A Projector-Camera System with Real-Time Photometric Adaptation for Dynamic Environments

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DESCRIPTION

Projection systems can be used to implement augmented reality [2,6], as well as to create both displays and interfaces on ordinary surfaces [4,5]. Ordinary surfaces have varying reflectance, color, and geometry. Current methods [1,3,7] use a camera to account for these variations, but are fundamentally limited since they assume the camera, projector, and scene are static. In this video, we describe a technique for photometrically adaptive projection that makes it possible to handle a dynamic environment.

We begin by presenting a co-axial projector-camera system. It consists of a camera and beam splitter, which attaches to an off-the-shelf projector. The co-axial design makes geometric calibration scene-independent. To handle photometric changes, our method uses the errors between the desired and measured appearance of the projected image. A key novel aspect of our algorithm is that we combine a physics-based model with dynamic feedback to achieve real time adaptation to the changing environment.

We verify our algorithm through a wide variety of experiments. We show that it is accurate and runs in real-time. Fig. 1 shows as example that a scene moves during a projection. As shown in Fig. 1(b), the original surface pattern (as illustrated in Fig. 1(a)) can be made to disappear. Fig. 1(c) shows that the surface pattern becomes visible on the building wall after the scene is moved. When our adaptation is applied, the pattern again vanishes as shown in Fig. 1(d). Our algorithm moves beyond the limits of a static environment to make real-time color compensation in a dynamic environment possible. It can be applied broadly to assist HCI, visualization, shape recovery, and entertainment applications.

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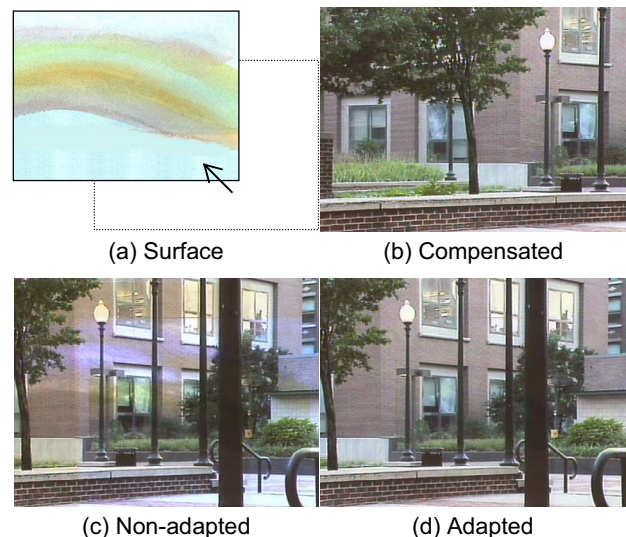
(a) Surface   (b) Compensated

(c) Non-adapted   (d) Adapted

Fig. 1

PROJECTING VIDEO ON A MOVING PAINTING. (A)ILLUSTRATION SHOWING THE PAINTING. (B) RESULTS USING PROJECTION OF CALIBRATION IMAGES. (C) RESULTS WITHOUT ADAPTATION. (D) VIDEO COMPENSATED FOR SCENE MOTION USING PHOTOMETRIC ADAPTATION.