



Chapter 2

Hierarchical Online Image Authentication Centers with Multi-Capabilities

2.1 Overview of Proposed Concepts

In Section 2.1.1, the principle of the proposed hierarchical online authentication centers is described. The functions of the central and the local image authentication centers are introduced in Section 2.1.2. And in Section 2.2, all functions in the proposed centers are described. Finally, in Section 2.3, some discussions and a summary are made.

2.1.1 Principle of Proposed Hierarchical Online Authentication Centers

The proposed authentication system adopts a two-level structure proposed by Cheng and Tsai [11], as shown in Figure 2.1. The upper-level is a trusted third party, called a central image authentication center and the lower-level could be composed of some kinds of organizations, such as museums, galleries, and so on.

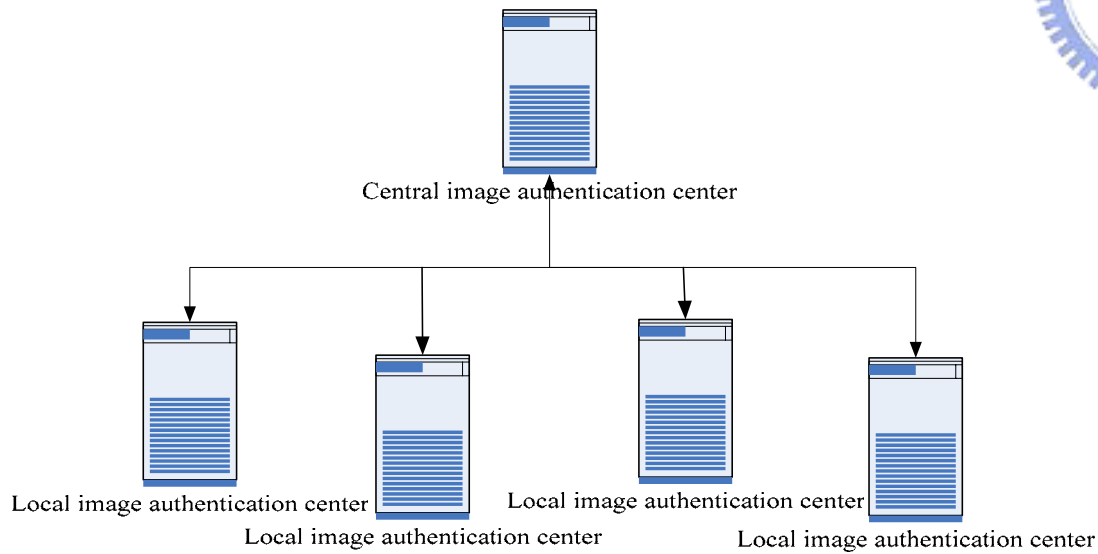


Figure 2.1 A hierarchical image authentication mechanism.

To our best of knowledge, there is yet no implemented system considering an online authentication mechanism. Traditionally, image owners go to an image authentication center to register their copyrighted images. And when infringement of copyright occurs, they must go to the image authentication center again to prove that they possess the copyrighted images and that someone has infringed the copyright of their images.

In the proposed hierarchical online authentication system, image owners also need to go to the central image authentication center to register their copyrighted images and pre-defined watermarks. But after the registration, image owners take on the role of local image authentication centers. Two of our developed software packages integrated with watermarking techniques for copyright protection of images can be provided to each local image authentication center. They can use a software package developed by Tsai and his students [1, 11], called InfoProtector, to embed their registered watermarks into registered images to protect the copyright of the images. And if they find that someone reposts the copyrighted images on the Internet without permission, they can verify the ownership of the images immediately by



using the other software package, which is developed in this study, and request the central image authentication center to issue a certificate to keep a record of the infringement. It is more efficient than the traditional way we just mentioned in the last paragraph because it is unnecessary to go to the authentication center in person now. And an illegal user will have no time to vanish the evidence.

