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Optimal Output Level Selection for Multilevel Halftoning Based on Visual Experiments Using Spatially Modulated Gratings

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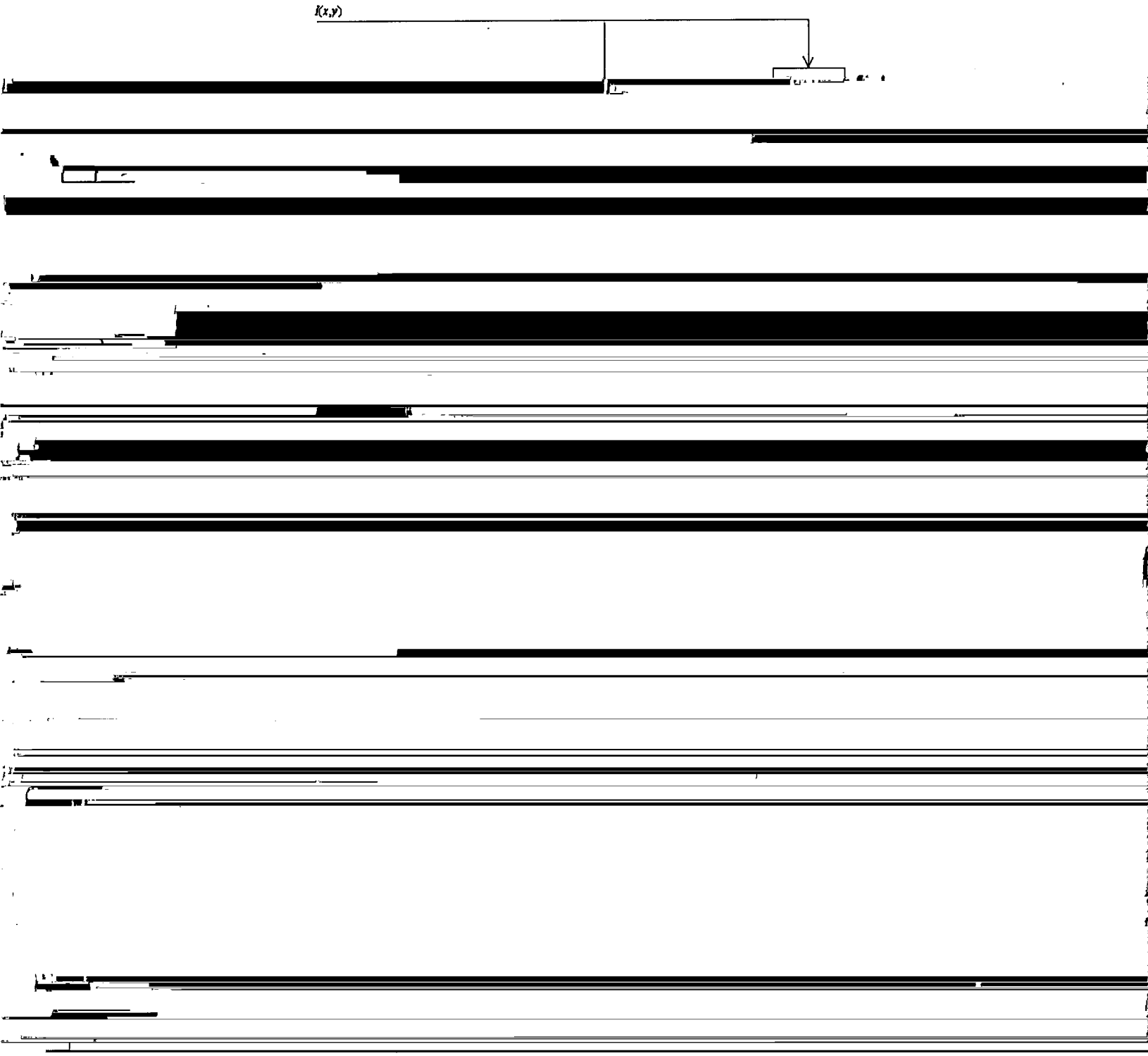


Figure 1. Multilevel halftoning using a stochastic screen.

