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Portfolio Paper

Patterns of Crowd Behavior Using a Hidden Network Structure

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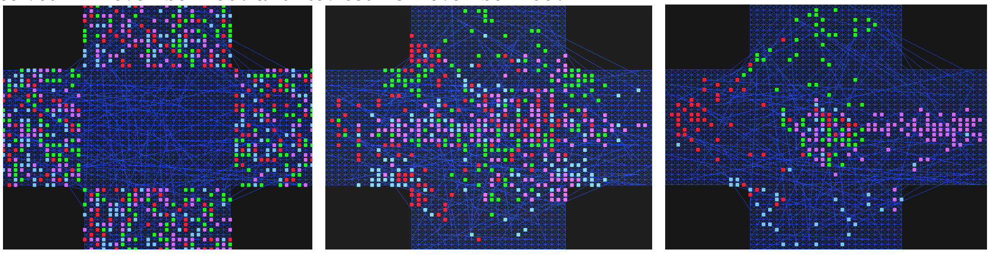

Fig. 1. Agents move on a network in an intersection according to some rules. Colored points show agents.

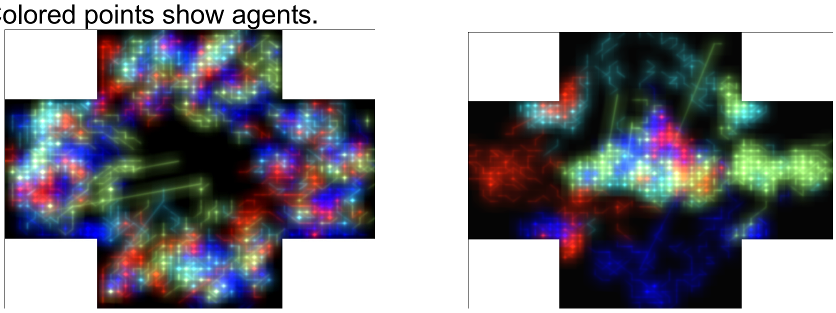

Fig. 2. Trajectories of each agents are visualized by Pixel Exposure Method with an exposure of 3 steps.

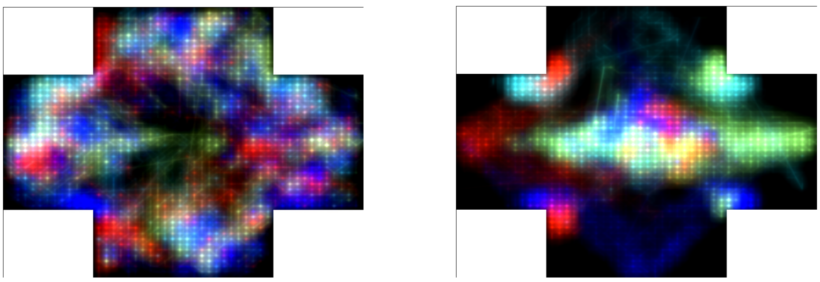

Fig. 3. Trajectories of each agents are visualized by Pixel Exposure Method with an exposure of 15 steps.

Various patterns emerge from crowd behaviors; march, vibration, straying, a swarm of mosquitoes, etc. It has been considered that such a pattern is caused by some interaction between individuals forming the crowd. Reproduction of the pattern has been explored in many previous works(1). Patterns represent a static and a dynamic state. Both have a certain kind of beauty like fluid art(2), (3), so that they are used for the particular motif of a picture or industrial design(4). We try to reproduce the patterns using a multi-agent simulation for crowd behavior in a space, where a network structure is assumed to exist behind the crowd. These figures show patterns emerge from the movement of agents in an intersection region, which consists of a network as shown in Fig. 1. After visualizing it using *Pixel Exposure Method*(5), a large scale structure appears (in Figs. 2 and 3).

