FM Screening Dot Gain Calibration by Shaving each Individual Dot

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Abstract: The goal of this paper is to show an alternative way to standardize Frequency Modulate and the resulting effects of linearization. The usual compensation for dot gain in standard FM calibration is achieved by dot removal, therefore, diminishing the dot population. In the proposed method no dots are removed. By decreasing each individual dot size the negative effect is alleviated and, therefore, smooth tone transitions are sustained. As dot replication modifies FM dot sizes by expanding individual dots several times some of the sub dots can be removed to compensate for color casting and dot gain without changing dot position or removing full dots. This process is especially suited for dual resolution RIP models.

Introduction

Dot implosion is the proposed key factor in this work as an alternative process when using FM screens, this method is closely related to dot area density and also to Visual Acuity in general as well as Visual Angle, Contrast sensitivity and Minimum Angle of Resolution in particular. In order to shave FM dots a matrix of 2x2 subdots or more have to be used; this explains why there is a pixel replication principle always present as a factor but where most of line work could be an exception, the driving problem to be researched will be mainly based on the need to compensate for dot gain but not the only one that matters to us, so other factors as important consequences that will occupy our attention towards dot clustering and noise fading. A referential background exposition consider necessary in this case, will end up in the process to standardize FM screens utilizing resolution acuity patterns and tone wedge files; by comparing the traditional way of calibration that recalls screen libraries or generates them for given steps of different dot percentage substitutions and the one that is proposed by the concept of dot implosions.

Dot shaving is nothing else that sub dot removal and could be applied to any resulting FM screening independently of the preprocessing of an image, making

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possible the chance of being End User controllable, even though, for better results dual resolution raster image processing would make a better model to recommend, in general, line work at higher screen rulings delivers improved results over lower ones, but only if the screen ruling is still below or equal to the achievable top resolution that a specific media can reproduce with the limitations that its own dot gain restraints.

Avoiding dot clustering is one of the improvements that can be applied to gain smoothness and gives the chance of increasing the screen ruling in a substantial way in order to augment definition and the control of gray scale printability; in color separations, specifically in textile and aluminum can printing, it matters that a combination of overlapped dots stay from reaching other dots or dot combinations that will create muddy looks and dullness and, in theory, as it is going to be demonstrated with piezo ink jet printing, ink savings in other processes can be achieved by dot shaving as dot gain helps FM dots to grow again at a close approximation of the preconceived dot sizes with a minimum affection to overall density.

Referential Background

Visual acuity measurements fall in the psychophysical field of knowledge this means that for a perfect observer, threshold is the point where stimulus can just be detected, in the case of human observation is not the same way, for us thresholds are often defined in probabilistic terms, in order to determine a spatial resolving capacity of our visual system to detect the minimum angle of resolution that shows isolated fine detail differentiated by a gap to other objects pointing the ability to detect that separation acuity. The yes and no procedure will be used as our preferred choice of psychophysical method to find the presence or the absence of an object.

Resolution acuity called “minimum separable” acuity can be found by utilizing target resolution patterns in the object form of either dots, gratings or checkerboard (Figure 1) to discriminate the separation between its elements for this type of visual acuity, it will be correlated, in terms of our model, to printers and media resolution.

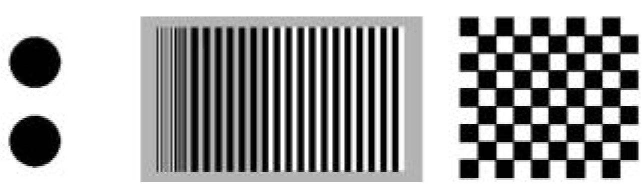


Figure 1. Target resolution patterns

In order to interpret visual acuity measurements we need to understand the concept of visual angle. The visual angle of an object refers to the size of the object measured in units of degrees, if we take our eye visual angle, that is defined as an Isosceles triangle (Figure 2), then some basic trigonometry can be used to find its angle.

