Augmented Clothing

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Abstract

Augmented reality (AR) is the concept of inserting virtual objects into real scenes. Typically, these augmentations are aligned with rigid planar objects in the scene, which can sometimes be restrictive. This poster presents a method to perform real-time 2D augmentations on non-rigid objects, such as clothing. In addition, a novel technique to establish common illumination and render augmentations with correct real world shadows is included. The ability to render augmentations on clothing leads to applications in fashion, advertising and museum entertainment. Results of the augmented clothing system are demonstrated with an application to interactively create t-shirt designs by augmenting logos.

1 System Overview

This system operates on video images from a live camera. A set of trackable markers are placed on the surface of a piece of cloth. The marker locations are used to build a virtual mesh representation of the cloth that is rendered with a texture on top of the video image in each frame. In addition, the real world illumination environment is acquired from the input image and a shadow texture is generated and blended with the augmentation during rendering. The output is a mixed-reality video frame that contains an illumination-correct 2D augmentation on the surface of clothing. Figure 1 illustrates the operation of the system for each video frame.

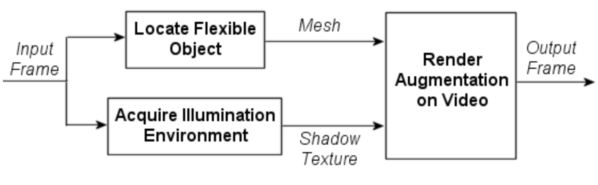

Figure 1: Overview of augmented clothing system.

A similar cloth tracking method is proposed by Guskov et al. [2, 1]. However their system is designed for motion capture and recovery of the 3D model, not real-time augmentations with correct illumination.

2 Locating Flexible Objects

In order to locate the cloth, a set of small circular markers (or targets) are placed on its surface, similar to the markers of Naimark and Foxlin [3]. The markers consist of an inner black circle surrounded by a white ring and a sequence of ten white and black ring segments on the outer border. The outer ring segments represent a 10-bit binary code, used to identify the marker. Tracking the markers starts by adaptively thresholding the grayscale input image, finding contour regions, and computing contour centers. Then the center points are triangulated and a clustering step is performed to group contours that belong to the same target. The contour closest to the cluster center that sufficiently resembles an ellipse is chosen as the target center in each cluster. These steps are illustrated in Figure 2.

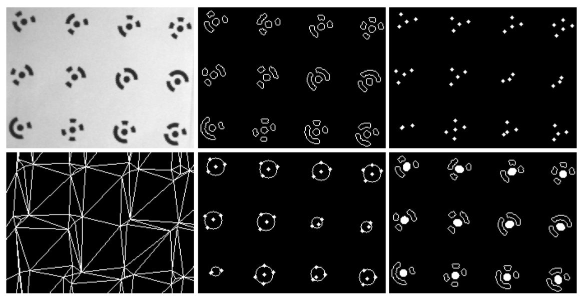

Figure 2: Finding the circular target centers (magnified region of an input image). From top left: Input; Contours are found; Center of each contour; Delaunay triangulation; Result of clustering; Target centers are found.

Once the target centers are found, the elliptical projection of the center circle is enlarged to represent the outer border of each target. Then the targets are unwarped to remove perspective distortion and sampled at various locations to determine the identity of each target. The topology of the targets on the cloth surface is known, and each target maps to one vertex in the mesh representation. The mesh is computed dynamically in each frame using the located targets. If a target is not found then the mesh is interpolated at that location, preventing holes. Figure 3 illustrates the dynamic generation of the augmentation mesh.

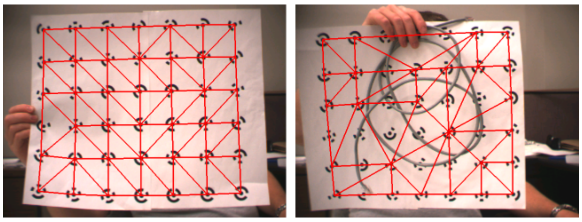

Figure 3: Dynamic triangulation (shown on paper), when all targets are found (left) and when some targets are not found due to occlusion (right).

3 Acquiring Illumination Environment

The flexibility of cloth produces many ripples and wrinkles during interaction, which lead to self-shadows. Rendering these and other shadows with the augmentation greatly increases the realism of the AR experience. The illumination technique uses the fact that the cloth is white and that the input image exhibits the exact shadows to be rendered. For this reason, the grayscale image of the input is used as a shadow texture and blended with the augmentation. However, the circular targets should not appear in the shadow texture, so they are removed using a simple online inpainting algorithm. The shadow texture is rendered using the projected screen coordinates of the mesh vertices as texture coordinates.

4 Rendering Augmentations on Clothing

Augmentations are rendered in two passes. The first pass renders the textured mesh and the second pass re-draws the mesh using the shadow texture and OpenGL blending. Figure 4 illustrates illumination-correct augmentations on a flexible sheet of paper, and Figure 5 shows augmentations on cloth undergoing ripples and wrinkles.

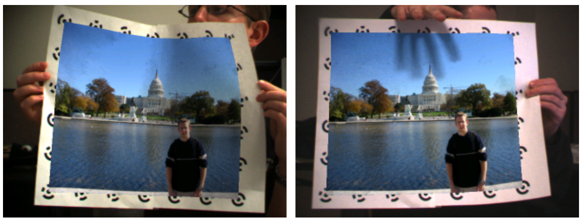

Figure 4: Illumination-correct flexible augmentations (shown on paper), illustrating self-shadows (left) and exact shadow of a hand (right).

An application of the augmented clothing system is demonstrated in Figure 6. In this application a user wears

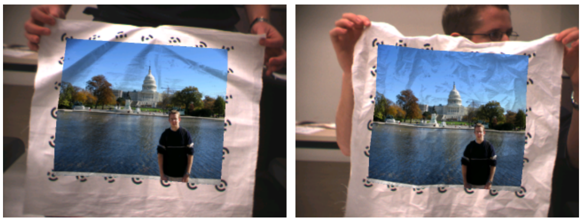

Figure 5: Cloth augmentations including rippling cloth (left) and wrinkled cloth (right).

a t-shirt containing a set of targets and then different logos can be selected and augmented onto the shirt. This allows the user to interactively create t-shirt designs.

Figure 6: Augmented t-shirt application

Other applications include a virtual fashion show, advertising on sports uniforms during televised broadcasts, and interactive museum displays.

Acknowledgements

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References

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[3] Leonid Naimark and Eric Foxlin. Circular data matrix fiducial system and robust image processing for a wearable vision-inertial self-tracker. In *International Symposium on Mixed and Augmented Reality (ISMAR 2002)*, pages 27–36, 2002.