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Portfolio Paper

Optical Effects of Wake Liquid Vortices

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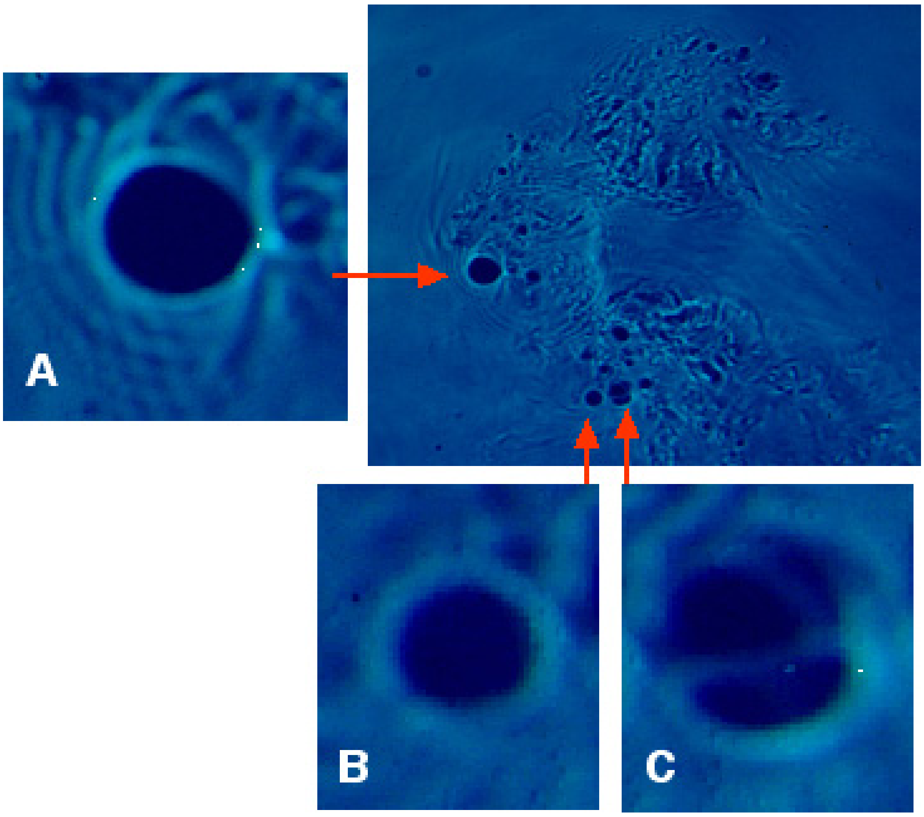

The above photograph, among other hydrodynamic displays, it captures the refracted shadows of a multitude of free surface, cusp shaped, vortices on the bottom of a swimming pool. Professor Kiehn while emerging from a pool in Brazil[1] noticed the intriguing optical properties associated with vortices of this kind. The present flow was generated in a large swimming pool using a thin wooden plank of approximately 20 cm in width. The board was first lowered into water; it was translated to the left, and then it was slowly fully withdrawn. The image, taken from above the swimming poor in sunshine, 40 seconds after the board was fully withdrawn, shows a snapshot of the highly dynamic translating wake development. A Nikon digital camera D50 was used to capture this image. Amongst some other fluid mechanical manifestations it also reveals that the field is infested by a swarm of hydraulic vortices. Appearing in both whirls of the enlargements (A) & (B) is the characteristic dark disk-halo optical pattern. Off course in (A) the corona is interacting with Kelvin's ripples (visible to the left of the vortex) produced by the moving pressure disturbance and other neighboring vortices. Magnification (C) depicts the early beginnings of a single vortex mutation into three vortices. Coalescence of vortices can also momentarily generate comparable refracted patterns.

Reference : (1) Sterling, M. H. et al., Phys. Fluids, 30-11 (1987), 3624.

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Portfolio Paper

Wall Cavitation Caused by Projectile Impact

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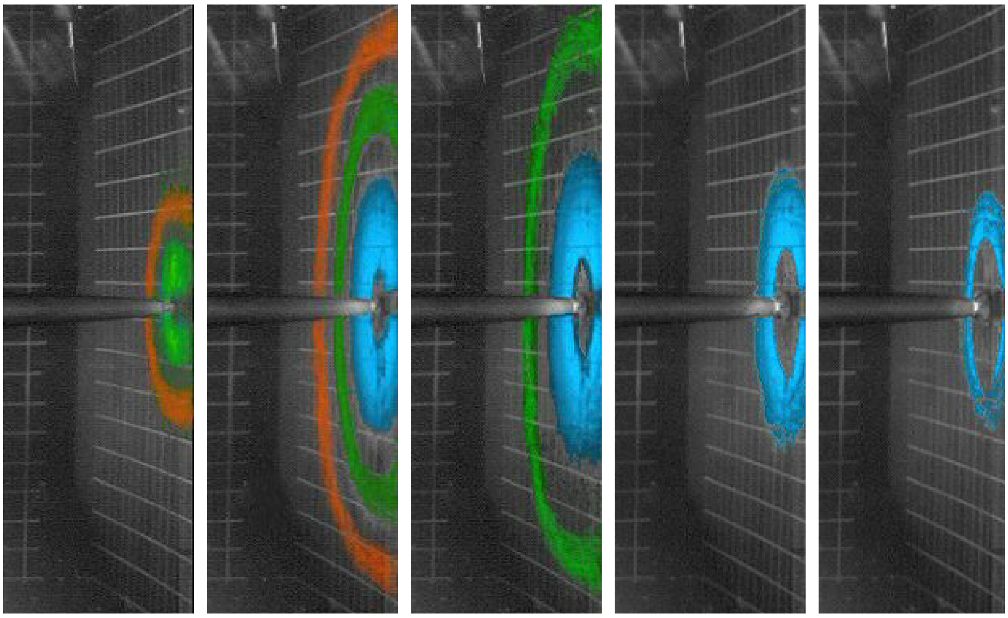

