Perspective Driven Barrier Grid Animation

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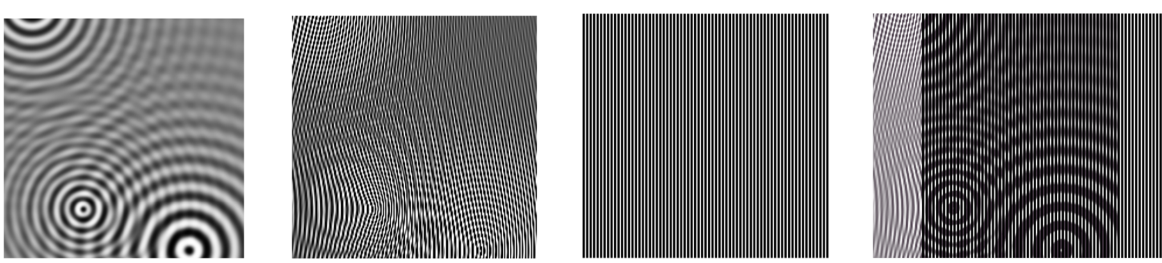
Abstract

In this paper we explore the concept of Barrier Grid Animation (BGA) on an architectural scale, emphasizing the dynamic effect produced by the observer's position in relation to the system. The standard method for creating BGA involves superimposing two layers, producing the effect by sliding the strips layer from its original position. I aim to examine BGA from a spatial perspective, with the effect activated by the observer's movement.
As a case study, this method was used for a site specific artwork at Palazzo Strozzi in Florence where the pattern appears to change with the shifting perspectives of the visitors. By doing so, I aim to demonstrate the potential for creating dynamic and interactive BGA patterns in art and architectural design, providing a basic and flexible setup that can be used for different scenarios and at different scales.

Introduction

Barrier grid animation (BGA) or picket-fence animation is a well-known concept developed in the 1890s and largely applied in postcards, books and small artworks as a relatively inexpensive and simple way to produce animated images in prints. It is also known as Moiré Animation, Kinegram, Magic Moving Images or Scanimation.

The basic setup characterizing this dynamic visual phenomenon, is composed by two overlapping layers: the "animation layer", placed at the back, where multiple images (the frames of the animation) are subdivided into strips and interleaved, as can be seen in Figure 1(b) and a second layer called "barrier grid", serving as a modulator and consisting of a series of black slits alternating with transparent gaps, as shown in Figure 1(c). The latter permits the selective visibility of strips from a single interleaved image at any given moment. The translational displacement of the grid relative to the interleaved image induces a sequential presentation of each image, thereby facilitating a coherent animated visual experience for the viewer. The size of the slits is determined by the desired resolution of the animation and the number of frames.



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

Figure 1: *(a) target image frame. (b) interleaved image. (c) barrier grid. (d) Overlay of the interleaved image with the barrier grid layer.*

Despite its simplicity, this phenomenon has mainly been explored on a two-dimensional setup, where the two layers slide on top of each other by manually shifting one of them. As a result, this process was used more commonly as a tabletop device and was little adopted at an architectural scale. This paper demonstrates how achieving the same animation effect is possible without translating the two layers, but only by changing the observer's perspective. This means that the animation's velocity is controlled by the subjective viewer's speed rather than the mechanical movement of the layers.

Methods

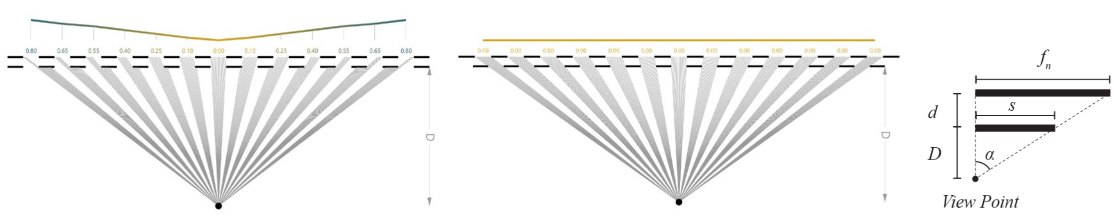
In its two-dimensional setup (Figure 2), BGA is characterized by two aligned layers where the ratio of the width (b) of a barrier segment to the width (s) of a slit is determined by the number of animation frames via the following formula:

$$b = (n - 1) \cdot s$$

Where b and s represent the relative widths of the black and transparent slits, respectively and n is the number of the animation frames. The distance between the two layers (d) in this case is irrelevant as they overlap and slide on each other; therefore, the width of the animation frames (f_n) and the width of the transparent slit (s) are equal.

