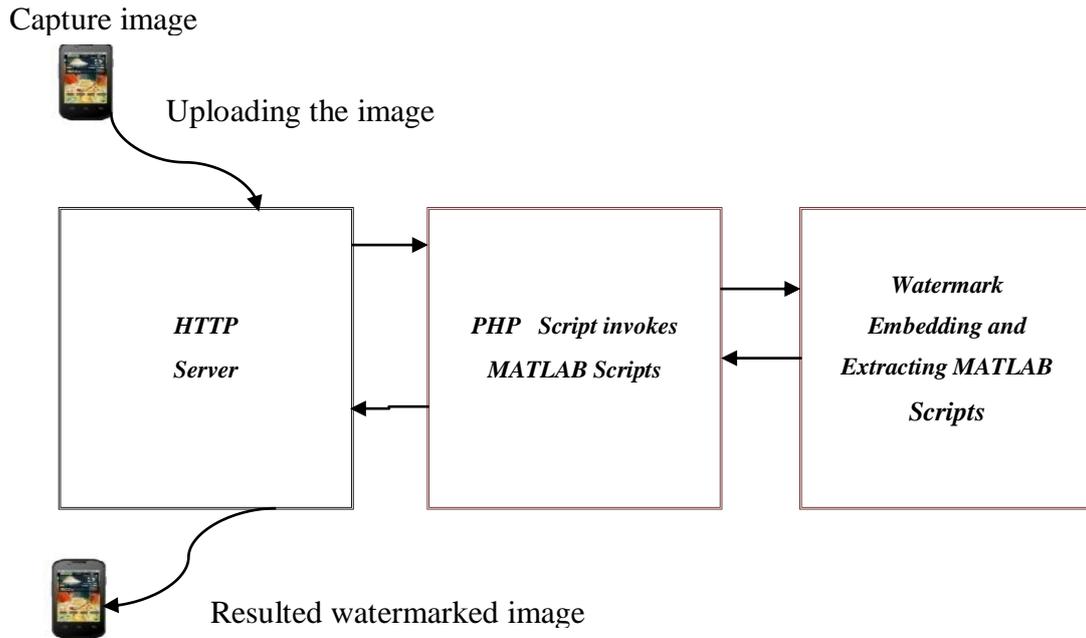


Fig. 1. Client-Server Image Processing System [7].