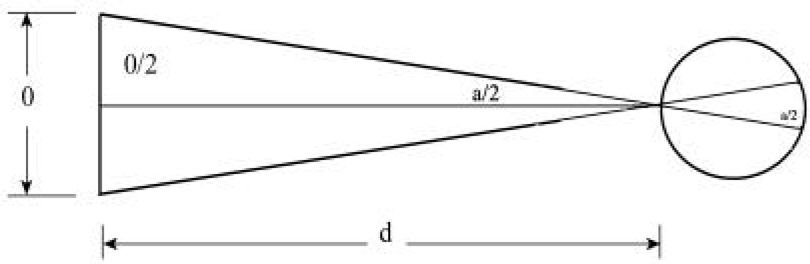


Figure 2.Visual Angle of the Eye covers objects seen by our visual system

To find the visual angle the following calculation has to be made:

$$\mathrm{Tan}(\alpha/2)=(O/2)/d \qquad (1)$$

where,

O: Object
a: Visual angle
d: distance from the center of the object to the eye

For practical purposes to find the size of an object the two other values are given; a distance from the eye to an object of 28.65 cm and a visual angle of one degree those values will solve an object size of 0.5 cm as a result. Cone spacing at the fovea is approximately 28 seconds of arc or close to 0.5 minutes and at one degree angle covering an object of 0.5 cm, this means that based on cone spacing about 120 half minutes will correspond to the maximum number of stimulus per degree that can be recognized for that specific distance in terms of a light and dark Contrast grating (Figure 3), so that a separation or gap between objects becomes of the same size, giving a possibility of 60-63 cycles per degree; by a simple arithmetic solution at 28.65 cm distance from our eye a normal visual acuity resolution is around 240-252 objects or 120-126 cycles per centimeter.

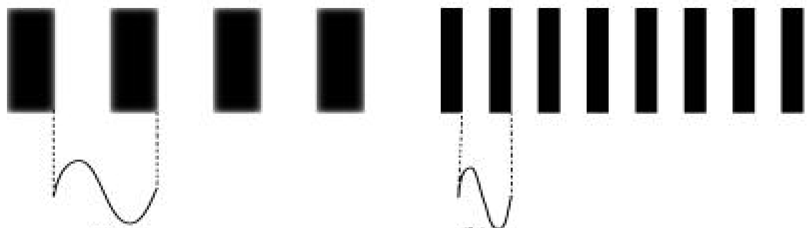


Figure 3. Light and dark grating are shown above, (a) and (b) represent 1 wave per cycle at different frequencies. For 28.65 cm distance a cycle is 0.00833 cm.

With the data obtained from our one degree angle object it is possible to determined the required resolution within those two imaginary lines into visual space to describe in printing terms how scanning and printing will match the minimum separable acuity for eye resolution in Table 1

Distance	dpc	dpi
0.28 meters	240.00	609.60
0.57 meters	120.00	304.80
1.14 meters	60.00	152.40
2.29 meters	30.00	76.20
4.58 meters	15.00	38.10
9.16 meters	7.50	19.05
18.33 meters	3.75	9.52
36.66 meters	1.87	4.76
73.32 meters	0.93	2.38
146.64 meters	0.46	1.19
170.00 meters	0.38	1.00

Table 1. Shows the relation between distance and the required resolution to describe in a 1:1 pixel per dot per centimeter maximum detail.

Point spread function and contrast sensitivity work as limits to visual acuity, on the point spread side, objects we look at are imaged at the back of the eye. If we take a point source, the image will be distributed on the retina as a point spread function due to distortions created by the optics of the eye and the diffraction of light; to calculate the resolution of the eye for stimuli that are degraded the Raleigh criteria states that 2 points or lines are just resolved if the peak of the point spread function lies in the first trough of the other point spread function (Figure 4), on the contrast sensitivity also grating patterns are used as measuring

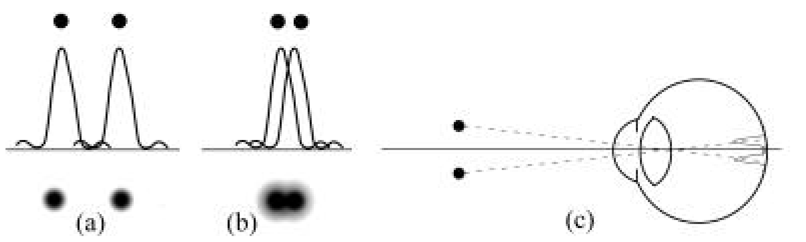


Figure 4. In (a) dots separated by a gap laying on the first trough, (b) dots separated by a gap laying on the second trough, (c) dots in visual space registered as point spread function.

the resolving power of the eye. The contrast of gratings is its differential intensity threshold, which is defined as the ratio,

$$C=(lmax-lmin)/(lmax+lmin) \qquad (2)$$

where,

C	contrast
Lmax	maximum luminance
Lmin	minimum luminance

C can have a value from 0.0 to 1.0, contrast sensitivity measures not only the contrast level but also the object size (Figure 5), this means that high contrast allows smaller size objects to be differentiate by that of the visual system of the eye. We have now two main sources for causing dot clusters in highlights; the distance between dots which is influenced by point spread function and high contrast related to the contrast sensitivity modulation.

