Research of Reproduction Characteristic Based on FM Screening Map Printing

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Abstract Nowadays, AM screening is widely used to process manuscripts in map printing. Its reproduction characteristic and the printing technology are relatively ripe. However, AM screening map printing has some flaws like line sawtooth, moiré, undesirable gradation, etc. To some extent, FM screening can solve these problems. But up till now, the research of its reproduction characteristic and principle have been limited within qualitative analysis while there is no quantitative research. Therefore, it can not be applied in production. In this study, take FM screening as the research object, the reproduction characteristic and principle of FM screening map printing were rcsearched using the methods of plate making, plate linearization, map printing and dot gain compensation, etc. It will be of practical significance.

Key words FM screening; Map printing; Reproduction characteristic; Plate linearization; Dot gain compensation

调频加网地图印刷阶调复制特性研究

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摘要 目前地图印刷广泛采用调幅加网对原稿进行处理，其阶调复制特性和印刷技术已非常成熟。但由于调幅加网存在一定的缺陷，印制的地图存在诸如线条锯齿感、龟纹、阶调层次表现不佳等问题。调频加网能在一定程度上解决这些问题，但其用于地图印刷时的阶调复制特性和规律，目前只有定性分析，没有定量研究，还不能广泛应用于生产实践。本研究在实验基础上，以调频加网为研究对象，通过制版、印版线性化、印刷成图、网点增大补偿等手段，探索了调频加网地图印刷的阶调复制特性和规律，具有一定的实践指导意义。

关键词 调频加网；地图印刷；阶调复制特性；印版线性化；网点增大补偿
中图分类号 TS810.4 **文献标识码** A **文章编号** 1674－5752(2013)02－35－06

0 Introduction

Nowadays, AM screening is widely used to process manuscripts in map printing. Maps can be grouped into two types according to their formats. They are line graphics and image maps. The linear features of line graphic are generally printed by using spot color while image map printing is similar to common image printing. With the maturity of four－color printing condition, map printing using AM screening still cannot avoid some flaws such as line sawtooth, low color expressive force, moiré, etc. FM screening can solve these problems to some extent, but its application in map printing still settled on the experimental stage, which has not been studied quantitatively or used widely in production. The reproduction characteristics of FM screening map printing are

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not clear. In this study, the experiment was used to research the reproduction characteristic and principle of four – color FM screening map printing[1].

1 Research on CTP Plate Linearization and Dot Gain Compensation Method

Plate linearization is defined as the process of correcting plate dot area percentage into manuscript value or being proportional to manuscript value, which can be realized by using transform function in PS language or transfer function. Linearization should be completed before RIP process. When applying CTP to make plate, the densimeter was used to measure the value of density and dot area percentage. Then prepress software was used to adjust the linearization curves. Finally, the adjusted linearization curves under the current printing conditions were saved[2].

The essence of dot gain compensation on the stage of printing export is reversely calculating the compensated dot area percentages corresponding to manuscript value by using dot gain curves of printing sample and printing machine, which is based on the principle of inverse function. The compensation methods of line graphics and image maps are different. Line graphics are not continuous images, which needs compensating linear features and areal features' filling area separately, while image maps can be compensated by using compensation curves directly. Dot gain compensation curves are got by curve fitting method, in which process the output values are dot area percentage of manuscript values, the input values are compensated dot area percentage values[3]. The principle was shown in Fig. 1.

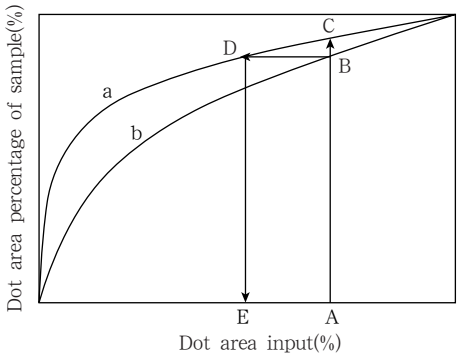

Fig. 1 Fitting method of dot gain compensation curve
图 1 网点增大补偿曲线拟合方法

In theory, the more key dots are chosen, the more precise the fitted curve will be, which can ultimately reflect the dot gain principle. In addition, the degree of curve function should be considered according to the real situation. Usually, quadratic function or cubic function can be used. Curve function with too high degree will not improve the effect of dot gain compensation but on the contrary increase the difficulty of calculating.