2.1.2 Functions of Central and Local Authentication Centers

There are four functions at both the central image authentication center and the local image authentication center. While the first three functions at the central center, namely, (1) online search of suspected images, (2) verification of watermarked images, and (3) fast watermark verification by progressive image matching, are the same as those at the central and local center, their fourth function differs from each other. The function of authentication and issuing certificates is only implemented at the central image authentication center in order to maintain the fairness of a certificate. That is, certificates can only be issued by a trusted third party. And the function of lossless visible watermarking is implemented only at local image authentication centers for the reason that legal users can be directly authorized to use local centers' copyrighted images. All service functions in the proposed centers are shown as Figure 2.2. More detailed descriptions about service functions in the proposed centers will be given in the following section.

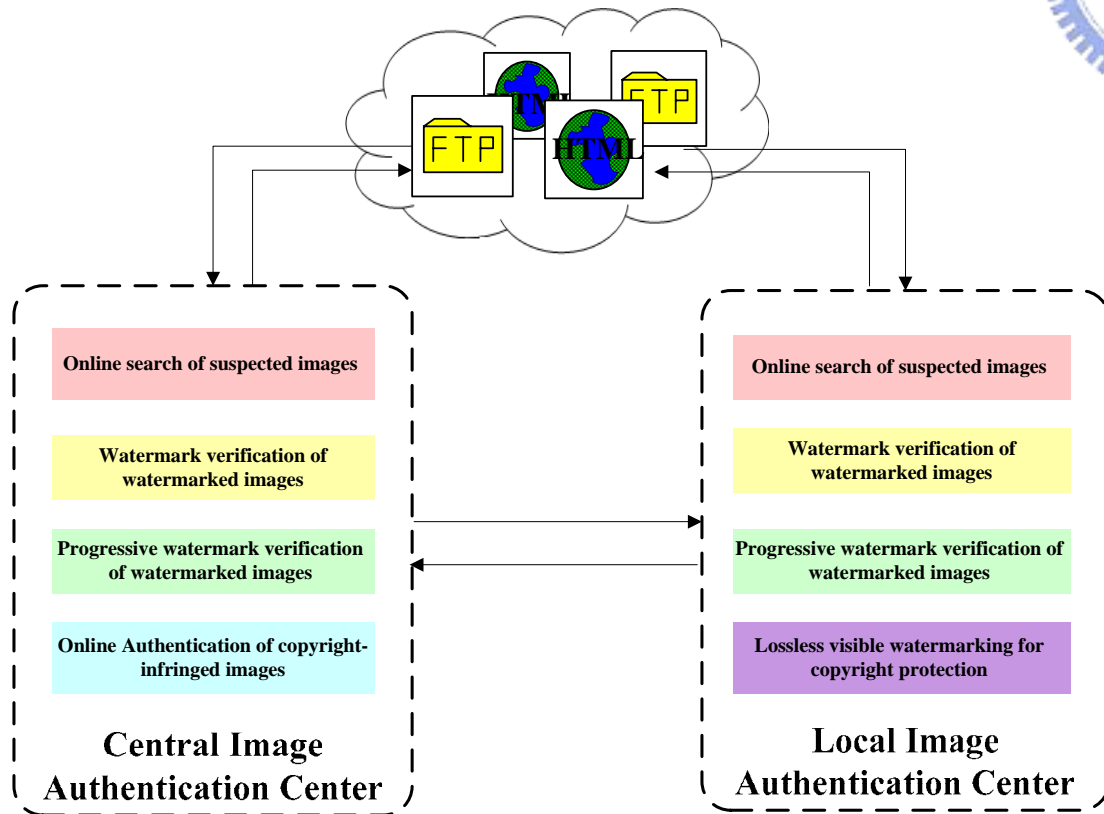


Figure 2.2 Service functions in proposed centers.

2.2 Functions in Proposed Centers

In Section 2.2.1, the functions of online search and verification of watermarked images for copyright infringement detection are briefly introduced. And online image authentication with security protection of authentication certificates is described in Section 2.2.2. The description of fast watermark verification by progressive image matching is briefly given in Section 2.2.3. Finally, the function of copyright protection of palette images by a lossless visible watermarking technique is described in Section 2.2.4.