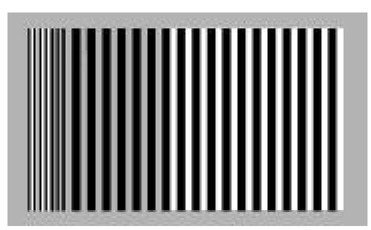
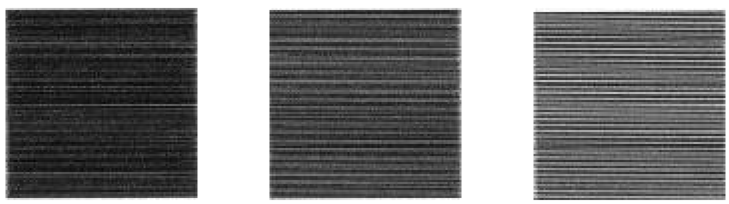


Figure 5. Contrast sensitivity depends on the size of objects and its contrast modulation when modifying objects distance, the changing background shows how contrast affects acuity resolution with similar objects.

Calibration Procedures

Three different processes would be made, first the printer resolution; defined as finding the smallest conceivable dot size for printer's addressability, this means that both lines of the grating dark and light should be of the same width as mentioned previously a Yes and No response method will be used implying line gratings with patterns going from one line dark to one line light if they are not equal then one line dark two lines light and so on until the value that we are looking it could be found (Picture 1), this will determine the printer resolution. Media for this test must be the one considered less absorbent.



Picture 1. Test for maximum dot resolution at printer addressability.

In our case the resulting values for our printer are acceptable when printing either two black lines separated by two lines or two black lines separated by four dots, in other words, for the first value of a relation of 2:2 the dot size including dot gain is close to 141 microns so the grating for its dot size will be 70 lines per centimeter and for the 2:4 relation the printed dot size would be 211 microns or 47 dots per centimeter in a more absorbent media, therefore there is the option to replicate pixels by a matrix of 2x2 or 3x3, in this case, its preferred a 3x3 expansion for absorbent media and a 2x2 expansion for less absorbent, either media could use a 3x3 dot replication the best distance range from our eye to the dot in visual space for 70 dots per centimeter would be at least 1 meter except if dot clustering is common, then it could be at least 2 meters for a preferred distance to look at this objects; for the 47 dots per centimeter the closest distance would be 1.45 meters or at least 2.9 meters when cluster problems are present, as it could be seen this printer resolution fits best for sign advertisement, bus wrapping, backlight signs and so on, as it is evident that a print like that can not be hold in our hands for a comfortable viewing distance as it could be a book or a magazine.

From the previous information it is possible to deduct the following, whatever media that we have to see holding it in our hands must be at least around 250 dots per centimeter to reach the threshold of our acuity resolution, a newspaper printing system implies in general that the output resolution of the prepress and printing device could reach, by far, beyond our visual acuity resolution, so nor the prepress system or our visual system fall above the minimum threshold except for the paper used to print news not being able to hold 125 cycles per centimeter because the dot gain is much larger on this newspaper than most of papers in the market today. As we begin to understand how there is an interdependence among visual acuity resolution of the human eye, the capability of printer to address small dots and the dot gain of media to be printed. In general if we are looking to reach the threshold of our visual system acuity resolution for a specific printing purpose then the remaining factors to match our ideal printer resolution are to discover the printer's real resolution capability and the media real resolution surrendered to the main objective of the printed material functionality.

Second calibration

Printing bigger dots substantially helps reducing dot gain, even tough, will not be the final solution, to attack this problem it is necessary to take the next step in the process to gain control of dot gain by manipulating its size, this process can be done by shaving each individual replicated dot, in order to match the pretended dot percentage of every step of the tone wedge, theoretically, by adjusting the dot gain of a single dot the rest of dots shaved in conjunction should represent the proposed tone values, however normally the contrast in the overall image varies (Figure 5) thru object size modifications and by the experience of approximation between objects, without changing the screen luminance; in a FM screening where dots play density variations thru dot population concentrations, contrast modulation is achieved by the varying distance from one dot to the other, not only within the same tonal value but also between different tonal ranges; if an isolated dot gets too close to another isolated dot then dot clustering could happen in at least two different situations the first because of a high contrast situation and the other if there is a screen with a flat and even, both affected by the point spread function, basically due to a larger dot reducing the present resolution of an image and requiring this portion of the image to be either seen further away or to be diffused. Flat shavings help (Figure 6 and 7) to improve smooth tone transitions.