2 Experiment on Reproduction Characteristic of FM Screening Map Printing

2.1 Experiment Principle

The aim of the experiment was to find out the plate linearization method and dot gain compensation curve which adapt to the current printing condition. Firstly, experiment manuscript was made after choosing experiment objects and designing color scales. Secondly, a suitable FM screening method was chosen to screen the objects. Meanwhile, a group of objects with AM screening were set as control group. Then the color scales were screened by using the same FM screening method. Finally, plates were made by CTP and linearized. After printing samples, dot area percentages were measured and dot gain compensation curves were calculated[4-5].

2.2 Experiment Condition and Process

Process of the experiment was shown in Fig. 2.

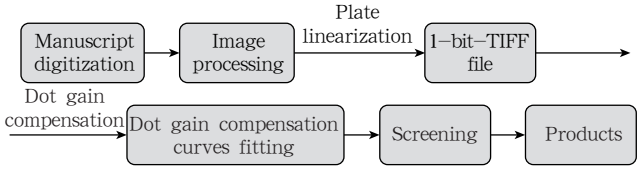

Fig. 2 FM plate linearization and dot gain compensation experiment
图 2 FM 印版线性化和网点增大补偿实验

Digital screening was aimed to processing pixels. In the experiment, manuscript which was to be screened was digitalized and dealt with by using image processing method. Then plate was made and linearized to get the adjusted 1 – bit – TIFF file. This file was used to initially print samples, and then data were measured to fit the dot gain compensation

curves. Finally, the manuscript was compensated and the plate was produced, which was adapted to the current printing condition. This plate can be used in production[6-7].

2.3 FM Screening Plate Linearization

Manuscript and plate preparation:

1) Designing and making manuscript which was shown in Fig. 3. The left side of the plate was the objects of line graphics and image maps. From the top to the bottom, it was the halftone images which were respectively processed with AM screening, 10μm dot FM screening, 20μm dot FM screening and 30μm dot FM screening. Especially, AM was 133lpi round dot screening.

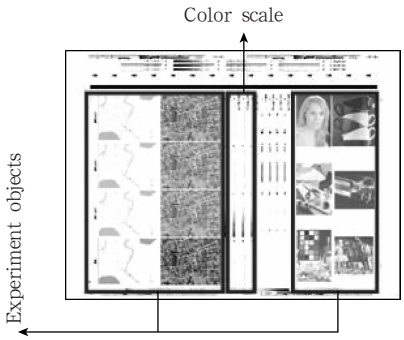

Fig. 3 Manuscript of FM plate linearization and dot gain compensation (Cyan plate)
图 3 调频加网印版线性化及网点增大补偿原稿(青版)

2) Designing and making color scales. CMYK four-color scales were made, in which dot area percentages were 1%, 2%, 3%, 4%, 5%, 7%, 10%, 15%, 20%, 25%, 30%, 40%, 50%, 60%, 70%, 75%, 80%, 85%, 90%, 95%, 100%. As Fig. 4 shown, color scales were screened in the same way as the experiment objects.

Fig. 4 Color scale of CMYK plates
图 4 CMYK 四色版色梯尺

3) Images for testing. The right side of the plate was the images which were used to test the effect of plate linearization and dot gain compensation. They were screened in the same way as the objects.

4) Plate making and linearization. 2400dpi laser typesetter was used to screen the manuscript. The treatment time was 25s. Fixed proportioning developing solution was used to process the plate. The temperature was 23℃ and the humidity was 58%.