space was designed to be linearly related to the human

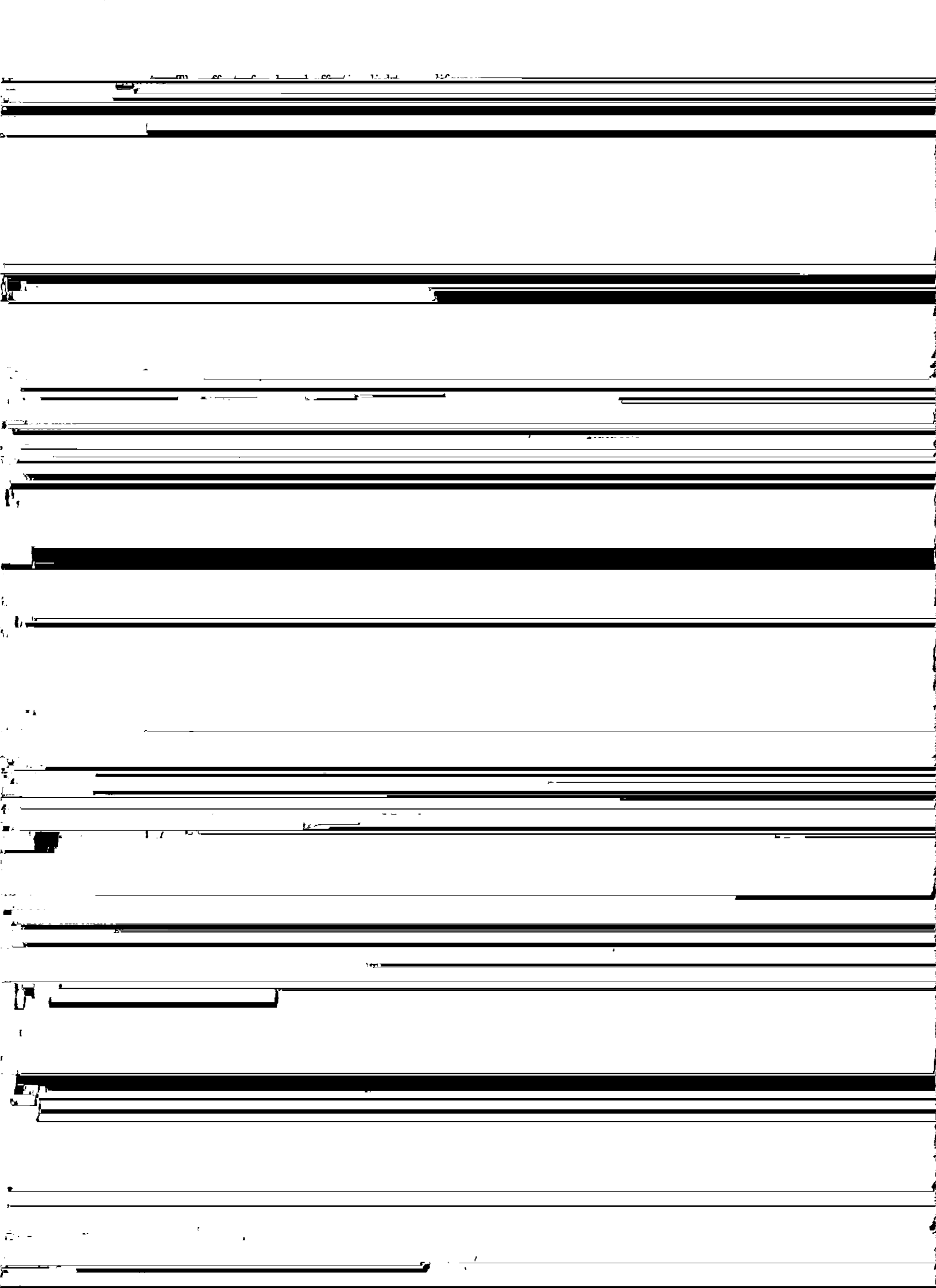
Experimental Design

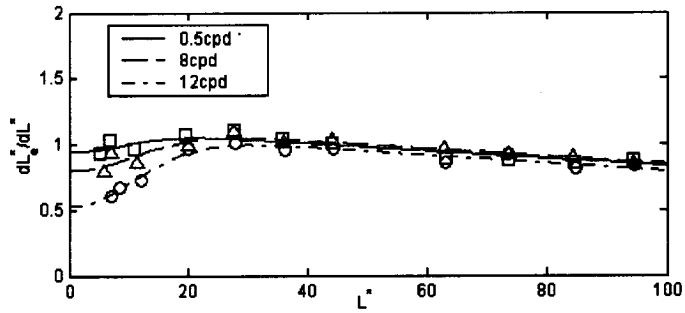
TABLE II. The p-Values of the Two-Tailed Student T-Test.

session 1: $\Delta L^* = 6.39$	sequence numbers										
p-value	1	2	3	4	5	6	7	8	9	10	11
f = 0.5, 8 cpd	0.256	0.239	0.272	0.522	0.824	0.664	0.802	0.145	0.296	0.491	0.568

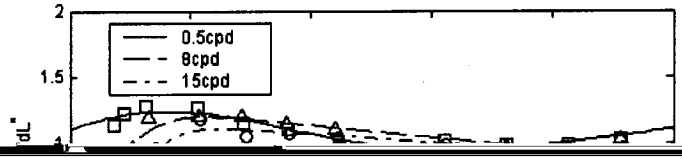
session 2: $\Delta L^* = 12.7$	sequence numbers										
p-value	1	2	3	4	5	6	7	8	9	10	11
f = 0.5 and 8 cpd	0.264	0.081	0.527	0.762	0.762	0.687	0.015	0.077	0.828	0.236	0.905

session 3: $\Delta L^* = 25.5$	sequence numbers										
p-value	1	2	3	4	5	6	7	8	9	10	11