Figure 6. Tone wedge where 2 sub dots are removed for a smooth tone transition.

Dot size becomes of a key importance to challenge our eye capabilities to discern detail and tonal values, if the dot is to small and falls beyond our acuity threshold then the photons that fall over the fovea cones will average its value and combine them with other dot values to deliver smooth contrast, if on the contrary dots are big or too close to each other, the real resolution will be

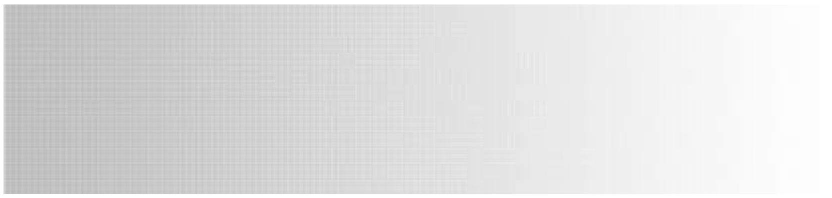


Figure 7. Same tone wedge as Figure 6 showing the results of an excessive shaving where 50% of sub dots were removed for an overall loss of contrast giving a low key result.

reduced and disturbing clusters or noise may be noticeable, Table 2 shows a directly proportional relation between the preferred dot size to be preserved and the acuity resolution to be sustained thru distance.

Dot Size	Distance
40 microns	0.30 meters
80 microns	0.60 meters
160 microns	1.20 meters
320 microns	2.40 meters
640 microns	4.80 meters
1000 microns	7.50 meters
1.00 cm	75.00 meters
2.54 cm	190.50 meters
5.00 cm	375.00 meters
10.00 cm	750.00 meters
1.00 meter	7.50 kilometers

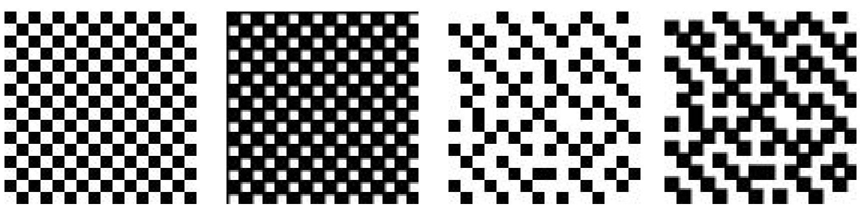
Table 2. The compared values between dot size and distance says that for every 1 micron increment in the dot width, its proportional increment in distance will be of 7500 microns to preserved a constant value in our preferred acuity resolution.

It is not a coincidence that the dot sizes in Table 2 always correspond approximately to a visual angle of 28 seconds of arc or 125 cycles per degree of acuity resolution that remains s a minimum goal for this model.

Third Calibration

Only one plane linearization has been tested so far, but in general color jobs are usually done, it is obvious that FM screening has some influence in printing today and it will have much more in the future, before attempting to approach to dot clustering and noise reduction a previous calibration has to be made as FM screening makes color casting an increased possibility to happen. So far our present model has been demonstrating flat shavings, if only this option were available it will make a very limited model, even though different options of dot shavings could be applied at once, it is the intention of this paper to leave a clear view of a feasible accomplishment required from particular necessities, therefore, plane shaving will be the next logical step in this process; color casting is not a rarity when utilizing FM screens, by shaving color planes in different manners it is possible to remove color casts, in several cases either ink pigmentation or color density unbalances bring as a result some color shading on images, if this is the case, independent plane flat shavings can be applied in order to remove those unwanted results from color unbalance.

Waiting intentionally for comparing a traditional FM linearization to our model of dot shaving has a purpose to show and demonstrate two different topics, the first one tell us about achieving a gray tonal value when utilizing CMYK tone wedge with the two opposed methods one will shave each plane in a different way if required by freely removing sub dots until gray scale values are obtained, the classical linearization by dot substitution diminishing the dot population; following is an explanation of our model concept and theoretically what happens in both systems, a simulated test of a checkerboard will describe in a graphic way (Figure 8) how a traditional calibration would be made for a dot size of

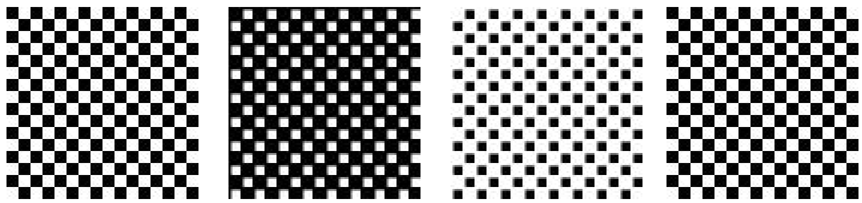


(a) (b) (c) (d)

Figure 8. (a) shows out target sample, (b) is a print without calibration, (c) is a target substitution after calibration and (c) is the resulting print after calibration.