As Fig. 5 shown, the key dots of 21 color scale were used to adjust the linearization curves. In the Fig. 5a – Fig. 5d were linearization curves for yellow, magenta, cyan and black plates respectively. After the linearization, the dot area percentages were the same as or proportional to the dot area percentages of the manuscript.

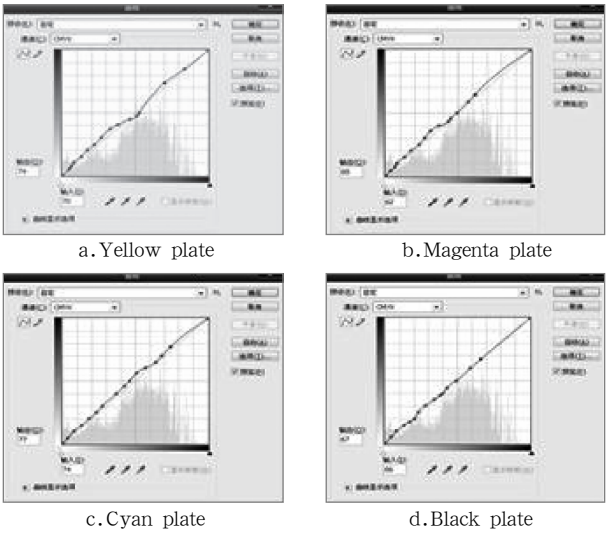

Fig. 5 Linearization curves setting of CMYK plates
图 5 CMYK 四色版线性化曲线设定

2.4 Fitting of FM Screening Dot Gain Compensation Curves

Dot gain is relatively severe in the process from the plate to the printing sample. Therefore, under the condition of plate linearization, artificial plate compensation is needed, which should make the output dot area percentages equal to the designed values or controlled within the range of error allowed. In this experiment, 10μm dot FM screening was set for example to illustrate the process of dot gain compensation and curves fitting[8].

1) Sample printing. Plates linearization were used to print samples. The printing conditions were as follows: ink (DIC Xinjinguan NEW CAPS – C); paper (157g/m^2 standard art paper); printing machine (Heidelberg CD102 printing machine); rotate speed of the printing machine (3000 – 15200r/s); temperature (18 – 22℃); relative humidity (60% – 70%).

2) Selecting the samples. 10 – 15 sheets of the printing samples which have relatively good quality were selected. Then the control strips were measured to get average density values. Finally, the samples whose density values were close to C: 1.5, M: 1.45, Y: 1.0, K: 1.7 as the standard ones were choosed. The process of measurement should be in the circumstance of sufficient light while the samples should be padded by white paper which has perfect glisten effect.

3) Measuring dot area percentages of the color scale. Densimeter was used to measure the CMYK dot area percentages and then the values were noted.

4) Charting the curves of dot gain absolute value and the curves of dot area percentages. The abscissas of dot gain absolute value curves were the designed dot area percentage values. The ordinates were the dot gain values, which standed for the absolute values of sample dot area percentages deducting the designed dot area percentages. The aim of charting the curves was to confirm the actual values for manuscript designing by applying geometric analysis method and inverse function method.

5) Fitting the curves of dot gain compensation and compensating the manuscript. Line graphic was vectorgraph whose elements need to be compensated separately while image maps were compensated directly by using fitted curves.

By gathering data, curves of dot gain absolute value were charted (cyan plate), as Fig. 6 shown. Other three plates were the same way.

