# CHAPTER V
# CONCLUSIONS AND SUGGESSION

## 5.1 Conclusions

The Spiral Error Diffusion technique can be used effectively as an algorithm for creating hybrid screen. The continuity of the AM and FM boundary can be obtained for the whole tonal range of tone reproduction.

To enable the algorithm to produce enough tones for the continuity of human perception, the parameters used for the hybrid screen should have the dpi/lpi ratio more than 12.

The cutoff used to quantify the amount of the FM screen in an image should have the code value in the range of 180-220, depending on the characteristic of an image and the user's requirement.

If the cut off is too low, the discontinuity at the boundary will be visually detected easier than that with a high code value. Furthermore, the cut off with low code value tends to be more influenced by dot gain. In the mixture area, an appropriate mixing bandwidth should be around 10-30. If the bandwidth is too small, the discontinuity caused by the difference in screen sizes will take place.

About the effective gamut, it is found that the gamut of the third step algorithm increases dramatically from the second step. It is able to vary the parameters in order to make the compatibility with the pointing system.

In order to response to the sharpness of the image, the total number of pixels in one FM dot should not be more than 25. If too many pixels are used, the image tone tends to disperse equally throughout the cell, which is not response to the fine detail of the original image.



## 5.2 Suggestion

In the printing tests using different conventional printing processes, it is found that the effective gamut of the algorithm is not wide enough for realistic use and the presence of dot gain has a significant effect on continuity. Furthermore, the loss of detail in the shadow area; which is similar to those happen in the highlight, could lead

to the possibility of using FM screen in the area to produce the better detail in shadow.

To improve the algorithm and enable it to produce the hybrid halftone for any printing process with the finest quality, the followings should be done.

### *5.2.1 Expanding the effective gamut area*

From the previous research, it is found that the effective gamut of the algorithm could be expand in the second step by grouping the FM pixels. In the 3rd step, the error would diffuse to every edges of the cell. Such diffusion made the error not thoroughly diffuse through out the image like the way the FM screen does.

The solution of this problem is to make the error of the cell transferable to another cell or to use the FM algorithm based on line-scan, instead of the sub-image. However, the compatibility between both AM and FM algorithms should be carefully concerned because it should lead to the ability to produce a homogeneous band mixed with both AM and FM screens.

### *5.2.2 Discontinuity caused by Dot gain*

One of the reasons for the discontinuity at the AM and FM boundary is that those screens have different sensitivity levels of dot gain. The AM screen is less influenced by the effect of dot gain than the FM. as mentioned in 2.1.2. As a result, an image using a combination of both screens would show a discontinuity at the boundary

The solution of this problem could be done by reducing the effect of dot gain by applying the dot gain compensating curve with the original before making halftone. Before inputting the compensating values, the right compensation could help the system produce an image with a good tone reproduction similar to the original. To compensate the influence of dot gain, two types of algorithms can be used.

#### 5.2.2.1 Tone Reproduction Curve Compensation

This method has been widely used in the industry. This kind of compensation is the algorithm that: The tone reproduction has to be measured through out the whole

tonal range from 0-100%. Then, a graph is plotted to find the values for the compensation.

Due to the need of measurements of dot gain in every time that the parameter used to control the screen mixing ratio is changed. This method has found unsuitable to use it for hybrid screen.

5.2.2.2 Dot size Compensation

Regarding AM screen, this method could give the same result as those the received from tone reproduction curve compensation because tones of this kind of screen are directly depend on the dot size. On the other hand, the tones produced Using by FM screen depend on the number of the screen dots.

As a result, the compensation has to deal with the number of the screen dots, which can be considered not so suitable because the dot gain is the dimensional changing, not the number of dot. Furthermore, a unique parameter is used to compensate the size of the FM screen dots though out the image because all the FM dots in the image are equal in size.

Measuring the smallest screen dots used in the test chart designed to measure the dot gain can specify the characteristic of the system.

### *5.2.3 The Addition of FM screen in the shadow area*

In conventional printing, the application of FM screen in the highlight area could give a better image detail than that produced by AM screen. Similarly, the loss of an image detail in the shadow area could also be reduced by the use of the FM screen. However, there is a different between the algorithms for the FM screens used in the different areas of the image.

As mentioned in 3.4, the algorithms used for the highlight FM represents tones by using dispersed black dots on a white background, while dispersed white dot on a black background are used to represent the tone for the shadow FM. The latter kind of representation is used to make both the hole shape and hole size controllable which is an important factor for producing tones in the shadow while using the algorithm used for the highlight FM in the shadow, the size of the white hole in the shadow can not be control.

For this algorithm, with the FM added in the shadow of an image, the image has to divide into three parts, which are the FM area in the highlight, the AM area in the middle tone, and the FM area in the shadow. The threshold matrix has to be improved.

For this algorithm, the part for measuring the characteristic of the system must be included because the suitable hole size and the dot gain occurred in the shadow are somewhat different among the printing processes. As a result, the compensation has to be different. Because the suitable hole sizes can be varied among the printing process and the dot gain occurred in the shadow is somewhat different from one occurred in the highlight.

### *5.2.4 Further Development in Digital Workflow*

The Digital workflow mentioned in 3.2 has complicated working steps since there is a relationship between the halftoning process and the image manipulation in order to make a halftone image compatible with each output device. Furthermore, the controlling of the output device to create halftone has to be done through the application software or the output device's RIP. In this research, the program cannot control the output device directly. Thus, the best halftone image of it's potential still could not be made. All these problems can be solved by developing a hybrid screen program into a software RIP with it's own module in image manipulation and device controlling.