Fig. 1. Cavitation Formation Pattern.

The figure shows a series of five images taken at 139 μsecs apart of a ring pattern formed by cavitation bubbles. These bubbles were a result of a 12.7 mm diameter spherical projectile being propelled at a velocity of 335 m/s (1100 ft/s) through a target panel into a large scale fuel tank simulator that had dimensions of 1.83 m high x 1.83 m wide x 1.17 m long, filled with water, and impinging on the back wall of the tank where it was prevented from exiting. A high-speed digital camera acquired the images at 7207 frames/second through an acrylic side wall of the tank.

Cavitation within water occurs when the local water pressure decreases below a critical value(1), which occurs due to the pressure waves emitted from the projectile impact and resulting wall oscillations(2). These rings, pseudo-colored to highlight the effects, represent the low-pressure regions of the pressure waves as they move radially outwards from the impact point, before finally collapsing. The pattern is created due to a combination of the waves moving through the water and surface waves moving through the steel wall. The green ring in the first image matches the speed of sound through the water, while the red ring in the first image moves at a faster rate, consistent with the surface wave speed in steel. After the low-pressure regions pass, the cavitation bubbles collapse(1), (3), creating rings absent of cavitation bubbles.

References : (1) Trevena, D. H., Cavitation and Tension in Liquids, Adam Hilger (1987). (2) Bowden, F. P. and Field, J. E., Proceedings of the Royal Society of London, Series A, (1964), 282-1390. (3) Kutruff, K. H., The Journal of the Acoustical Society of America, 106-1 (1999), 190-194.

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Portfolio Paper

Hidden Images on Color Honeycomb Moiré Patterns

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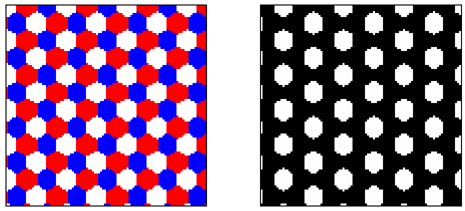
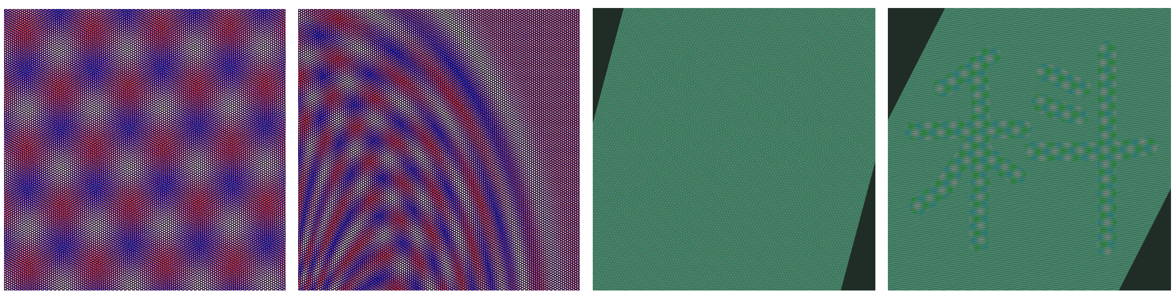
This portfolio paper shows colorful honeycomb moiré patterns and the application of honeycomb moiré to hidden images. It is well known that fine regular line patterns are overlapped to generate coarse moiré fringes. In order to generate spotted moiré, the authors have employed honeycomb patterns constructed 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.