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Portfolio Paper

Hidden Images on Color Honeycomb Moiré Patterns

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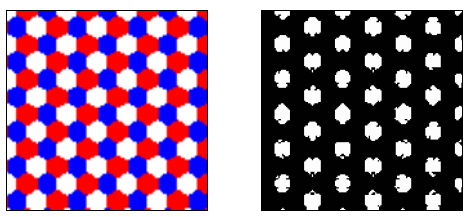
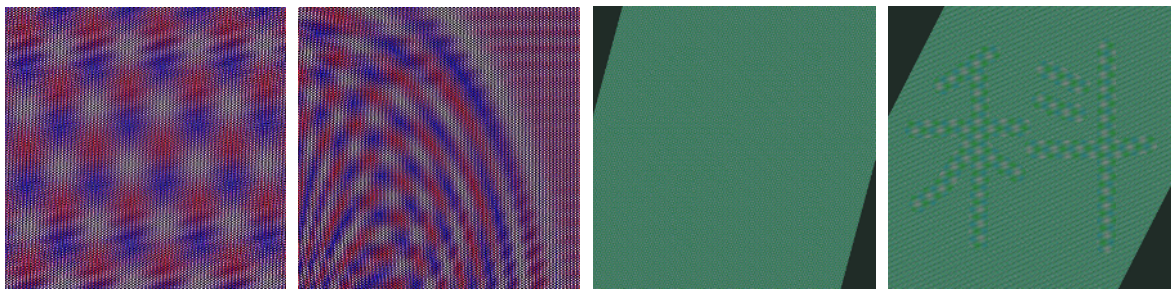
This portfolio paper shows colorful honeycomb moiré patterns and the application of honeycomb moiré to hidden images. It is well known that fine regular line patterns are overlapped to generate coarse moiré fringes. In order to generate spotted moiré, the authors have employed honeycomb patterns constructed with tiny hexagons as shown in Fig. 1. The left image is a color honeycomb pattern with red, blue and white hexagons used for a base pattern and the right one is a monochrome pattern for a screen overlapped on the base pattern, screen on which white color expresses transparent area. If these images are overlapped without shift and rotation, we can see only red hexagons through the transparent part of the screen. However, by rotating the screen at an overlapping angle θ, a spotted moiré pattern, that is called honeycomb moiré in this paper, is generated and the spatial frequency periodically changes with the overlapping angle. Figures 2(a) and (b) show a uniform honeycomb moiré for θ = 2 deg and a deformed one using a B/W screen modulated with some image effect software.



(a) Color honeycomb (b) B/W screen

Fig. 1. Base honeycomb pattern and screen pattern (enlarged).

Moiré is used as a technique of hidden image[1, 2] and the honeycomb moiré is also effective for hiding target images. Since the spatial frequency of honeycomb moiré periodically changes every 60 deg by rotating an overlapping screen, we have only to angularly modulate the honeycomb pattern in the area of target image at 30 deg on a base pattern or a screen one, in order to embed the image on the pattern. The spatial frequencies of honeycomb moiré in the target area and in the background are the same to each other at the overlapping angle 15 deg, hence the border of the target image become invisible. Inversely, the target image is clearly visible at the overlapping angles 0 and 30 deg because the spatial frequency on the area of the target image is quite different from that on the background. Figures 2(c) and (d) are an example of hidden and appeared images for a Chinese character "科" using color honeycomb moiré. In this case, the character is embedded in a base honeycomb pattern consisting of sky blue, green and white hexagons.



(a) Uniform pattern (θ = 2 deg) (b) Deformed pattern (θ = 0 deg) (c) Hidden image (θ = 15 deg) (d) Appeared image (θ = 27 deg)

Fig. 2. Color honeycomb moiré patterns and a pair of hidden and appeared images.

References: (1) Van Renesse, R. L., Proc. of SPIE, 4677, (2002), 333-348. (2) Amidror, I., Proc. of SPIE, 4677, (2002), 89-100.