40 microns, having a checkerboard of Yes and No stimulus being a 50% screen is a lot easier to notice dot gain, if this screen (a) were printed without compensation for dot gain something similar to be (b) would be obtained, in order to counterattack for that increase in area density a call for a substitution or the generation of a screen (c) that in terms, of being printed would deliver a compensated screen (d) that would correspond in area density to the originally desired target (a), it is clear that important data has to be removed with those dots that have to be cleared to allow room for others that will represent, included their dot gain, the checkerboard general area density, the significance of this is that for achieving high detail in FM images thru this method of linearization, very small dots from 10 to 20 microns are required to be printed in order to

compensate for its dot population lose and still be able to show an abundant detail. On the other hand dot implosion shows (Figure 9) the sequence of its calibration process, beginning with a similar target, but changing its processes

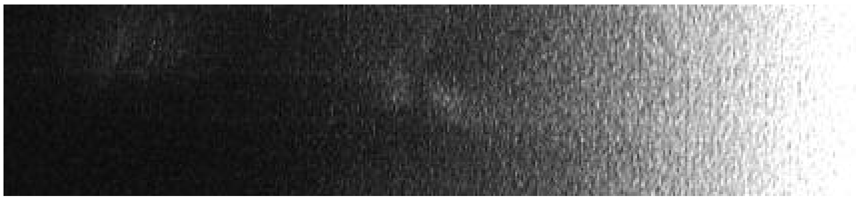


(a) (b) (c) (d)

Figure 9. (a) shows a 50% screen, (b) reflects the same screen with dot gain, (c) shows the same screen shaved before printing and (d) shows the achieved result of the prepared (c) screen.

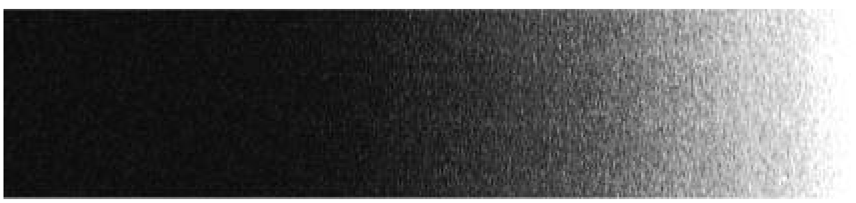
and describing on how our model will act for the same 50% checkerboard target (a) that was used as a sample image having also 40 micron dots built with a 4x4 matrix, (b) reflects the same result without shaving, on the other image (c) shows how 7 sub dots were removed from every individual 40 micron dot to compensate for dot gain, each dot preserving a 9 sub dots forming the shaved dots where each sub dot measures around 10 microns, it is understood that the objective is to have a printed image to look as much as possible to the source (d) image, target resolution thresholds help us identify very small size objects that affect our perception of detail, tone wedges help us find smooth tonal range; both methods of calibration arrive at the same result regarding area density, but disregard what it becomes their profound differences. On our next non hypothetical experiment for getting the right values for our tone wedge two different procedures will be followed, they will be basically the same as for our simulated demonstrating process, the traditional method will reach its calibrated values thru dot removal while our proposed method will reach the same point thru shaving each separated plane. There is little to say about the traditional calibration for FM screening, even though the results will be explained in more detail as it is relevant especially for ink consumption.