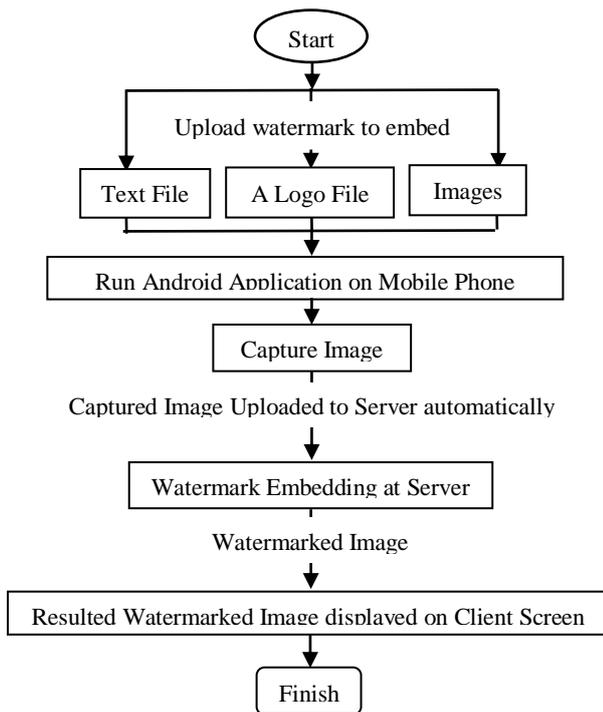


Fig. 2 (a) User Flow Chart for Watermark Embedding

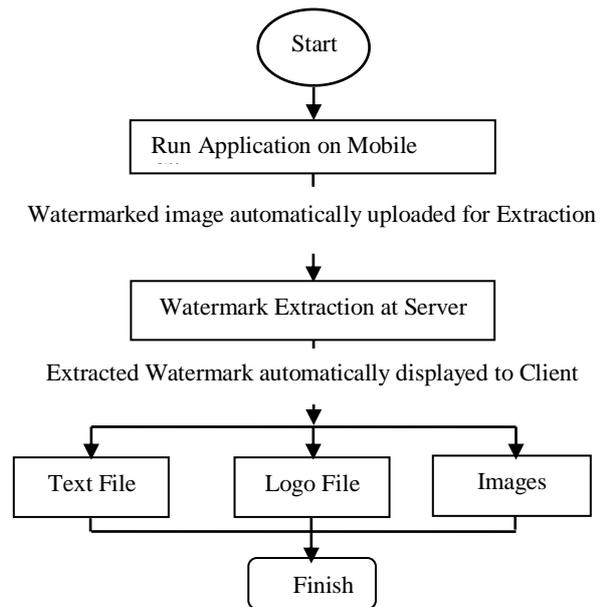


Fig. 2 (b) User Flow Chart for Watermark Extraction

Once the setup is configured and ready, Matlab code for different types of watermarking algorithm can be written on the server and can be tested. In this paper, results for both the watermarking techniques i.e. visible as well as imperceptible have been implemented. As discussed in section II, watermarking in transform domain is more robust than in spatial domain, watermarking algorithms for DCT and DWT are implemented. For this paper, results only for non-blind watermarking algorithms are shown where original image is required for extraction process.

A. Algorithm for visible watermarking

A.1 DCT Algorithm

The steps for watermark insertion are discussed below [9]:

- The original color image I (to be watermarked) and the watermark image W are reading. (Both the images may be not of equal size).
- Resize watermark image if necessary to make it equal to the size of host image.
- The DCT coefficients for both host image and watermark image to be found out.
- Define value of embedding factor (α) suitable for visible watermarking.
- The DCT coefficient of the host image and watermark image is modified using the following equation. The IDCT of modified coefficients give the watermarked image.

$$I_{wi,j} = I_{ij} + \alpha w_{ij}, i, j = 1, \dots, n \quad (1)$$

To extract the watermark applying the following equation:

$$w_{ij} = (I_{wi,j} - I_{ij})/\alpha \quad (2)$$

Where $I_{wi,j}$ = Watermarked Image.

I_{ij} = Original Image.

w_{ij} = Watermark Image

A.2 DWT Algorithm

The steps for watermark embedding are discussed below [9]:

- Read cover image, watermark image.
- Obtain the Two levels DWT decomposition of the cover image I.
- Define value of embedding factor (α) suitable for visible watermarking.
- Modify the DWT coefficients in the LL band:

$$LL_{wi,j} = LL_{ij} + \alpha_k w_{ij}, i, j = 1, \dots, n \quad (3)$$

- Apply inverse DWT to obtain the watermarked cover Image, I_w .

To extract the watermark applying the following equation:

$$w_{ij} = (LL_{wi,j} - LL_{ij})/\alpha \quad (4)$$

Where $LL_{wi,j}$ = Low frequency component of watermarked image.

LL_{ij} = Low frequency component of original image.

w_{ij} = Watermark Image.

B. Algorithm for invisible watermarking

Same steps as given in section A.1 and A.2 are being followed. Only the value of embedding factor (α) is defined to make the water mark invisible. Also, before calculating the DCT coefficients and 2- level DWT coefficients, original color image is converted from RGB color domain to YCbCr domain and watermark is added in Y component of the original image. Watermarked image is again converted to RGB color domain before it can be displayed on the user mobile phone screen.

