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Properties of Jointly-Blue Noise Masks and Applications to Color Halftoning

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With [illegible] of blue noise halftoning as a preferred halftoning technique, the issues of Moiré patterns in conventional

rithms to generate high quality, visually pleasing blue noise patterns that exhibit specific spectral characteristics and small pixel errors.

of co lor planes.

Shifted Masks

In the color halftoning with blue noise, the combination of different color planes is, to some extent, a synthesis of blue noise patterns. Compared to the studies of blue noise on gray scale halftoning, the properties of the analysis and synthesis of multiple, superimposed blue noise patterns have received less attention, despite

Spatially shifted versions of masks can be used for each color channel to minimize the number of the dots that are overlaid.[19,20] For example, a blue noise mask can be used for the cyan color channel. Then the mask is shifted by some number of pixels and then applied to the magenta channel. This shift is circularly periodic patterns. Figure

on of two blue noise patterns can result

ity binary pattern, that is to say a pattern

ve "graininess".

is interesting is the fact that the

mathematical and theoreti-

cal concepts of blue noise patterns and their combina-

tions are explored in next section.

We address the properties of two mutually exclusive

noise

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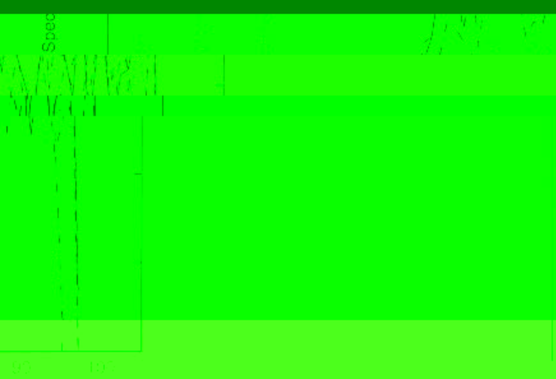
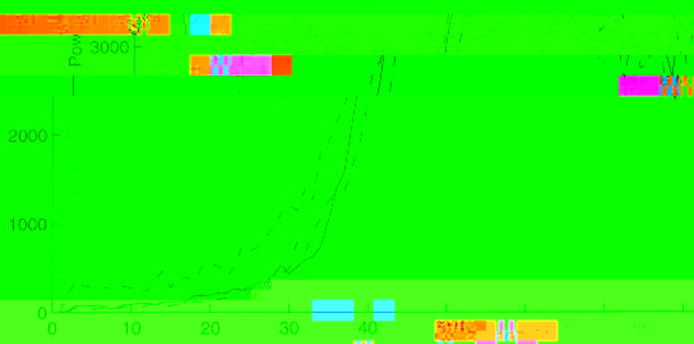
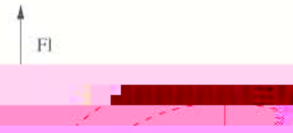




Only the RAPS of the combined patterns are

... Average Power Spectra of the patterns in Figs. 1 through 4. ... plotted



The principal frequency f_g varies from gray level g and has th[illegible]

$$\sqrt{g} \quad \text{if } g \leq 1/2$$

[illegible]

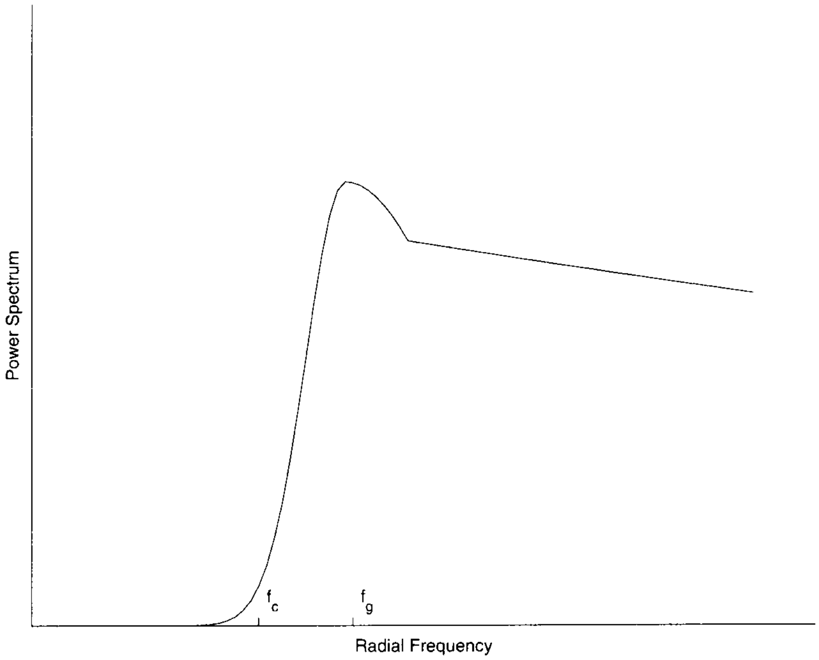


Figure 7. Radial average power spectrum of a typical blue noise pattern.