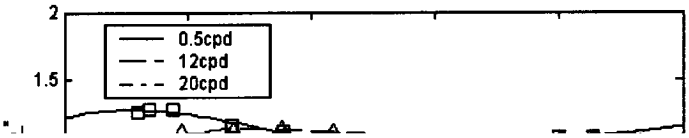


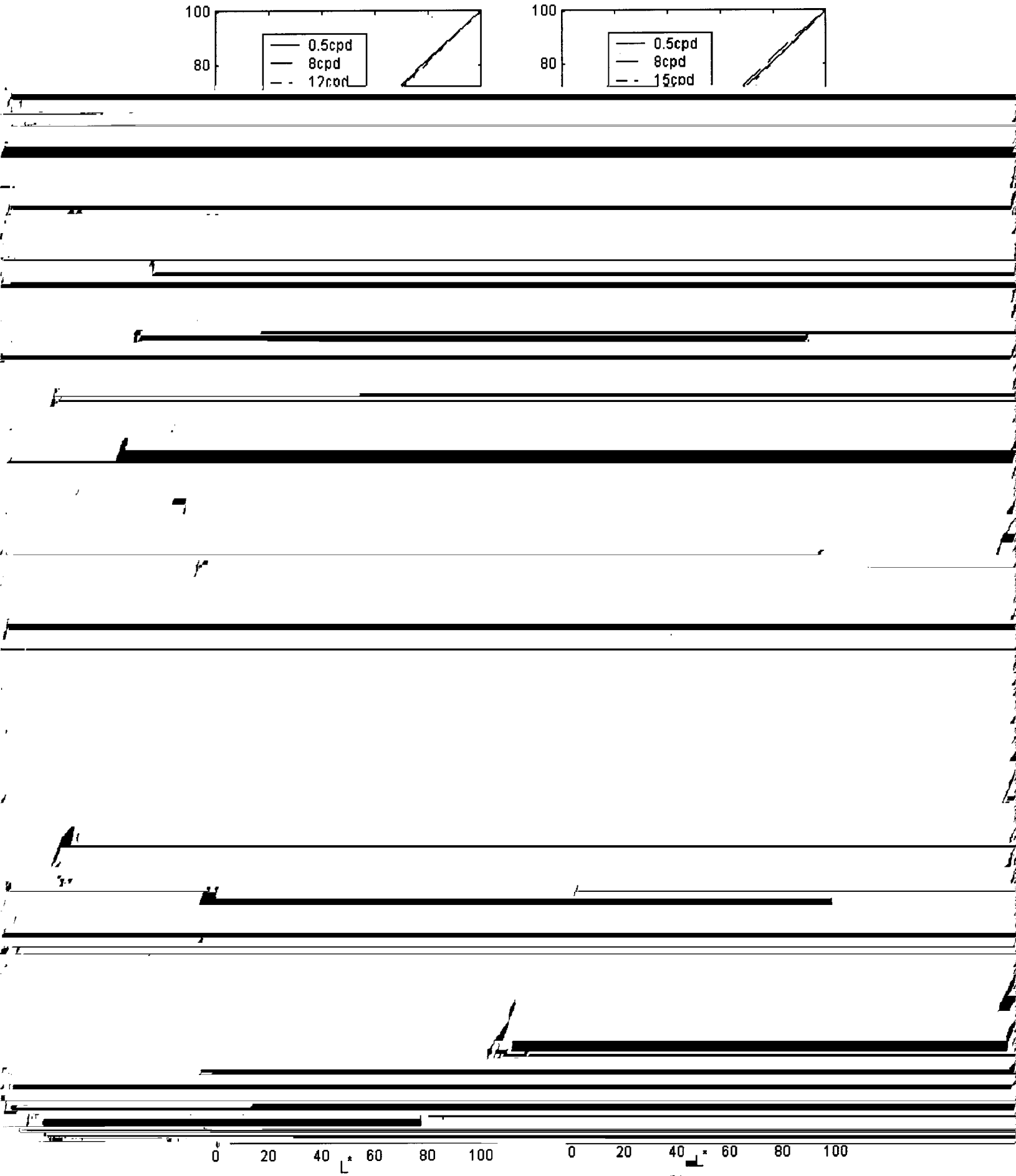

0.5cpd
8cpd
12cpd
dL*e/dL*
L*
0
0.5
1
1.5
2
0
20
40
60
80
100

(a)


0.5cpd
8cpd
15cpd
dL*
1
1.5
2

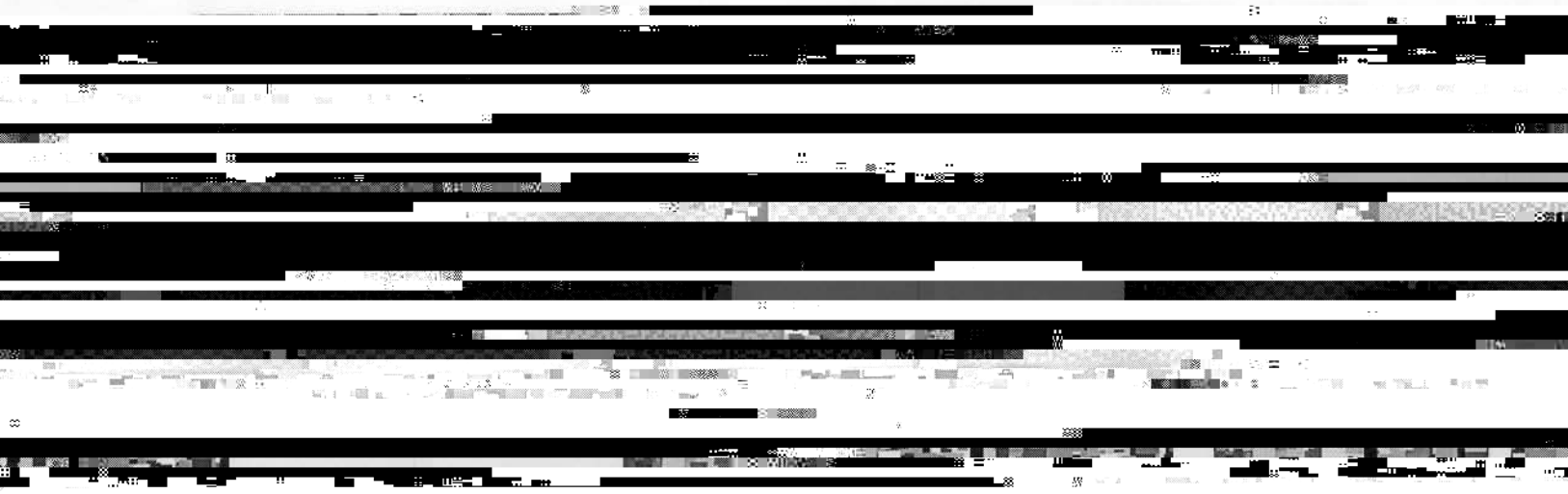
(b)


