Co-Res Screening
New Fujifilm Screening Technology

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Abstract: Three technologies enable Fuji Co-Res Screening to support a sufficient number of gray levels to be able to output high definition 300lpi screens using any output machines with 2400dpi resolution and lower. Multi-Template Technology is an algorithm based on the characteristics of human perception and Multi-Template Technology is based on output characteristics simulation substitution. Moiré Suppression Technology enables the process. This gives any process the quality of 300lpi with the cost and productivity of 175dpi or doubles the productivity of systems using normal screen rulings; and can be used for any Fuji digital film, plate or proofing process. It can best be described as redistributed AM screening.

Introduction

Screening has always been the gating factor for the speed versus quality value proposition in the printing industry. The need to convert continuous tone images to lithographic go/no go dots in order to print can probably be regarded as one of the major hurdles that has limited the industry in competing with other communication media. Yet, despite this importance, very few significant advances have been made to the technology over the years. Classical screening was simply an attempt to reproduce the continuous tone images with a sub visual go/no go grid. Over the years this analog process was refined using variations in the patterns and the shapes of the dots produced to achieve differing visual effects and reduce printing problems.

When the industry switched to digital processes in the '70s, the classical process was reproduced using computers to generate the grid patterns and dot shapes. Since then, refinements have been continually made using the ever increasing abilities of the computer based raster image processors, but new breakthroughs have not been developed. One characteristic of this high-resolution AM screening is that data processing requirements during the RIPing stage are proportional to screen ruling. For example to increase screen frequencies from 175 lpi to 300 lpi, printers must also

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increase the resolution of the halftones from 2,400/2,540 dpi to 4,000 dpi or more to maintain a full visual range of tones. Even with today's faster hardware, throughput suffers when printers RIP files at such high resolutions.

Stochastic screening was the first successful attempt to develop a quality alternative to classic screening. Classical screening is grid based and dot amplitude modulated (increases in tone values are accomplished by adding pixels to the borders of each dot to progressively fill up the grid) to produce the various tones required. This tends to produce two basic problems. First, the grids produce visual moirés or interference patterns between the four process color grids and with some fine patterns in the image itself. Second, the dots shapes tend to produce discontinuous results as the dot amplitudes are modulated across the tone scale. This is called tone jumping and can be seen on the printed image where all the dots in a given area reach a connection point with their neighbors and produce fine bridges that pick up more ink than was intended. This can be exacerbated if the resolution of the pixels that are used to make the dots is not fine enough due to the limits of the output unit. Stochastic screening eliminates both effects by substituting a randomized distribution of the pixels to fill up the grid area.

The problem with stochastic screening is that the random distribution of the dots produces random patterns that can visually disrupt the image unless the units operate at close to their finest resolution outputs. This causes two basic problems. First, the pixel sized dots that must be used, can easily be lost in prepress or on press. And second, the edge to surface area of these dots is much higher that in the classical system, where most pixels touch other pixels, and this produces more sensitivity to the printing process such as increased "dot gain" (due to ink overlapping the edge of the dot) and paper piling (due to the inability of the fountain solution to adequately dampen the dot area). Stochastic screening eliminates the quality problems of classical screening, but it requires increased and different process control on press and does not address the speed quality conundrum in prepress.

Fuji Co-Res Screening

Fuji has re-evaluated the classical screening options in light of presently available technology with the goal to develop a new screening algorithm that allows users to either increase quality or speed using their present equipment. With Fujifilm's Co-Res, which stands for Common Resolution Screening, the user has the option to choose either high resolution or speed on their existing prepress equipment while also minimizing grid pattern effects.

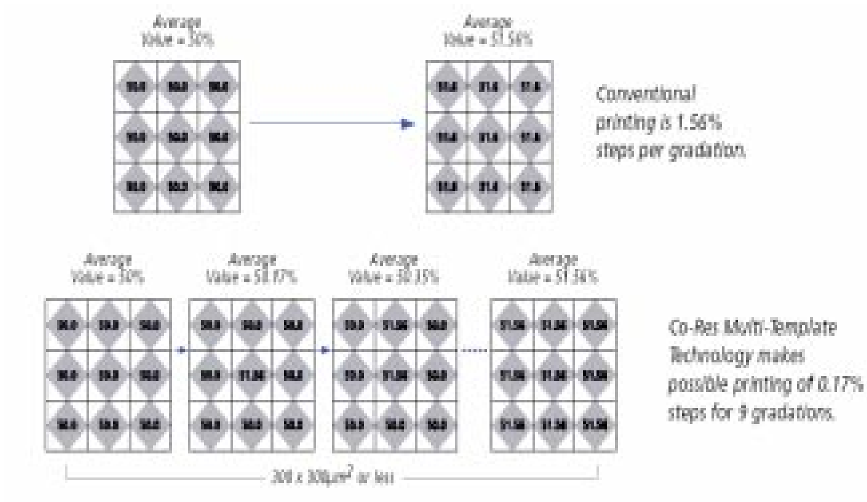
The Co-Res process is possible because of the limitations in the human perception of color and density. At best, human beings can only register cognitive differences in spots measuring at least 300 microns squared, or about a hundred line screen dot. The reason that finer line screens are needed in classical screening is that the multi dot rosette pattern on classical screening and the multi dot random pattern on stochastic screening are large enough to be discernable at these levels. If these patterns can be eliminated, it is no longer necessary to use ultra fine screens as long as the given area addressed does not exceed the 300 microns squared. The following table gives the ratio of the number of pixels in that area for different resolution output units.