On our proposed method and based on the principle that by compensating for a dot gain of each individual dot, the searched result of compensating for all different area percentages will be achieved, taking the resulting highest addressable resolution for the printer tested in Figure 6 the 47 dots per centimeter resolution with a 3x3 matrix will be used to print a tone wedge from 0 to 255 values, as 4 color planes are used our combined area density is increased, therefore the removal of sub dots will be higher, after density and color testing was done the values obtained were for C were 5 sub dots removed, M 5 sub dots removed, Y 5 sub dots removed and K 4 sub dots removed, the tone wedge before shaving occurred had 197.48% total ink value, once expanded and shaved its total ink value decreased to 93.42% (Picture 2), it is important to outline that



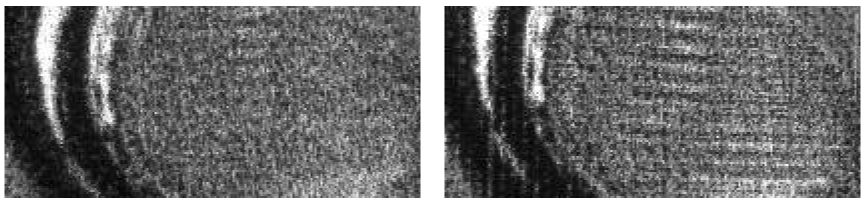
Picture 2. Tone wedge total ink value after dot shaving calibration is 93.42% departing from an original ink value of 197.28% at 47 dpc with a dot size of 210 microns and a pixel replication of 3x3.

the total ink values that are being used do not represent the maximum coverage for a specific area of the tone wedge because the algorithm used give us the average ink spent for the total printed area by counting the total amount of bits that represent the activation of the ink jets from a total area of 400%, the same rule applies for traditionally screened tone wedge at the maximum addressability of the printer (Picture 3) which is 3 times higher than the maximum addressable resolution, by making a comparison between the two screened tone wedge total



Picture 3. Total ink value after tonal range density calibration is 113.03% departing from an original ink value of 199.6% at 142 dpc with a dot size of 70 microns and no replication.

Ink values a 2.32% difference results from the departing unshaved screened tone wedge compared to the no calibrated traditionally screened tone wedge using this extra ink possibly coming from the increased population mainly in the first quarter tones, this difference will be further augmented after both methods conclude their calibrations resulting in a 19.61% minus the original difference of 2.32% the obtained value for ink saving becomes 17.29%. A second test was performed where the traditionally screened file reduced its ink consumption, trying to match the shaved tone wedge, reaching a value of 79.2% and the shaved tone wedge 81.91% total ink delivered, now the ink difference worked slightly in an opposite direction, however there is a fact that holds importance; both files were calibrated as close as possible obtaining 1.74 and 1.76 density respectively at the 75% mark, to arrive to these values the traditional FM file had to be brought down to only 76 steps from a 0-255 scale becoming an input 180-255 reduced scale, following these calibrations another target was used to test printed output different from a tone wedge, a picture of a group of vehicles was used to compare and verify detail allover and check how the lost data from the traditional FM screen compares to the 3 times bigger dot shaved FM screen detail (Picture 4), as (a) shows a flat image due to the lack of enough tonal level.



(a) (b)

Picture 4. A small part of the 142 dpc (a) screened and calibrated image in the usual way and (b) the 47 dpc shaved image showing better detail.

File compression matters, the entire file of (a) the standard 1 bit per pixel FM screen compressed from 67,227, 150 Mb to 40,977,590 Mb and the unexpanded FM file compressed from 7,470,667 Mb to 5,606,453 Mb.

Fourth Calibration

Dot clustering becomes apparent when two FM dots are close enough from each other to fall in the limits of the eye system's resolution acuity, in order to be able to detect dot clusters there has to be at least an even portion of background that results in a contrasting value compared to the clustered dots, these means that if there is either a bright background or a relative flat pattern of dots and its harmony pattern is broken by other neighboring dots it is probable that a dot cluster would manifest. One of dot cluster's characteristics is that its size is at least 50% bigger in width and 100% bigger in dot area density or even larger if we take on account dot gain either optical or mechanical, plus the spread point function (Figure 4) that certainly affects dot clustering, because acuity resolution is at its peak on a high contrast point in the contrast sensitivity function curve, contrast modulation is the actual force that helps avoid size increments, as object separation will diminish cluster effects along with reducing the size of dots.

A dot cluster physically reduces printed resolution seen in visual space, these means that a dot cluster in a 250 dpc resolution will be of a minimum of 187.5 dpc, if we follow the values registered in Table 1 it will be necessary to back up 15 cms to keep with the acuity resolution threshold, the power of contrast modulation by dot shaving shown in Figure 7 affects the entire tonal range values, in order to affect only the areas where dot clustering is happening it is necessary to shave only specific values of this tonal range in a way that avoids to touch other parts of an image. The dot clustering effect will increase as we add mo re color planes that are similar in tonal value as the black plane.

