Chapter 7
Conclusions and Suggestions for Future Works

7.1 Conclusions

In this study, hierarchical online image authentication centers with multi-capabilities have been proposed for copyright protection of images of various formats. A system of image authentication organization has been proposed, which includes a single central image authentication center with four functions and multiple local image authentication centers with four functions each. The four functions of the central and local image authentication centers are not exactly the same. Online search, watermark verification, and fast watermark verification are the same functions in all centers, but the online authentication function is only implemented at the central image authentication center, and the lossless watermarking technique is only implemented at local image authentication centers.

First, the method for online search and verification of watermarked images for copyright infringement detection has been proposed. A method using a depth first search algorithm to detect images in webpages and a method using a breadth first search algorithm to detect images in public FTP servers have been proposed. After downloading suspected images, we can verify watermarked images for copyright infringement protection by extracting all information embedded in the images.

Next, a method for online authentication with security protection of

authentication certificates has been proposed. When a local image authentication center finds copyright-infringed images, it can send the URLs of these images to the central image authentication center and requests the central center to issue certificates. As a consequence, the local image authentication center can file a lawsuit with certificates as proofs of the infringement when he/she requires. In addition, because of the significant importance of the certificate, we have proposed a method to detect certificate tampering by applying a famous hash function, the SHA-1.

Besides, a method for fast watermark verification by progressive image matching has been proposed. By such a kind of method, we can verify watermarked images more efficiently and faster. During the extraction process, the amount of extracted image blocks increase round-by-round. Within four rounds, more and more pixels of the suspected image are checked to decide whether the image is a copyright-infringed one. And image blocks are grouped by their positions in order to make the extracted watermark pixels look meaningful. That is, we can see an indistinct extracted watermark turning into a clearer extracted watermark.

Finally, a method for copyright protection of GIF images by a robust lossless visible watermarking technique has been proposed. Two color palettes are set up for embedding a given watermark. In the recovery process, two color palettes are also set up and they are exactly the same as the palettes set up in the embedding process because the changes in the embedding process do not influence the pixel values which are needed to set up the two color palettes. And we make the method robust against removal attacks by applying a watermarking key. If an illegal user tries to remove the embedded watermark without a right key, watermark-shaped noise will remain on the recovered image. Moreover, instead of using a transparent watermark, an opaque watermark is embedded into the cover image for better advertising effects and copyright declaration. To the best of our knowledge, there is no paper on lossless

visible watermarking of palette images so far.

7.2 Suggestions for Future Works

In this study, we have proposed a system of hierarchical online image authentication centers with multi-capabilities and some methods for copyright protection. However, some interesting topics are still worth further researches, which are listed as follows.

1. How to extend the proposed methods to other kinds of digital multimedia, such as video, audio, and other image formats?

2. How to authenticate other kinds of digital multimedia online?

3. How to search suspected images actively and not to result in heavy computing loading?

4. Hew to enhance the efficiency of watermark verification?

5. How to authenticate the integrity of a GIF image by lossless watermarking techniques?