$D_1(k,l)$ and $D_2(k,l)$, respectively. Overlaying or superimposing these two patterns yields a new pattern $p(m,n)$

spectrum of $p(m,n)$ depends not only on the power spectra of $d_1(m,n)$ and $d_2(m,n)$ but also on the Fourier trans-

visibility to human eyes. In grayscale halftoning, one blue noise mask is created by successively adding or

$$E_2 = L_s(s_2) + L_d(D_1 + D_2) + L_t(T) \tag{14}$$

removing dots from a single blue noise pattern, whereas in color halftoning, three or four dithering masks are required for most of the color halftoning applications.

$$E_3 = L_s(s_3) + L_d(D_2 + D_3) + L_t(T) \tag{15}$$

E_3 reflects the synthetic effects on single, double

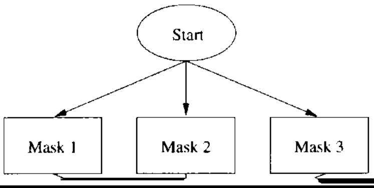


TABLE II. MSE by HVS Model

pattern	MSE × 10^{-3}	pattern	MSE × 10^{-3}	pattern	MSE × 10^{-3}
A	5.042	(A+B)	7.339	(A+B+C)	7.072
B	5.008	(B+C)	7.470		
C	5.027	(C+A)	7.359		
single BN	4.567	single BN	5.670	single BN	7.261

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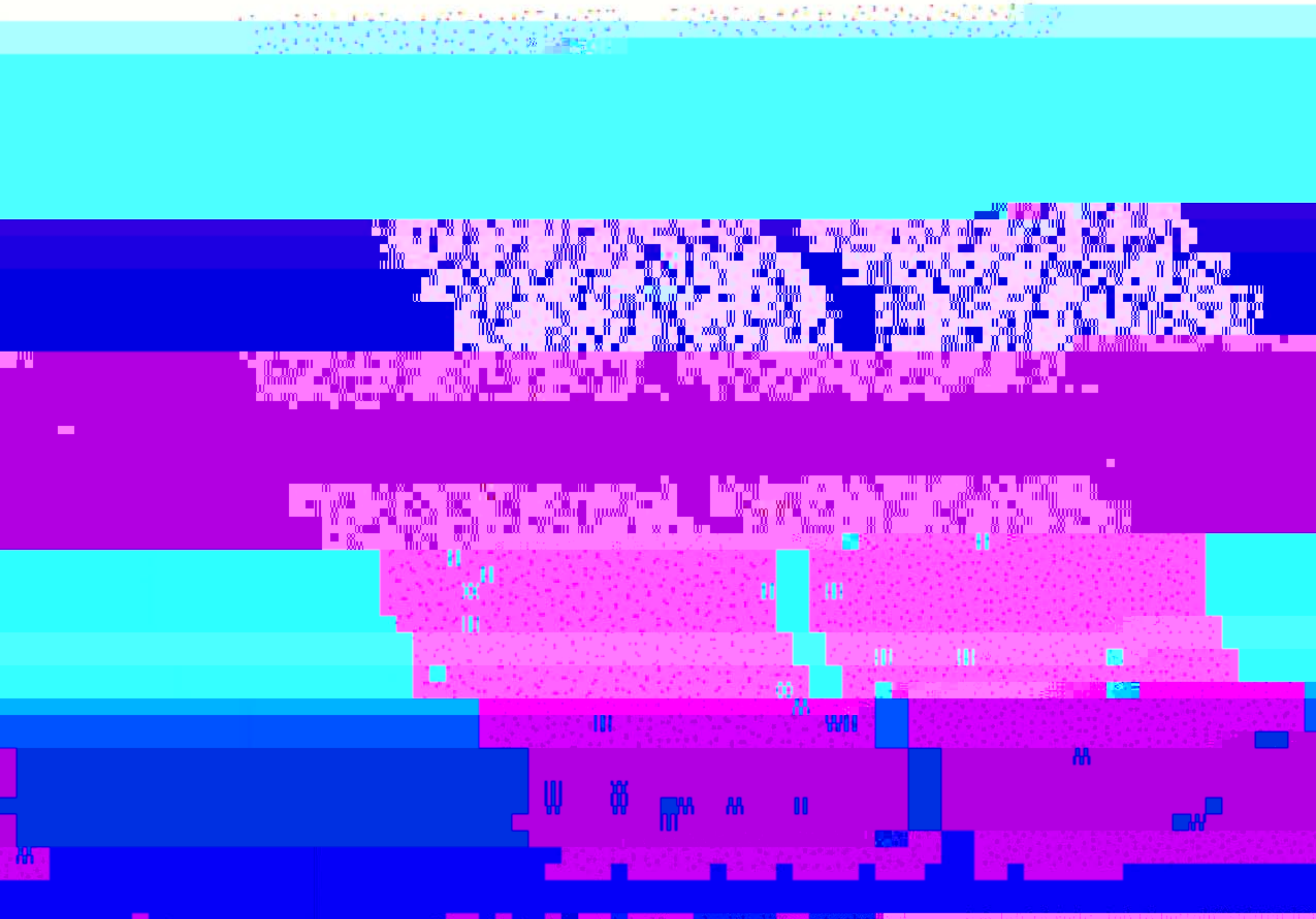

verted plus shifted

Plate ... halftoned with different sche... from left to right, top to bottom ...
masks, four ...sks and JBN...