Figure 2: *The base schematic setup of Barrier Grid Animation with its main parameters.*

When the proportions of the 2d setup are respected, all the slices of a specific frame are visible at the same time. The challenge of a perspective based BGA is primarily to determine the appropriate ratio between layers' distance and layers' width to allow the complete vision of all the slices of a single frame at different view positions. A schematic model (Figure 3) was built to compare different scenarios and to validate our assumptions. Due to its flexible open structure, the Grasshopper 3D plug-in for Rhinoceros was selected as the algorithm editor to support the digital workflow.



(a) (b) (c)

Figure 3: *Analysis models evaluating the percentage of frames obstructed by the barrier grid. In the scheme (a) both the layers have equal unitary width. In scheme (b) the "animation layer" is scaled in accordance with the target viewpoint, as illustrated in the third scheme (c).*

The initial setup we evaluated, shown in Figure 3(a), is formed by two identical layers precisely placed in front of each other, where the transparent and black slits have the same width (defining a two frame animation). The model highlights the percentage of visual rays blocked by the barrier grid that attempt to hit the animation frames facing the transparent slits. From the graph curve on top of the scheme we can observe how the legibility of the image is gradually reduced towards the edges of the screen.

Consequently, to achieve a homogeneous effect, the 'animation layer' must be stretched according to the chosen perspective view point and the set distance between the two layers, as can be seen in Figure 3(b). The width of the animation frames (f_n) can therefore be defined by simple trigonometry (as illustrated in diagram in Figure 4(c)), based on the target parameters of the viewpoint distance (D), layers′ distance (d), and unitary width of the barrier grid (s).

$$\tan\alpha = \frac{s}{D} = \frac{f_n}{(D+d)}$$

The "animation layer" will then result as the projection from the target view point of the barrier grid onto a plane, set at a defined distance from it.

Results and Reflections

This method was applied to the artwork "Under the weather" from Studio Olafur Eliasson, exhibited in 2022 at Palazzo Strozzi in Florence (Figure 4). Upon entering the courtyard of the palazzo, visitors encounter a large elliptical screen hanging above them. The artwork was positioned parallel to the ground, ensuring a consistent distance between the viewers and the screen. As visitors moved around the courtyard, the pattern appears to change with their shifting perspectives, encouraging them to continue to move. In this way, the Barrier Grid Animation creates an interactive visual experience that is informed not only by the work, but by the visitors varying viewpoints and movements.

Figure 4: *"Under the weather", Studio Olafur Elisson, 2022 - Fondazione Palazzo Strozzi, Florence Photo: Ela Bialkowska, OKNO Studio. Courtesy Fondazione Palazzo Strozzi.*

In this case study, the barrier grid layer was created using recycled polypropylene strapping, precisely arranged at equal intervals, while the interleaved image was printed on a textile mesh placed above it at a given offset distance. Thanks to the flexibility of the algorithmic framework, it was easy to adjust the design to fit the spatial constraints of the location and the chosen material properties.

Figure 5 demonstrates that when the viewpoint is moved perpendicular to the direction of the barrier grid, the percentage of visual rays obstructed by the barrier grid and unable to reach the target "animation frame", remains constant across the entire screen. This indicates that, in the presented method, positional changes do not affect the legibility of the image.

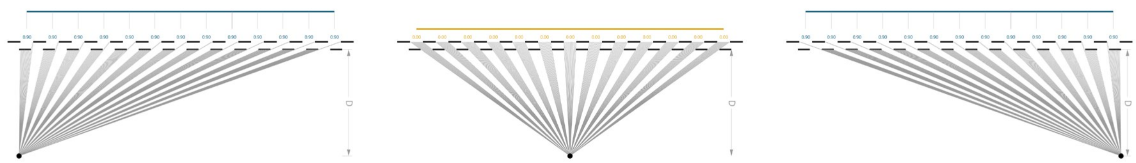


Figure 5: *Studies of image legibility at different viewer positions.*

Unlike the two-dimensional BGA, where the animation speed is controlled by the mechanical sliding of one layer over the other, the three-dimensional model enables precise definition of the frequency of the animation loops by adjusting the distance between the two layers. The larger the spacing, the greater the number of repeats when moving from one side of the screen to the other.

Conclusions

This paper shows how standard methods of animated postcards could be translated to an architectural scale and enhance and trigger our relationship with our surroundings. This model is not limited to Barrier Grid Animation but can be applied to all types of Moiré patterns, conventionally treated in two dimensions by layer superimposition.

Some issues still remain in the development of this technique. The method described in this study is applied to a specific case scenario where the distance between the viewer and the screen is constant. If the distance varies, the viewer's vision of individual frames will be partial and gradually blend together with the other image portions. In addition to this, the effect is also triggered and limited by the linear motion on the axis perpendicular to the direction of the slits; if the observer moves parallel to the slits, they will not experience the virtual animation of the screen. A new methodology capable of multidimensional navigation is currently being developed.

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