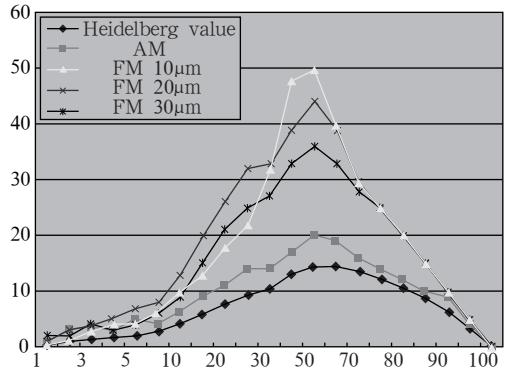

Fig. 6 Dot gain absolute value curves of cyan plate
图 6 青版网点增大绝对值曲线

According to the measured values, the CMYK dot area percentages curves were charted, as Fig. 7 shown (cyan plate).

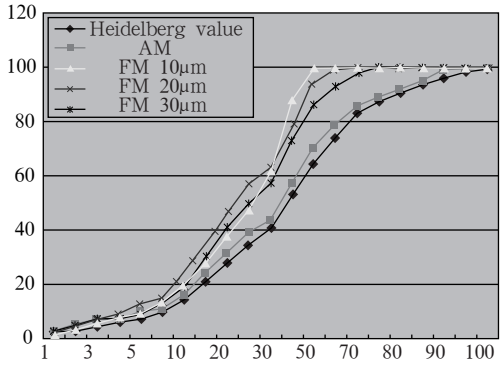

Fig. 7 Dot area percentages curves of cyan plate
图 7 青版网点百分率曲线

The compensation curves were fitted according to the data obtained. Eq. 1 – Eq. 4 were dot gain compensation functions of CMYK with AM screening.

$$C: y = 0.0010x^2 + 0.8890x - 0.5014 \quad (1)$$

$$M: y = 0.0033x^2 + 0.5927x + 1.1908 \quad (2)$$

$$Y: y = 0.0021x^2 + 0.7012x + 0.3120 \quad (3)$$

$$K: y = 0.0033x^2 + 0.5640x + 1.0656 \quad (4)$$

Eq. 5 – Eq. 8 were dot gain compensation functions of CMYK with 10μm FM screening.

$$C: y = 0.0005x^2 + 0.5820x + 0.8460 \quad (5)$$

$$M: y = 0.0003x^2 + 0.5966x + 1.0198 \quad (6)$$

$$Y: y = 0.0005x^2 + 0.5530x + 0.6707 \quad (7)$$

$$K: y = 0.0004x^2 + 0.5640x + 0.9683 \quad (8)$$

Eq. 9 – Eq. 12 were dot gain compensation functions of CMYK with 20μm FM screening.

$$C: y = 0.0008x^2 + 0.5726x + 0.0894 \quad (9)$$

$$M: y = 0.0007x^2 + 0.5665x + 0.5789 \quad (10)$$

$$Y: y = 0.0007x^2 + 0.5540x - 0.0772 \quad (11)$$

$$K: y = 0.0007x^2 + 0.5760x + 0.2956 \quad (12)$$

Eq. 13 – Eq. 16 were dot gain compensation functions of CMYK with 30μm FM screening.

$$C: y = 0.0014x^2 + 0.6012x + 0.5835 \quad (13)$$

$$M: y = 0.0008x^2 + 0.5732x + 0.3986 \quad (14)$$

$$Y: y = 0.0011x^2 + 0.5717x - 0.0663 \quad (15)$$

$$K: y = 0.0012x^2 + 0.5689x + 0.3377 \quad (16)$$

Compensation curves were used to compensate the manuscript and samples were printed. Through measuring the

sample data, the dot gain absolute value curves and the dot area percentages curves were charted and the initial compensation was done. The same method was used to compensate the manuscript more times and finally got the products whose dot gain values were controlled within the allowed error range. Fig. 8 showed the dot gain absolute value curves of cyan plate through AM screening and FM screening with different dot sizes, as Fig. 9 shown. Other three plates were processed with the same way.