0.5cpd
12cpd
20cpd
1.5
2


100
80
0.5cpd
8cpd
12cpd
100
80
0.5cpd
8cpd
15cpd
0
20
40
60
80
100
L*
(a)
0
20
40
60
80
100
L*
(b)
100
80
60
0.5cpd
12cpd
20cpd

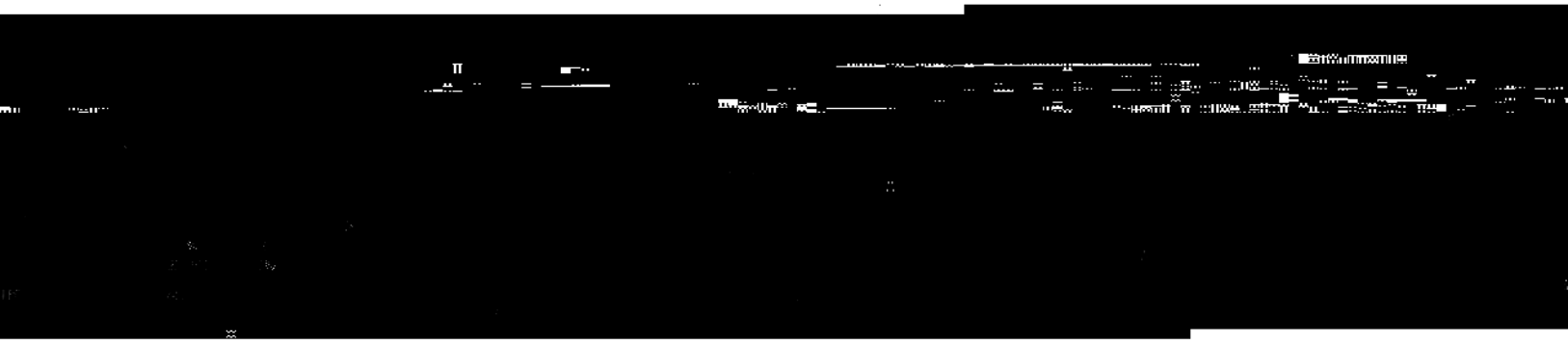
[redacted]

(b) (a)



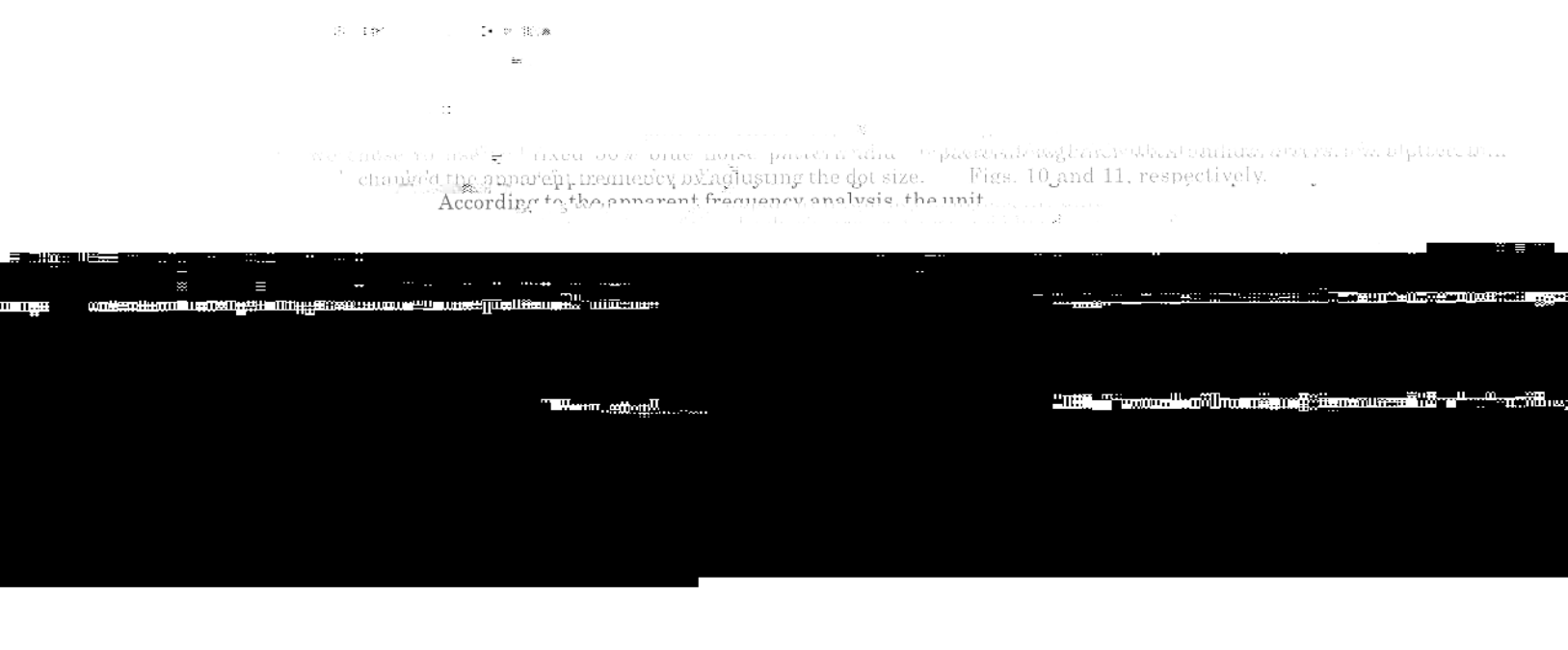
[redacted] is the test patch.