2.2.1 Online Search and Verification of Watermarked Images for Copyright Infringement Detection

Online search and verification of watermarked images for copyright infringement detection are fundamental functions in the proposed centers. They are implemented at both central and local image authentication centers.

When a local image authentication center browses on the Internet, and finds that someone posts images belonging to him/her in webpages or in public FTP servers without permission. The local image authentication center can search and download the suspected images, including BMP, JPEG and GIF files, and then use adopted techniques to check whether the suspected images have been processed by the software package InfoProtector or not. If the answer is yes, then the local image authentication center extracts all information embedded in those images to check the owners of the suspected images. If the extracted watermark is the same as the local image authentication center's registered watermark, the infringement of copyright is confirmed. The local image authentication center can choose to request the central image authentication center to issue a certificate to keep a record of the infringement. We will describe more about the function of authentication in the next section. The central image authentication center can also search and verify the suspected images actively in order to carry out the protection for intellectual property rights.

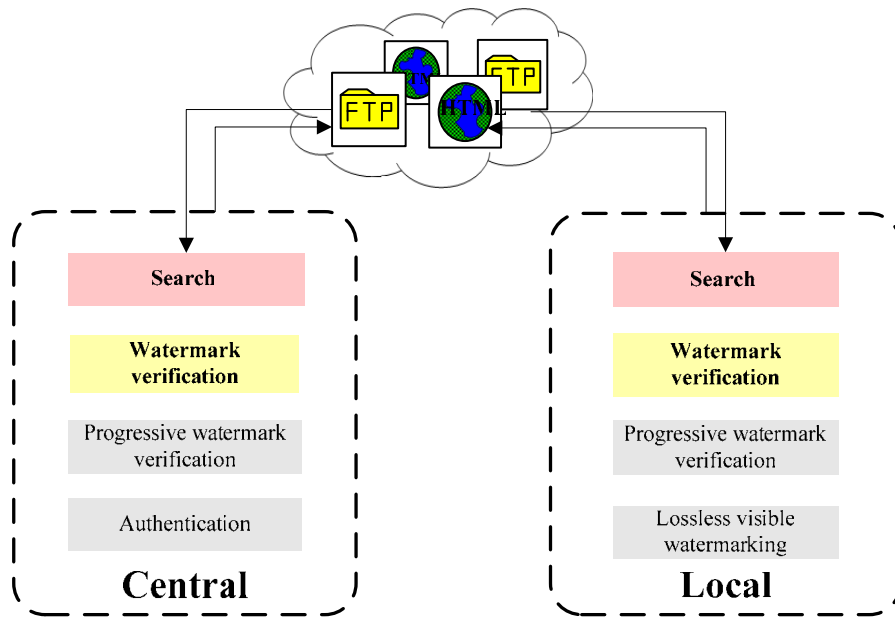
An advantage of implementing functions of online search and verification of watermarked images in both central and local image authentication centers is the enhancement of flexibility of the proposed system. A local image authentication