Cyan in the first place and Magenta in the second will contribute to the dot clustering effect, another factor to contribute is high absorption of some papers that will expand dot's critical point spread function and finally line work is a major producer of dot clusters and jagged silhouettes that can be reduced by simply increasing its resolution beyond our eye's acuity resolution and here is where in our model is recommended a dual resolution raster option.

Following (Figure 10) dot shaving is applied to a dot cluster in the flat mode

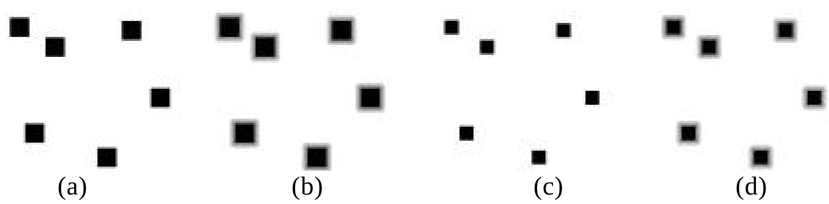


Figure 10. (a) is the target file to be matched, (b) represents a print without shaving, (c) shows a shaved target and (d) the resulting shaved image.

resulting in an image that has grown back to the original size without a beneficial effect on the cluster on the right upper corner, in order to correct for that particular pair of clustered dots an extra shaving has to be applied as in Figure 11 this process fulfills our requirement and varies the contrast

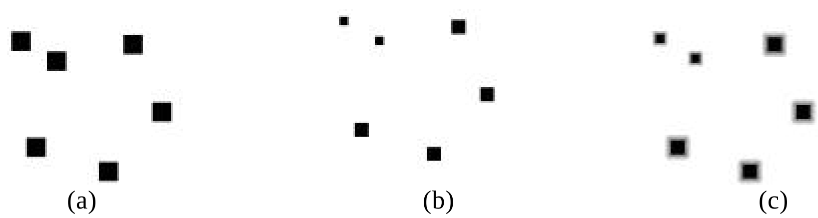
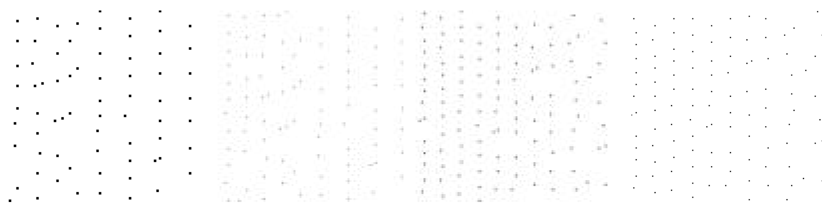


Figure 11. (a) represents the target image to be matched, (b) is the shaved image with a bigger remo val on the two dots of the upper right corner and (c) shows the resulting effect after being printed.

modulation in specific reference to the probable dot cluster (b) by increasing the distance between dots and by modifying its printed size to at least 50% of the original size or 25% its dot area. In the traditional FM screening calibration a comparable process is not possible in a conventional way, there are some approaches to solve specific problems like area density in the highlights with ink jet printing where two extra inks are added that hold a lower density and are called light colors that replace the standard density colors, they usually are cyan and magenta, Thru dot shaving some levels of the tonal range can be shaved in a way to print smaller dots (Figure 12) than the original target dots, this means



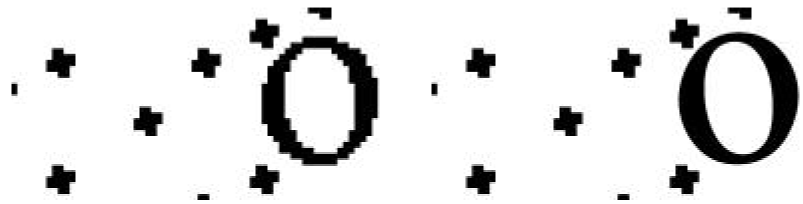
(a) (b) (c) (d)

Figure 12. Here is shown magenta (a) and cyan screens (b) represented by its light magenta (b) and light cyan (d) version.

that even if the main purpose of dot shaving is to return to a dot size that represents its original size after printing, in some cases like dot clustering or a highlight representation for smoother and lighter colors, dot shaving could act in a way to reduce the size of the printed dots in a separated mode from the general structure of dot shaving, this variable mode of shaving can be applied to dots in a differentiated fashion to individual dots like dot clusters, color planes, either highlights or shadows, purpose of applications or printing processes, but still surrender to the acuity resolution of eye our visual system, the media real holding resolution and the printer addressable true resolution.