Output Resolution (dpi)	Approx. Pixel Size (μm^2/dot)	Approx. No. of Pixels Per 300μm^2
1200.0	21.2	200
1219.2	20.8	208
1270.0	20.0	225
1828.8	13.9	465
2000.0	12.7	558
2400.0	10.6	800
2438.4	10.4	832
2540.0	10.0	900
3657.6	6.9	1890
4000.0	6.4	2197

Table 1 Number of Pixels per 300μm^2 Per Output Resolution

Further, it is accepted in our industry that, irrespective of screen frequency, printed matter must be able to show 256 gray levels per halftone in order to avoid tone jumping or banding. As a result, using traditional screening techniques requires resolutions of 4,800 dpi to maintain 256 gray levels at 300 lpi. At 2,400 dpi, only 64 gray levels are possible at the 300 lpi ruling, with halftone increments of 1.56% causing visible tone jumps with each step.

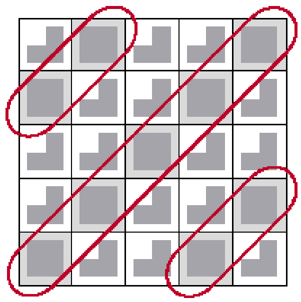
Co-Res employs Multi-Template Technology, which arranges a separate grid of halftone dots, at lower gradations within the 300-micron squared area. The make up of the grid and the dots can be derived from the chart. For example at a resolution of 2400dpi there are 800 pixels available in a 300 micron squared area. 300 line screen dots, each with 64 gray levels (8x8), can be arranged in a 3x3 matrix within that area with plenty of room to allow for screen angles (8x8x3x3 = 576 pixels required). This effectively increases the number of gray levels by a factor of nine. The result is that Co-Res can readily achieve halftone increments of 0.17% at 300 lpi and 2,400 dpi. This supercedes the industry standard formula $(dpi/lpi)^2$ = gray levels. With Fujifilm Multi-Template Technology the result is a markedly smoother image transition (see illustration) that does not tax the RIP.



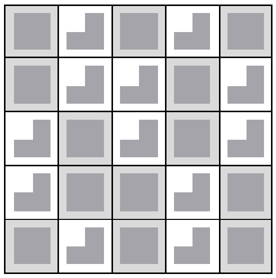
Or, as an option, the process can improve productivity. Co-Res can produce 175-line screen work, but use an output resolution of just 1,219 dpi. This would increase the throughput on a platesetter from 27 plates per hour to 40 plates per hour! Also, Co-Res can be intermingled with conventional screening with the same line screens. The workflow, make-ready and printing are the same.

Image Quality Issues

This type of approach is susceptible to certain problems. First is single-color moiré because the travel of the platesetter's imaging head (scanning pitch) and the halftone frequency may come into conflict. Co-Res's unique moiré suppression algorithm predicts when and where single-color moiré will occur and then alters the halftone dot construction to suppress it. This algorithm will also increase definition in the image.



Halftone dot arrangement resulting in pronounced moiré, as highlighted above.



Adjusted halftone dot arrangement resulting in suppressed moiré.

Second, tone jumping in the midtones (30% to 70% halftones) due to connection points can be a major problem on press. Co-Res eliminates this problem by varying the dot shape in different parts of the halftone range. In the highlights and shadows, Co-Res uses a round dot shape; the circular shape has short borders that resist dot gain. For the midtones, however, Co-Res alters the dot shape from round to square so that the halftone dots connect more gradually at the intersections. The result of this is that there is a smooth tonal shift.

Conclusion

The Fuji Co-Res Screening system can best be described as redistributed AM screening which combines the familiarity of classical screening plus moiré and tone jumping suppression with either process speed or resolution improvement.