Chapter 6
Conclusions and Suggestions for Future Works

6.1 Conclusions

In this study, we have proposed methods for art image creation and data hiding. These two topics are integrated into one which is then solved by a single approach in the proposed methods. Therefore, users can easily and simultaneously generate art images and embed data in them. The embedded data may be a secret image, a watermark, or authentication signals. By embedding the data we mentioned before, users can achieve the purpose of covert communication, copyright protection, and image authentication, respectively or integrally. Different from traditional image data hiding techniques, we hide data in the individual features of art images.

In this study, we investigated three different types of art images. They are puzzle image, pointillistic image, and circular-dotted image.

For puzzle images, we implemented the concept of information sharing by separating a puzzle image into a number of puzzle pieces, and randomly divide them into several groups. The number of the groups is equal to the number of the information sharing participants, and each participant can get one group of the puzzle pieces. Naturally, we have proposed a method that can recover the puzzle image automatically when all of the participants return their own groups of digital puzzle pieces. We found three different types of puzzle piece features into which data can be embedded, namely, puzzle piece orientation, puzzle piece size, and puzzle piece angle. We embed a secret image, a watermark, and authentication signals into these features,

respectively. In the proposed system, we can sequentially embed data into the three features as needed.

A pointillistic image is an image created by imitating the style of the pointillistic painter via a computer. In pointillistic images, we use only one feature for data hiding, that is, the RGB values of each color dot of a digital pointillistic image. However, we can combine two kinds of data by appending an ending pattern between them. Therefore, a secret message and a watermark can be embedded at a time. All of the colors in a pointillistic image are chosen from a color table, which is established by the program. By changing the RGB value of the center of each color dot, we can achieve the purpose of data hiding.

In circular-dotted images, we used only one feature for data hiding, namely, the drawing order of the circular dots on a digital circular-dotted image. Similar to the data hiding process in digital pointillistic images, we also append an ending pattern to combine two kinds of data, so that a secret message and a watermark can be embedded at a time. By applying the dot overlapping scheme to control the drawing order of circular dots, we can achieve the purpose of data hiding.

According to our research, we can make a conclusion that if there is an image feature of an art image which can be modified and detected, there will be a corresponding data hiding technique. And the three applications of data hiding, copyright protection, covert communication, and image authentication, can thus be achieved.

6.2 Suggestions for Future Works

In this study, we have proposed some methods for creation of puzzle images, pointillistic images, and circular-dotted images, as well as data hiding techniques for these three types of art images. The three applications of secret communication, copyright protection, and image authentication are also carried out by utilizing the proposed data hiding techniques. However, there are still some interesting topics which are worth further studies.

For puzzle images:

1. Using more puzzle piece features for embedding more data into digital puzzle images.
2. Enhancing the performance speed of the puzzle image reconstruction process. For example, we can utilize a content matching scheme while performing the reconstruction process.
3. Create different shapes of puzzle pieces. For example, create honey-comb shaped puzzle pieces.

For pointillistic images:

1. Refining the pointillistic image creation skill to make the created pointillistic image more like a real painting drawn from a pointillistic painter.

For circular-dotted images:

1. Adding visual effects, such as burnish, texture, etc. onto each circular dot regions to make the circular-dotted image look more appealing. By burnishing each circular dot, the circular-dotted image may look like a stained glass image.

2. Using more features such as the texture of the circular dots for embedding more data into circular-dotted images.

For all art images:

1. Extending the proposed methods to survive print-and-scan attacks.
2. Investigating other types of art image creation methods and searching for the specific image features for data hiding.

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