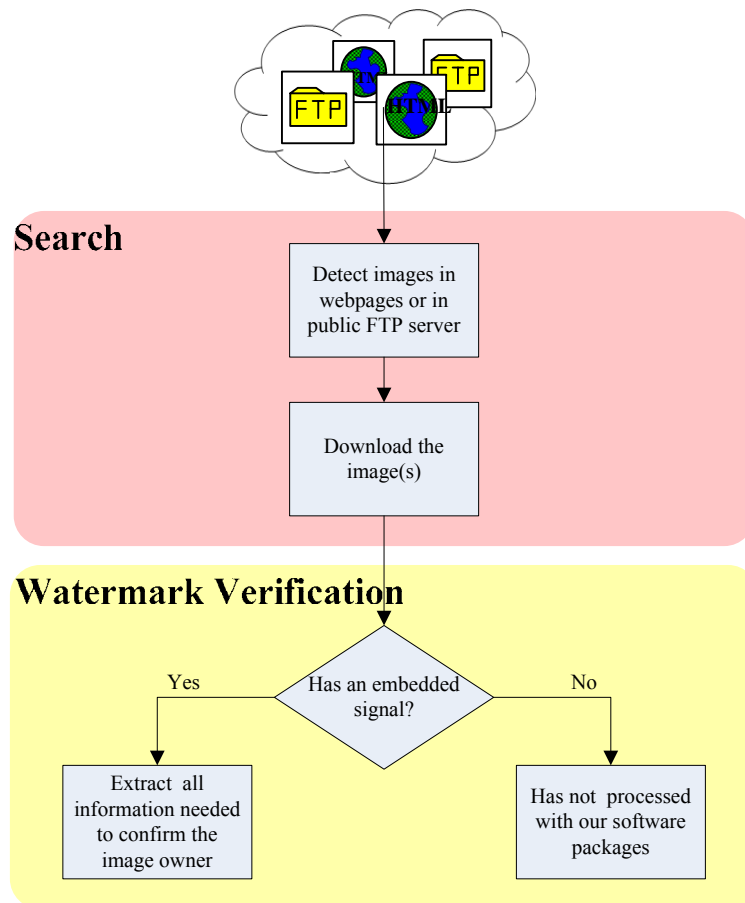
center can choose to request the central image authentication center for authenticating a suspected image, all images in a webpage, or all images in a public FTP server according to the balance of network loading and the computing power of the central image authentication center. When the network is heavily loaded or the central image authentication center is weak in computing, a local image authentication center can take over the functions of online search of suspected images and verification of watermarked images in advance, and the central image authentication center can just authenticate a suspected image.

On the contrary, if the network is slightly loaded and the central image authentication center is powerful in computing, the central image authentication center can authenticate all the images in a webpage or in a public FTP server. That is, the local image authentication center gives the URL of a webpage or that of a public FTP server to the central image authentication center, and the central center will search and download all the suspected images. After checking the owner of those suspected images, the central center will issue the certificate of each suspected image and send it back to the local image authentication center.

Functions used in the proposed method for online search and verification of watermarked images for copyright infringement detection are shown in Figure 2.3(a), and Figure 2.3(b) shows a flowchart of the proposed online search and verification method for watermarked images. More detailed descriptions will be given in the next chapter.



(a)



(b)

Figure 2.3 (a) Functions used in proposed method for online search and verification of watermarked images for copyright infringement detection. (b) A flowchart of proposed method for online search and verification of watermarked images.



2.2.2 Online Image Authentication with Security Protection of Authentication Certificates

For the fairness of issued certificates, we implement in this study the functions of authentication and certificate issuing which is conducted only in the central image authentication center. As mentioned in the previous section, it is possible for a suspected image or all suspected images in a webpage or all suspected images in a public FTP server to be authenticated by the central image authentication center. Which way should be done depends on the network loading and the computing power of the central image authentication center.