Figure 8. The illustration of the new stimuli [redacted] grating on the rig



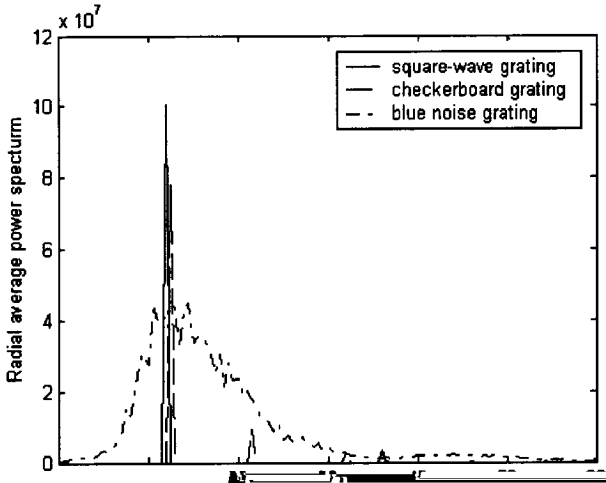
[redacted]

[redacted] the frequency [redacted] dominant radial frequencies, but the unit feature sizes [redacted] be analyzed based on



[redacted] changed the apparent frequency by adjusting the dot size. Figs. 10 and 11, respectively.

According to the apparent frequency analysis, the unit [redacted]



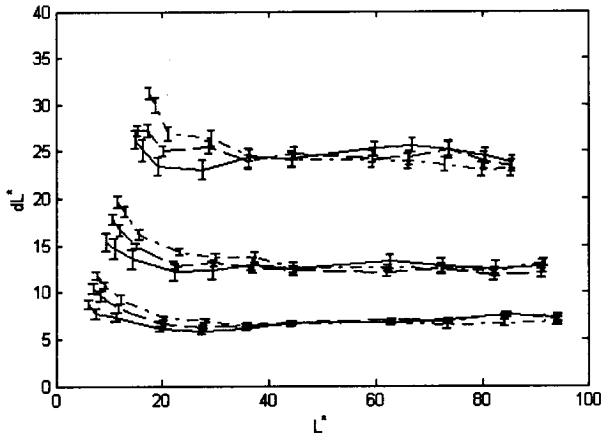
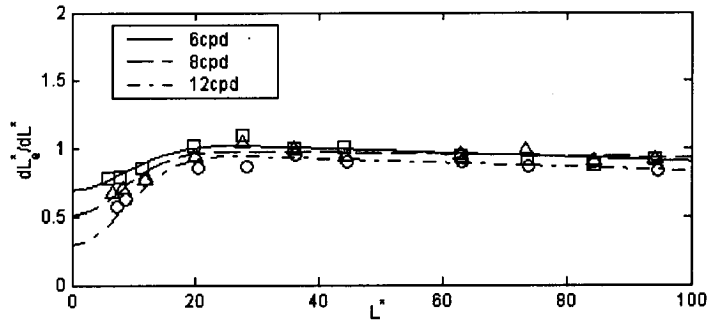
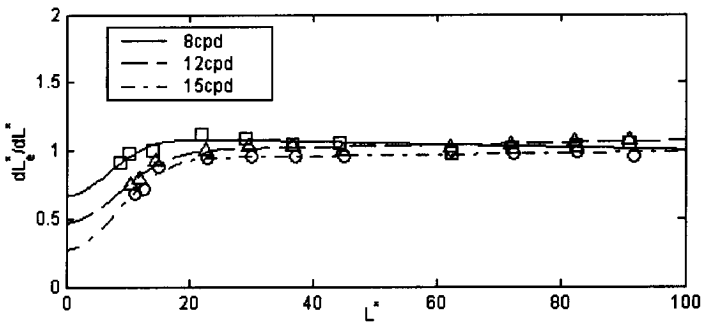