IV. Results and Analysis

Results for visible watermarking schemes are shown first. Fig. 3(a) and Fig. 4(a) show the watermarked images using DCT and 2-level DWT with watermark is visible. Fig. 3(b) and Fig. 4(b) show the extracted watermark as it is seen on the mobile phone screen. The watermark can be a gray or binary image. Fig. 5(a) and Fig. 6(a) shows the results for imperceptible watermarked images using DCT watermarking scheme and DWT respectively. Fig. 5(b) and Fig. 6(b), shows the respective extracted watermark.

PSNR value is also calculated for the watermarked image. PSNR value calculated for visible watermarking schemes lies between 25 to 35 dB. The PSNR value calculated for invisible watermarking scheme calculated is between 30 to 45 dB when calculated for different images which is fairly good for wireless medium. Table. I give the PSNR value calculated for the given images in dB.



Fig. 3(a) Visible Watermarked Image using DCT as

Fig. 3(b) Extracted watermark as displayed on mobile screen.

displayed on mobile phone screen.



Fig. 4(a) Invisible Watermarked Image using DCT as displayed on mobile phone screen.

Fig. 4(b) Extracted watermark as displayed on mobile screen.

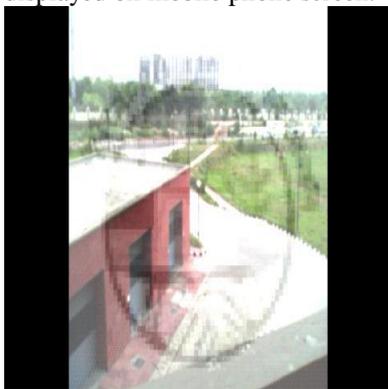


Fig. 5(a) Visible Watermarked Image using DWT as displayed on mobile phone screen.

Fig. 5(b) Extracted watermark as displayed on mobile screen.

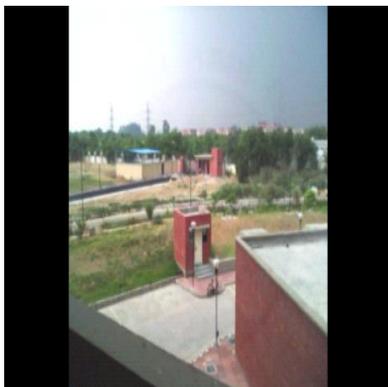


Fig. 6(a) Visible Watermarked Image using DWT as displayed on mobile phone screen.

Fig. 6(b) Extracted watermark as displayed on mobile screen.

Table. I: PSNR Value of watermarked Images.

Sr. No.	Watermarked Image	PSNR value in dB
1	Fig. 3(a)	24.6
2	Fig. 4(a)	31.4
3	Fig. 5(a)	25.1
4	Fig. 6(a)	32.8

IV.1 Time Evaluation Analysis for Embedding and Extraction processes

Once the system becomes stable, the time required for watermark embedding process ranges from 30 to 40 seconds i.e. from uploading the image to the server till the watermarked image is displayed on the mobile phone. For the extraction process, elapsed time ranges from 20 to 30 seconds till the extracted watermark is displayed on the mobile phone screen. Both time estimates are calculated through stop-watch analysis and on 2G mobile network.

V. Conclusion and Future Work

In this paper, we have demonstrated and discussed a novel and real time web based technique for watermarking the color images automatically, for android mobile phones for copyright protection and authentication without using the processing power of smartphone. We have also provided the results for the same. A comprehensive testing has been done to evaluate quality and time elapsed for the result. As shown the quality of the resulted watermarked image is having an excellent visual quality, the time for embedding and extracting the watermark is having a fair balance with the complexity of the used watermarking algorithm, the PSNR value of watermarked images are also good. For future works, others watermark algorithms for embedding are to be studied and robustness analysis for the same to be done. Due to limitation of time constraint, we are not able to do optimization of the JAVA code and Matlab code .In future; we may do the implementation of proposed method for blind watermarking schemes.

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