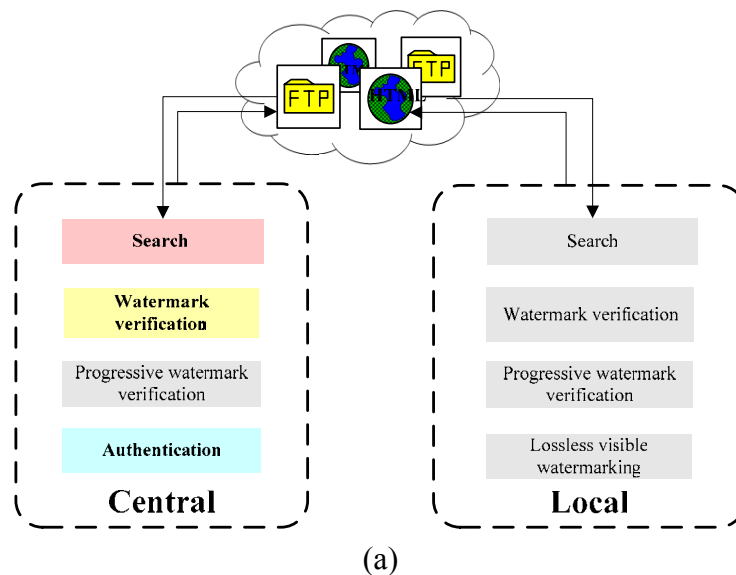
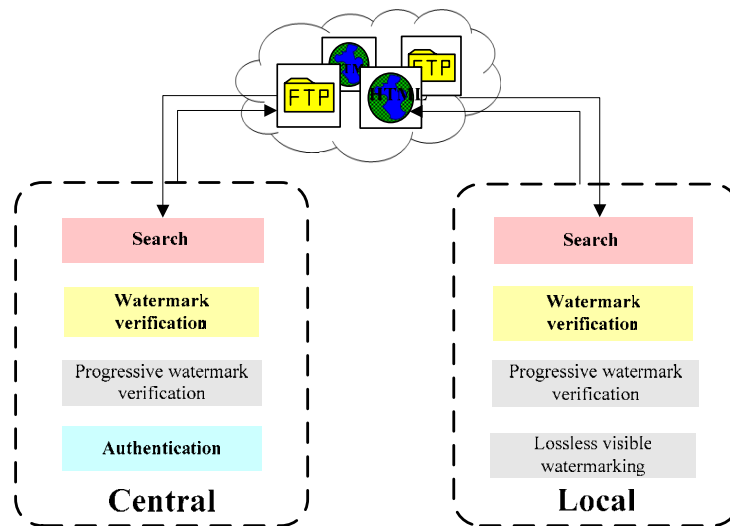
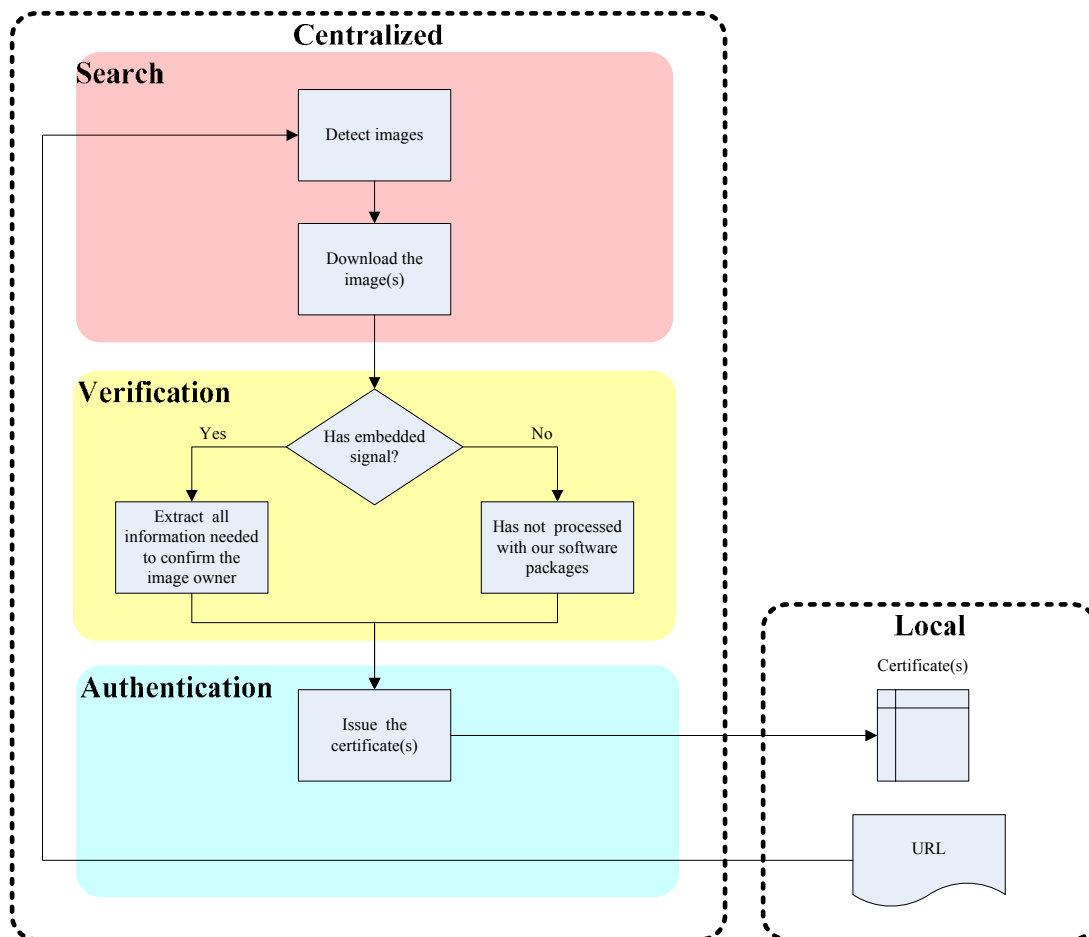