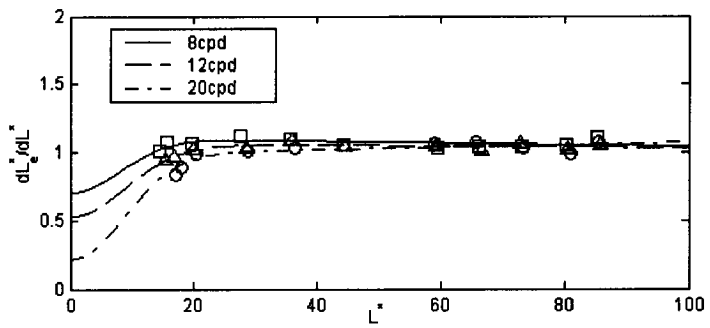
Figure 11. The average results of the six observations for the



(a)

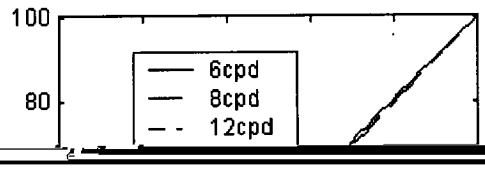


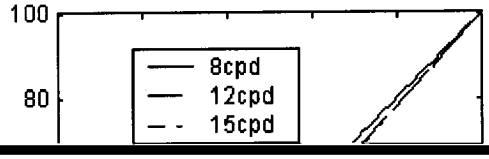
(b)

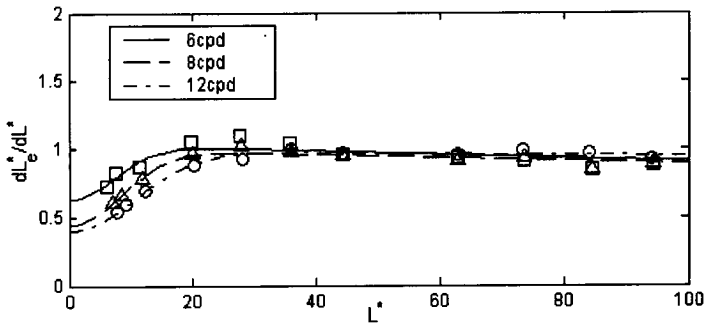


(c)

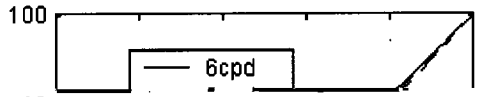
Figure 12. dL^*_e/dL^* (a) $\Delta L^* = 6.20$, (b) $\Delta L^* = 12.7$, and (c) $\Delta L^* = 25.5$. Checkerboard grating.

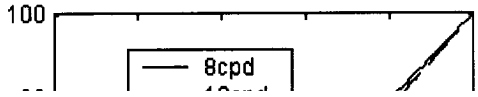

100
80
6cpd
8cpd
12cpd

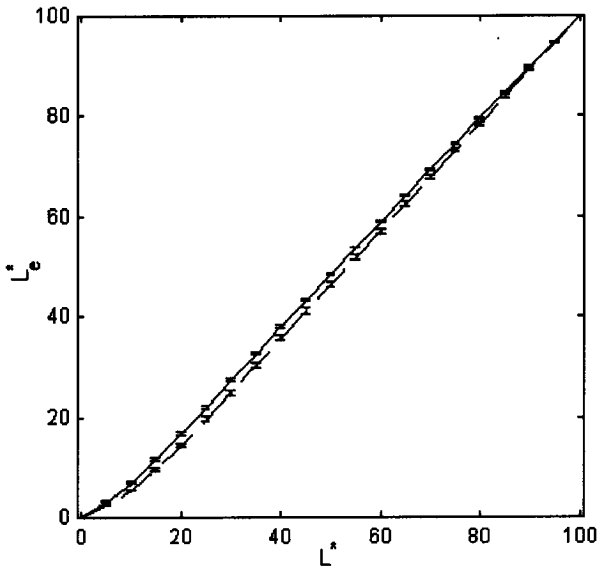

100
80
8cpd
12cpd
15cpd

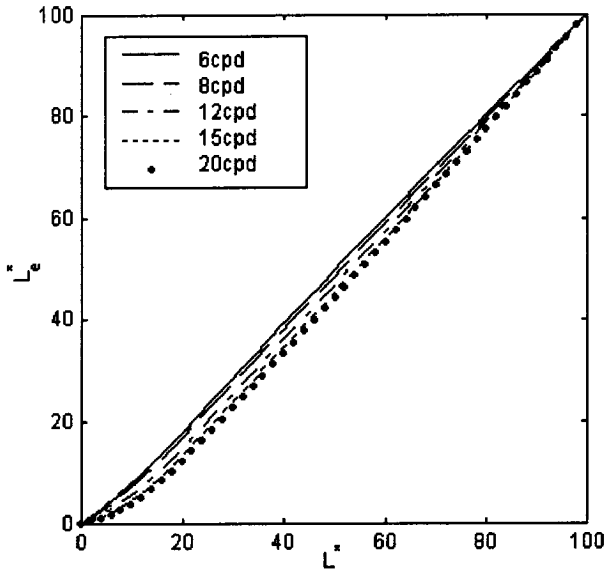


(a)


100
6cpd

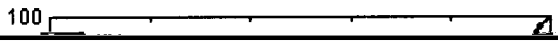

100
8cpd

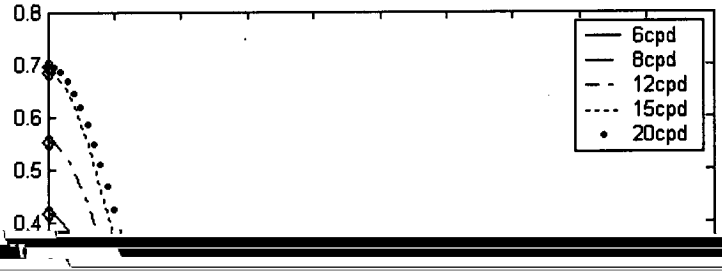




(a)