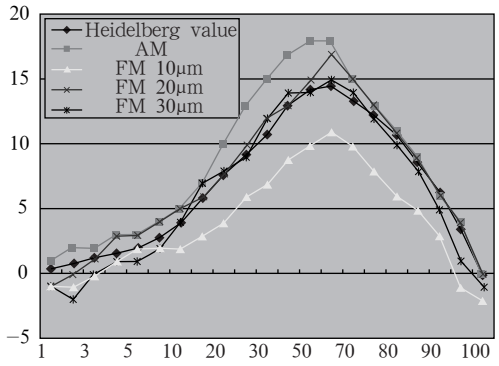

Fig. 8 Dot gain absolute value curves of cyan plate ofter compensation

图 8 补偿后青版网点增大绝对值曲线

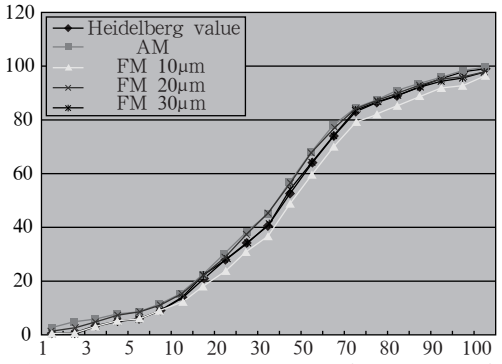

Fig. 9 Dot area percentages curves of cyan plate ofter compensation

图 9 补偿后青版网点百分率曲线

3 Analysis of Experiment Results

3.1 Analysis of Data and Curves Prior to Compensation

Some conclusions can be obtained after analyzing Fig. 6. Neither AM screening nor FM screening could avoid the dot gain and their dot gain values both exceed Heidelberg dot gain values. The rules of dot gain for both screening methods were the same, in which the dot gain values were relatively low in the highlight tone and the shadow tone, while relatively high in the middle tone. The peak values of different screening methods and FM screening with different dot sizes emerged at different dot area percentages in theory on the curves. The dot gain of FM screening was more severe than AM screening. The smaller the FM dot size was, the more severe the dot gain would be. The printing of 10μm FM screening could be realized only under best printing conditions but had the most severe dot gain problems, in which combined levels emerged at the shadow gradation. Some color scales had much severe level combining.

Based on analyzing Fig. 7, it was found that both two screening methods had more severe dot gain than Heidelberg dot gain. On the whole, FM screening had much severe dot gain than AM screening. The smaller the dot size was, the more severe the dot gain would be. Level combining emerged very easily at the shadow gradation in FM screening. The smaller the dot size was, the more severe the level combining would be.

3.2 Analysis of Data and Curves after Compensation

From Fig. 8, some conclusions can be made. The dot gain tendency of CMYK plates didn't change, but the dot gain values decreased a lot after the compensation. The dots of FM 10μm screening were too tiny to be produced on the plates and to be printed on the samples. Though dot gain values of some color areas exceed Heidelberg values as the result of some objective and subjective reasons, yet on the whole, the dot gains of AM screening, FM 10μm screening and 20μm screening were controlled within the error range allowed. The compensation effect was good.

From Fig. 9, some conclusions can be made. The dot area percentages after compensation had been controlled within the error range allowed. From the highlight gradation to the shadow gradation, there was neither obvious level jump nor level combining at the shadow gradation. The adjusted levels were clear and evident, so the compensation effect was good.

4 Conclusions

In this study, FM screening was chosen as the object

and the experiment was used to deal with manuscript through AM screening and FM screening with different dot sizes. Printing plates were made through CTP and samples were printed. Then data were measured and compensation curves were fitted to compensate the manuscript. Finally, the products with permitted dot gain were obtained. By this experiment, the reproduction characteristic and principle of FM screening map printing were explored, in which CMYK dot gain compensation functions and curves of FM screening printing were got. These functions and curves could be used to induct printing practice.

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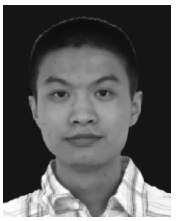

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