Figure 2.4 (a) Functions used in proposed method for online image authentication with a heavy loaded mode. (b) Functions used in proposed method for online image authentication with a slightly loaded mode. (c) A flowchart of proposed method for online image authentication.



(b)



(c)

Figure 2.4 (a) Functions used in proposed method for online image authentication with a heavy loaded mode. (b) Functions used in proposed method for online image authentication with a slightly loaded mode. (c) A flowchart of proposed method for online image authentication. (continued)



Figure 2.4(a) shows the functions used when a local image authentication center chooses to authenticate a suspected image due to the situation of encountering a heavily loaded network or weak computing power of the central image authentication center at that time. On the contrary, Figure 2.4(b) shows the functions used when a local image authentication center chooses to authenticate all suspected images in a webpage or in a public FTP server due to the case of having a slightly loaded network or strong computing power of the central image authentication center at that time. And Figure 2.4(c) shows a flowchart of the proposed method for online image authentication.

The issued certificate is the most important result of the proposed system, so the verification of integrity of issued certificates is a significant topic. We employ a famous hash algorithm for network security, called secure hash algorithm-1 to achieve this goal. More detailed descriptions will be given in Chapter 4.

2.2.3 Fast Watermark Verification by Progressive Image Matching

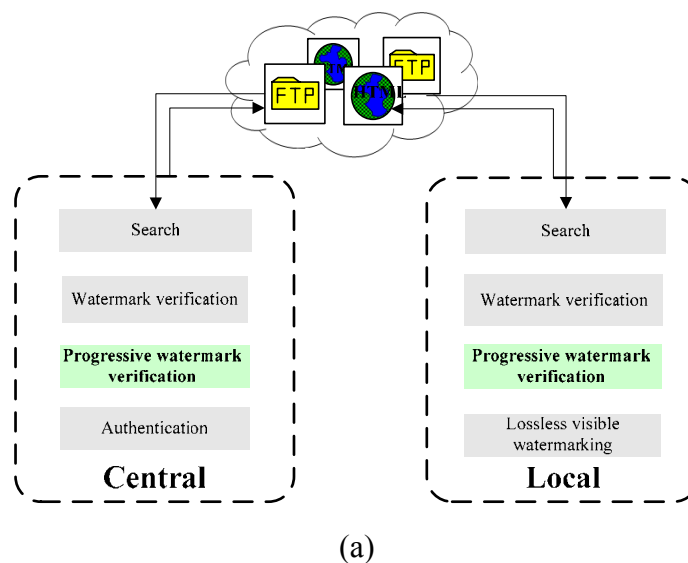
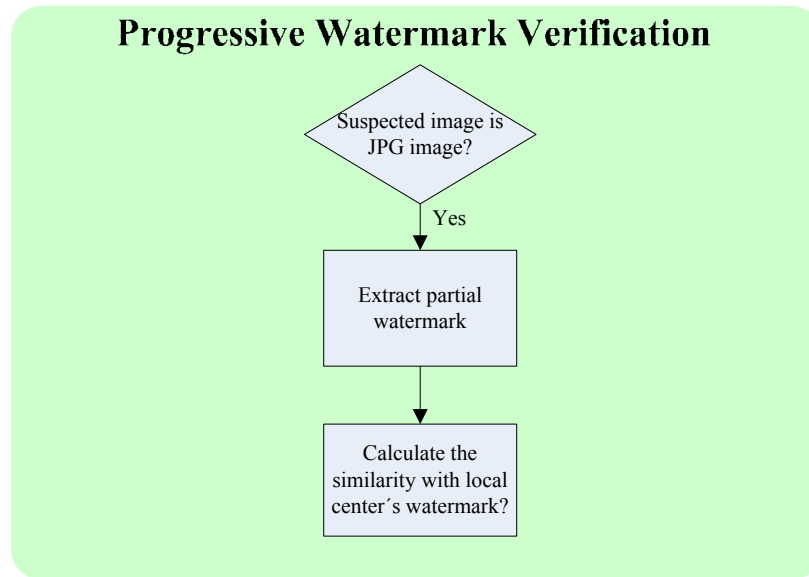