Figure 16. Average L_e^* (checkerboard and blue noise pattern) and the deviation from the average L_e^* versus L^* under fre-





L*

Figure 18. $d(L^*, L^*)/dL^*$ as a function of frequency (blue noise pattern). In this figure, for each curve, four points are selected:

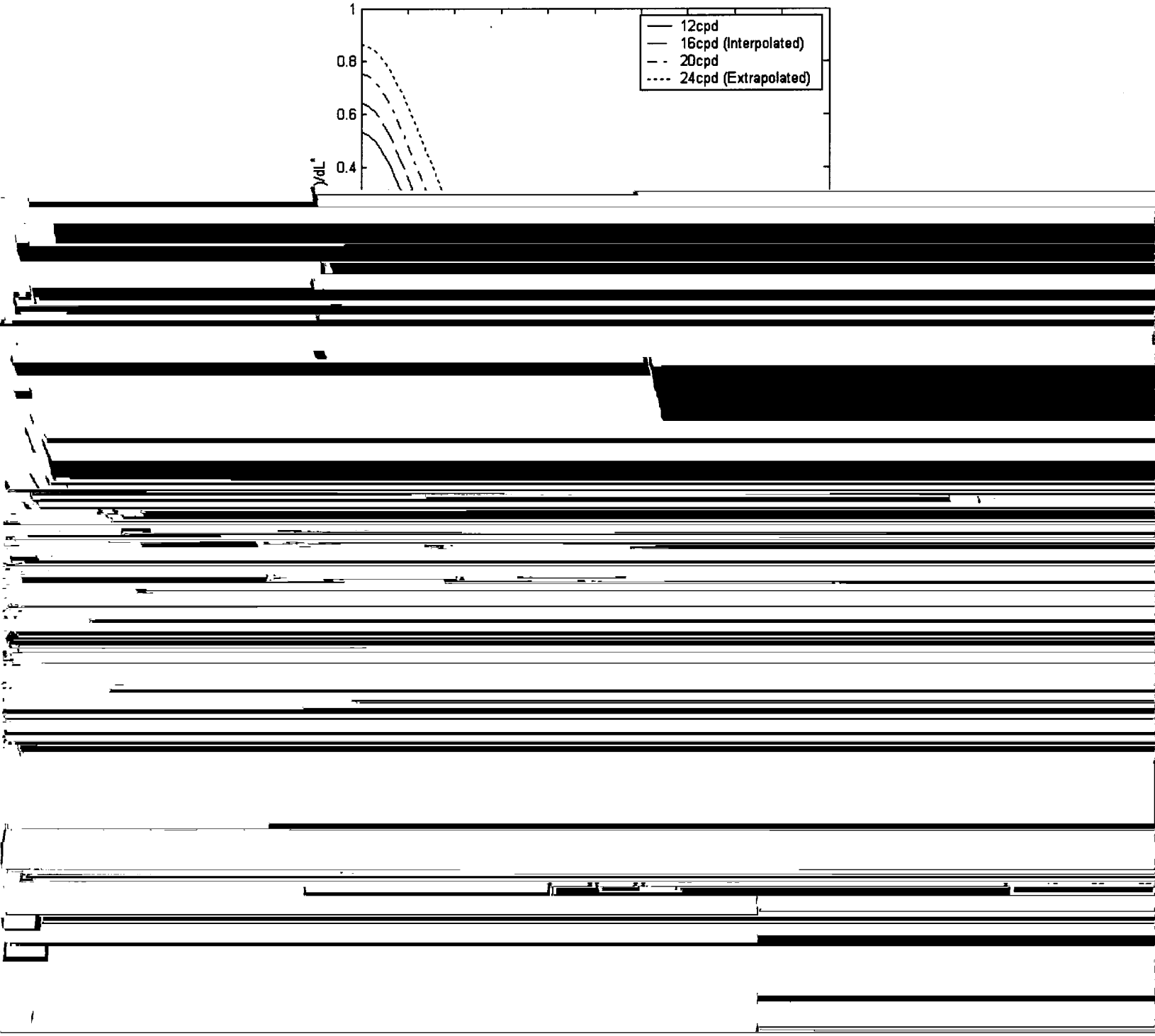
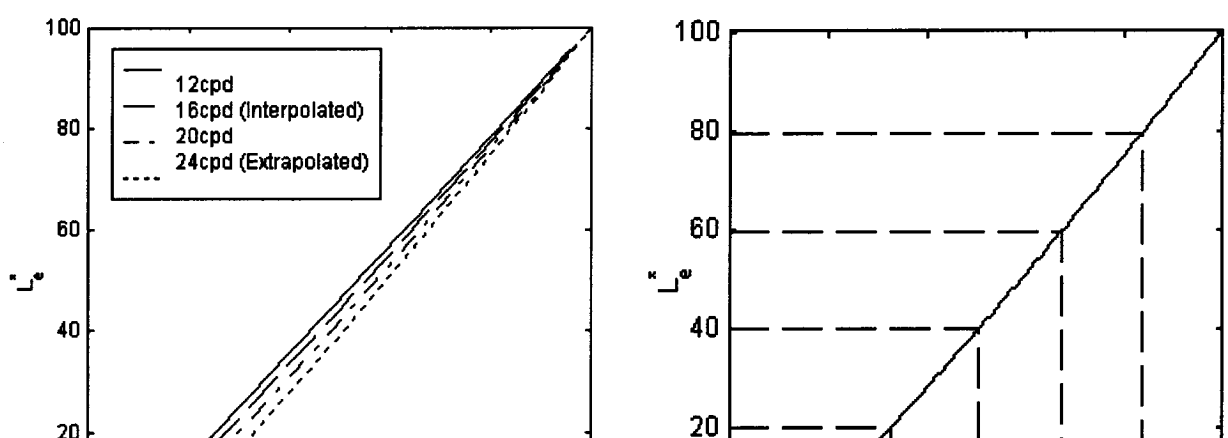
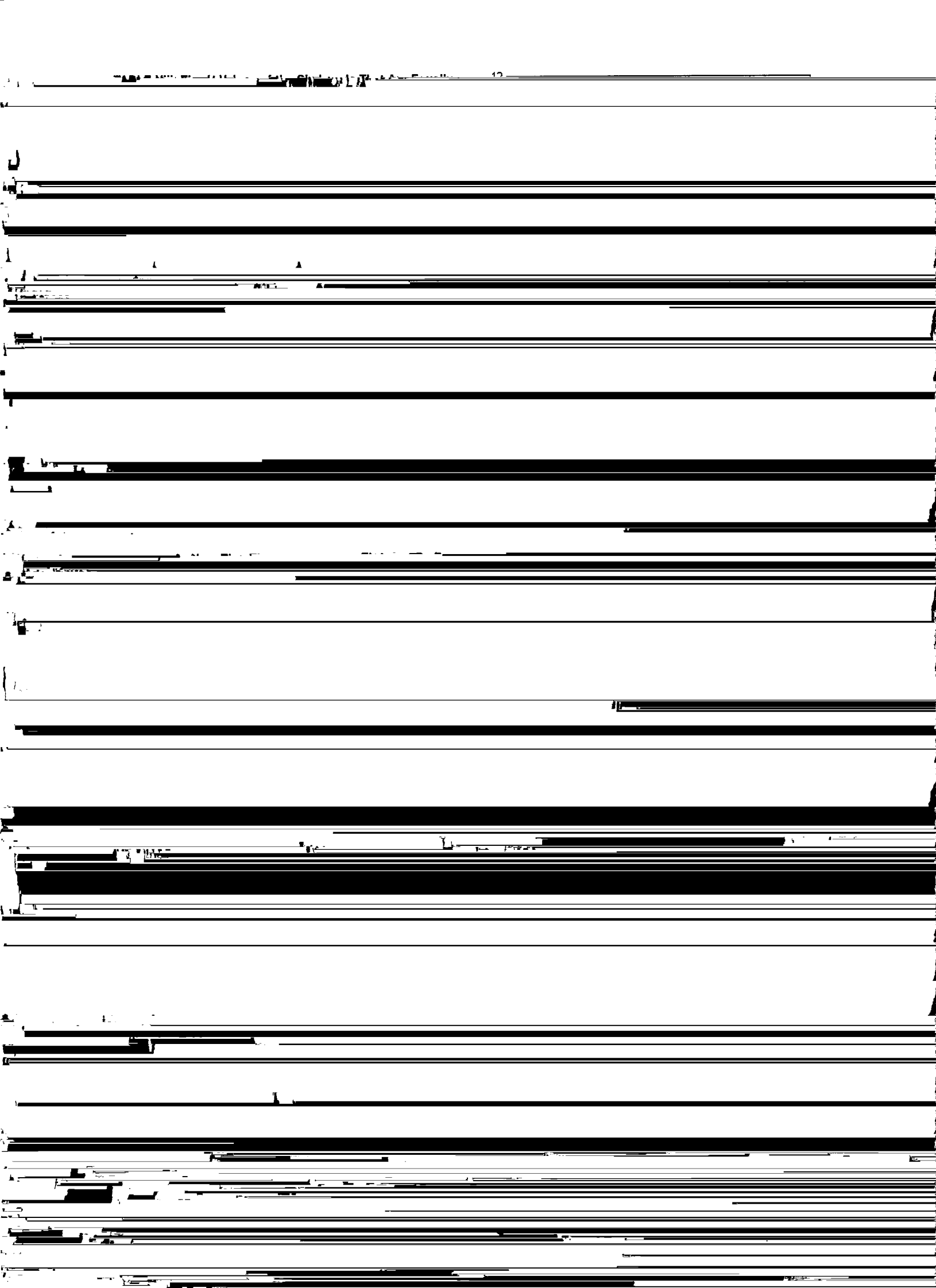


Figure 19. The predicted $d(L^*-L_o^*)/dL^*$ as a function of frequency. Blue noise pattern. The 16 cpd is obtained by interpolation, and the 24 cpd is obtained by extrapolation.





Conclusions

In this study, psychophysical experiments were described investigating lightness difference perception for spatially modulated patterns using a lightness differ-

produced halftone patterns where the pattern visibility is significantly more uniform than when the levels are equally spaced in L^*.