Dual Resolution

In line work, edge smoothness of fonts and illustrations, are good reasons to prefer a higher resolution screening that will fall beyond the eye resolution acuity, even if the printer's addressable resolution is a lot lower than the printer's addressability, outlines of solid blocks of overlapping dots where detail is not important will look much better if printed with big overlap percentages, as its profile will reduce jaggy effects (Figure 13), however if a variable output resolution device is available, higher output is considered to give better results and including in our model, generally, dot expansion may not be required.



(a) (b)

Figure 13. Image (a) of an expanded and shaved single resolution file and (b) a dual resolution file where just one part is expanded and shaved and the other part was screened at higher resolution.

Dual resolution raster image processors after interpreting a postscript file will separate from its object display list the continuous tone and high continuous tone from the line work objects, at this point, they could be rasterized in two different options, usually line work would be outputted at several times the continuous tone images resolution, it is important to mention that in our model the obtained raster files for either line work or continuous tone are screened one bit per pixel files in a sort of separated unexpanded ROOM files, an important reason for this is its high compressibility, as screened line work has high compression ratios, screened continuous tone images have low compression ratios, therefore it is more convenient not to expand images that will be shaved until just before merging with its line work for immediate printing when they arrive to their destination, if we go back to Picture 4 to compare the amount of data of each screened one bit file, both ZIP compressed, we get a big difference from the standard FM 40,977,590 Mb file vs. an unshaved 5,606,453 Mb file as no need to transmit 35,371,137 extra Mb, because in this case, there is better quality with the smaller file.

File size really matters for data transmission, talking about more traditional printing processes like offset and web systems where files could be as high as 1,417 dots per centimeter, if we compare classical AM screening to our model of FM screening the benefit will show immediately shortening transmission times, as AM screens have to be transmitted at the final output resolution of the imaging device, files tend to grow big, the same will be for a traditional FM screens and not so for our FM model with dual resolution raster image processing or a single resolution option as images do not need to be expanded before transmission.

Conclusions

Our proposed model for shaving each individual frequency modulated dot does tonal corrections on the already screened 1 bit per pixel files so it is not necessary to go back to the original 8 bit per channel file to apply calibrations, therefore, these files can be transmitted and later calibrated according to the requirements of the printing site so the primary user can send already screened files without applying calibrations, these model suits perfectly for remote raster image processing and either centralized or distributed printing and could be considered a lose less method as not a single level of the tonal range is lost from the original screened representation neither its dots are erased but they can be imploded, the distance between dots can be increased but this process does not relocates them, every detail registered is preserved down to one sub dot.

The maximum printable resolution of an output device can be matched by the original scanned file until it reaches our eye's acuity resolution limit, only constrained by media resolution thus avoiding unnecessary extra data that makes oversized files difficult to handle, bigger dots means less data but not necessarily less quality. Any FM screened file is subject to our model, this means that end users fit into this open architecture scheme allowing vast manipulation and wide flexibility, in terms of, multiple combined shavings performed at once for different purposes within the same file. Quality reproduction is a major asset for this model as care can be taken for true 1:1 scale reproduction and with the additional support of dual resolution schemes line work and illustrations look sharp and intense, for continuous tone images.

Ink optimal usage is easily achieved without having to deal with difficult tonal curve handling, therefore obtaining consistent consumption and positive ink savings is conceivable. Dot gain works to our model advantage as shaved dots come back to the originally planned dot sizes, spread ink due to dot gain is well spent avoiding an extended overlapping factor.

In terms of data transmission, the proposed FM screening model keeps files efficient having them several times smaller than similar FM files from a traditionally screened process, with the dual resolution model both type of files Line work and continuous tone are screened before transmission, and in a sense, complying with the concept of secure ROOM files.

Contrast modulation, color casts, dot clustering, selective color correction, ink density and tonal range control can be achieved with a single bit per pixel files of each color plane thru expansion and shaving, this method is suitable for processes where ink of one color has to be kept away from touching others, the same works, for metal deposition systems. Dot shaving has been particularly used in ink jet applications printing large format advertising for the last 5 years, and some experimentation has been done in flexography, screen printing and textile coloring, recent testing foresees an available open usage in the newspaper industry in a short time.

Every printing application represents a new challenge for the dot shaving model, as testing advances for specific requirements, specific shaving techniques helped by other similar complementary methods are arising, building and solidifying this method that even, if all the needed bases for growth have been strongly developed there is a better maturity period to be expected in the future to last for years, as there are so many different application fields to experiment with.

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