Figure 2.5 (a) Function used in proposed method for fast watermark verification by progressive image matching. (b) A flowchart of proposed method for fast watermark verification by progressive image matching.



(b)

Figure 2.5 (a) Function used in proposed method for fast watermark verification by progressive image matching. (b) A flowchart of proposed method for fast watermark verification by progressive image matching. (continued)

We implement the function of fast watermark verification by progressive image matching at both central and local image authentication centers. The function is faster than the traditional verification function mentioned previously. The functions used in this proposed method are shown in Figure 2.5(a).

It is not necessary to perform the watermark extraction process to an *entire* image under certain conditions. For example, we can reject the possibility of infringement of a suspected image immediately if a low similarity between partial pixels of the embedded watermark and the corresponding pixels of the declared image owner's watermark is found. Only when the similarity is high enough does it need to extract more image pixels to calculate a new similarity. It is more efficient to verify suspected images by this *progressive* way. A flowchart of the proposed method for fast watermark verification is shown in Figure 2.5(b). This method is only applicable to the JPEG image format. And more detailed descriptions will be given in Chapter 5.



2.2.4 Copyright Protection of Palette Images by A Robust Lossless Visible Watermarking Technique

The function of lossless visible watermarking is implemented only at local image authentication centers for the reason that legal users can be directly authorized to use local centers' copyrighted images.

The function of lossless visible watermarking provides local image authentication centers a tool for copyright protection. The embedded visible watermark has good advertising effects and copyright declaration while the property of "losslessness" saves local image authentication centers a lot of storage space by only preserving stego-images without saving original ones.

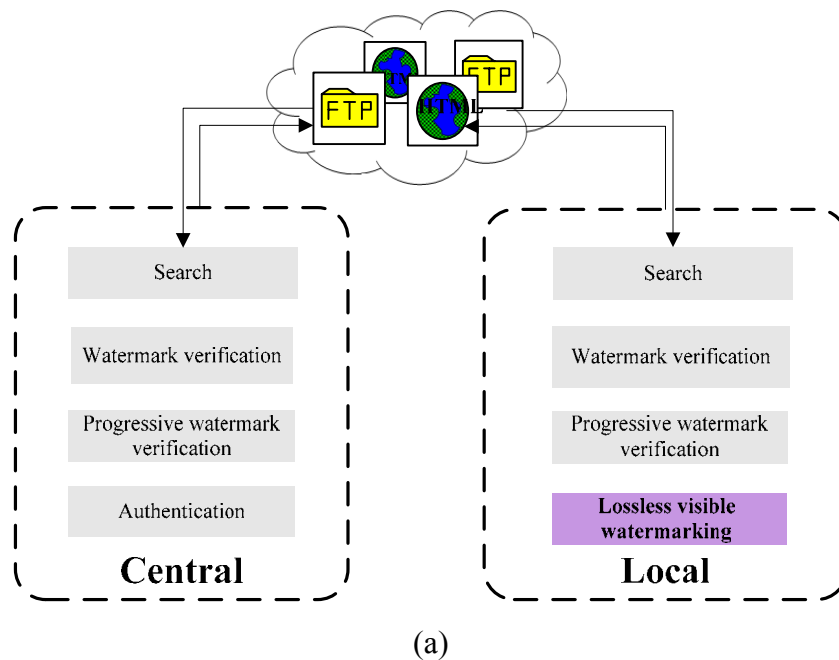


Figure 2.6 (a) Function used in proposed method for copyright protection by lossless visible watermarking. (b) A flowchart of proposed method for copyright protection by lossless visible watermarking.

