LITERATURE REVIEW - 3

Computer Graphics

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Paper 1: Swinging 3D Lamps: A Projection Technique to Create 3D Illusion on Static 2D Image

Published in: ACM SIGGRAPH Computer Graphics

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Authors: Markus Huber (University of Stuttgart)

Bernhard Eberhardt (Stuttgart Media University)

Daniel Weiskopf (University of Stuttgart)

Paper 2: Deformation Lamps: A Projection Technique to Make Static Objects Perceptually Dynamic

Published in: ACM Transactions on Applied Perception (TAP)

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Light projection is a powerful technique that can be used to edit the appearance of objects in real world. In Deformation lamps- a projection technique to make static objects perceptually dynamic, they propose an alternative light technique that adds a variety of illusory yet realistic distortions to a wide range of 2D and 3D projection targets. The key idea of their technique, referred to as (Deformation Lamps), is to project only dynamic luminance information, which effectively activates the motion (and shape) processing in the visual system while preserving the color and texture of the original object. Although the projected dynamic luminance information is spatially inconsistent with the color and texture of the target object, the observer's brain automatically combines these sensory signals in such a way as to correct the inconsistency across visual attributes. They conducted a psychophysical experiment to investigate the characteristics of the inconsistency correction and found that the correction was critically dependent on the retinal magnitude of the inconsistency. Another experiment showed that the perceived magnitude of image deformation produced by their techniques was underestimated. The results ruled out the possibility that the effect obtained by their technique

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stemmed simply from the physical change in an object's appearance by light projection. Finally, they discuss how their techniques can make the observers perceive a vivid and natural movement, deformation, or oscillation of a variety of static objects, including drawn pictures, printed photographs, sculptures with 3D shading, and objects with natural textures including human bodies.

In spatial augmented reality, the user's physical environment is augmented with light-projected images that are integrated directly into the user's environment. The light projection can dramatically modify the appearance of the real objects surrounding us by changing the light transport while keeping an object's physical material and shape intact. Dynamic aspects of an object's appearance can also be modified by light projection. They proposed a novel light projection technique called Deformation Lamps that makes a static object appear to deform and move while keeping the object's appearance almost intact. Their effects only superimpose dynamic luminance signals onto a colorful static object and produce an illusory but realistic movement of the object.

The representative system of their technique uses a camera-projector system. The system first takes a gray scale image of a colorful target object using a camera. Second, it creates a sequence of deformed gray scale images by dynamically deforming gray scale images in accordance with a sequence of predefined deformation maps. Third, the system subtracts the pixel intensity value of the original image from each deformation image. This results in a sequence of intensity difference images produced by the deformation sequence. Finally, the sequence of intensity difference images is projected as a gray scale image sequence onto the target object. Observers reviewing the target object have the illusory perception that the object, including its color components, is moving or deforming. Compensation of the projection image is optional. By manipulating deformation pattern and with proper image alignments, their technique can animate 3D textured/shaded objects.

According to standard definition of image movement i.e., spatial shifts of intensity/color pattern over time, their techniques does not always produce image movements of the intensity component in a physically correct way. It does not even produce image movements of the color component. Their technique creates impression that the object is moving without shifting the position of the object images. It adds luminous motion signals that activate the motion sensors in human visual system. It can add a variety of distortions/movements to static objects. They found that in many cases, simple projection of a dynamic achromatic pattern with manual adjustments of projection parameters such as contrast and gamma was sufficient to produce a convincing illusion of movement in real static object. Their technique is robust against a wide variation in projection/illumination conditions.

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The characteristic of image processing explain why our technique can effectively drive human motion sensors when the projected luminance pattern is at low contrast. A weighted summation of the original and shifted image results in a partially shifted image with the shift magnitude dependent on weight. Contrast of a projected shifted pattern is reduced; phase shift is reduced in the summation image as a natural shift. Given these properties of low level motion mechanism, it can be assumed that the gray scale dynamic image contains almost all the motion information needed to drive this mechanism. The motion mechanism favoring low frequency patterns is barely affected by the high-frequency reduction caused by optical blur. Therefore, in our technique, the projected dynamic image component is expected to activate the low-level motion mechanism in almost the same manner as would a color image sequence that the system was intended to produce. They consider that this inconsistency can be perceptually resolved by the brain when it integrates motion form and color signals.

Based on an experiment conducted their theory predicts that technique will have two properties dependent on human perceptual mechanism. For example, there must be a maximum limit to physical magnitude of deformation that is allowed for projected image. Though their technique consistently used a static object as a projection target it is possible, in a principle to give dynamic impression to surface of a moving object. To apply their technique to dynamic objects, they need to track the position and shape of moving objects in real time. Combining their techniques with other light projection techniques maybe an effective way of changing both the static and dynamic aspects of appearance of real object. For instance the shader lamp computation does not have to consider the objects movement at all if the computation is performed using their technique can access the object appearance modified only by the way of shader lamp.

Swinging 3D lamp is a multiuser and naked three dimensional display technique using a projector and common printed media. The basic idea involves combining “wiggle stereoscopy” a method of creating 3D images by exploiting motion parallax with “dynamic luminance” projection, a technique making static images dynamic. Wiggle stereoscopy can be realized by rapidly alternating between stereoscopic pairs on common flat screens. Motion parallax 3D display techniques involving head-tracking and multi view 3D display techniques such as parallax barriers and lenticular sheets also produce similar motion parallax effects when the viewing direction changes. Head tracking devices are normally limited to single person use as the displayed information depends on the position of the observer.

An additional technique utilized here is “dynamic luminance projection”. It is based on characteristic of human visual system in that it binds the input of the color, shape and motion to render a coherent visual scene while automatically correcting small alignments in characteristics. These dynamic patterns are simply obtained by subtracting the image from subtly deformed movie in every frame to provide the illusion of motion to observers, they are projected onto a static image as shown in the technique of deformation lamp. By combining these two phenomenon, swinging 3D lamps can realize the sudden change of a common normal static 2D image into moving 3D image that provides the viewer with the surprise as magic as motion captured serves as an illusion , the illusion amount collapses when the displacement amount of the original information surpasses the visual angle by approximately 0.2-0.3. Based on study they found that the low spatial frequency components of an image is more easily integrated into motion information than high frequency components in the area where the deformation of displacement amount is relatively large enables the successfully illusory integration of motion and static information while the total displacement is large thus it conveys a strong perception of the depth. Considering the amount of displacement of each pixel in motion pattern is solely determined by its depth value because objects are located farther from the convergence point move faster than the objects located closer, substitution of shallow DOF images that have several low frequency components in the out of focus area for the original image.

Wiggle stereoscopy, dynamic luminance projection and spatial augmented reality these phenomena combined together makes an actual 3D effect in image pixels. The aim involves of converting an RGB image into RGDB image in a simple and clever way. The proposed technique is useful for simple and eye catching 3D displays in public spaces because of the fact that depth information can be presented on the common printed images and that multiple people can perceive the depth without special glasses or equipment. Thus combining theory from these study materials is one of the effective way of conversion of motion to depth and the conversion of a static 2D image into 3D image in a simple manner.