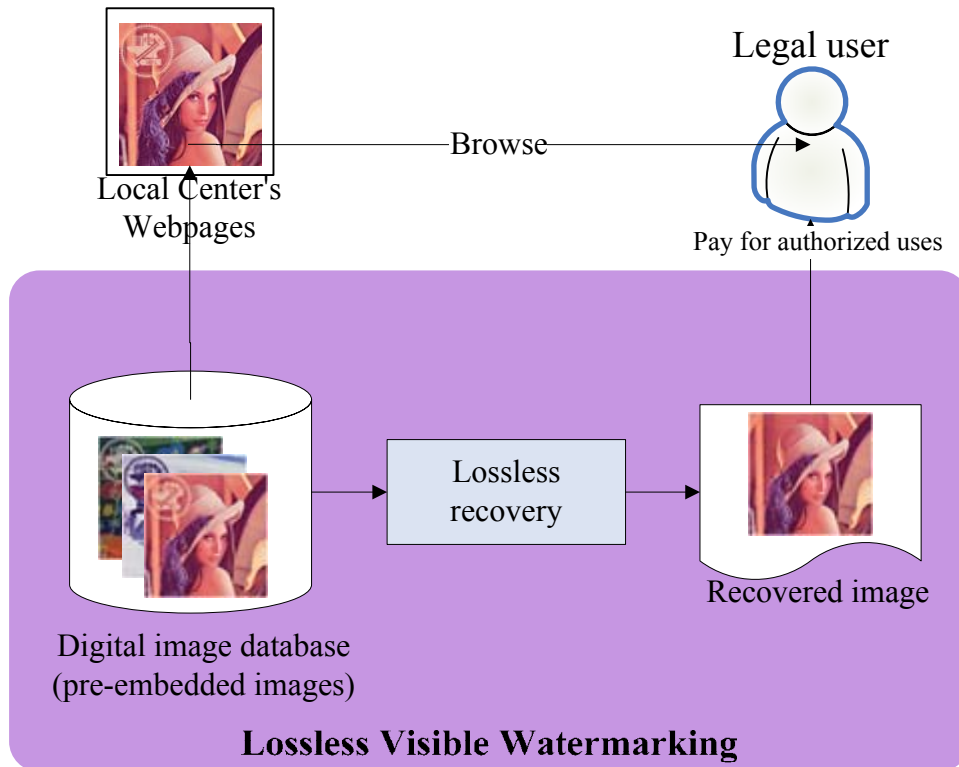


Figure 2.6 (a) Function used in proposed method for copyright protection by lossless visible watermarking. (b) A flowchart of proposed method for copyright protection by lossless visible watermarking. (continued)

Figure 2.6(a) shows the function used in the proposed method for copyright protection by lossless visible watermarking, and Figure 2.6(b) shows a flowchart of the proposed method. More detailed descriptions will be given in Chapter 6.

2.3 Discussions and Summary

In this chapter, a hierarchical online multi-functional image authentication system has been proposed. It is an innovative approach to implement such a kind of online image authentication system. As mentioned previously, there are a single central image authentication center and multiple local image authentication centers in



the proposed hierarchical system. And they all have four functions among five ones proposed in this study, namely, (1) online search of suspected images, (2) verification of watermarked images, (3) online authentication with certificate security protection, (4) fast watermark verification by progressive image matching, and (5) the function of lossless visible watermarking. The central image authentication center has four functions, which include the first four, while local image authentication centers have four functions, which include the first three and the fifth one.

As a matter of fact, besides a single central image authentication center and multiple local image authentication centers, we can recognize general people as the third level in the proposed hierarchical system. A person can request the central image authentication center for a simplified software package by e-mail. The simplified software package contains only two functions, which include online search of suspected images and verification of watermarked images for copyright infringement detection. People can check the validity of an image by our simplified software package for fear of misusing of copyrighted images.