Photometric Compensation for Practical and Complex Textures

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1 Introduction

We propose a photometric compensation for projecting arbitrary images on practical surfaces of our everyday life. Although many previous proposals have achieved fine compensation at their experimental environments [Nayar et al. 2003], they cannot support practical targets including high-contrast texture. In order to adapt to such situation, we need a time-consuming iterative processing with camera feedback. Even though the iterative processing is applied, we cannot obtain fine compensation because no camera pixels of a projector-camera system (procam) correspond perfectly to the pixels of the projector [Mihara et al. 2014].

2 Our proposal

Therefore, in our proposal, a phase-shift pattern projection, which is often used for precise 3D shape measurement, is used for sub-pixel registration of the procam. And also, in order to improve the compensation performance, the effects from neighboring projected pixels are added to the response function which represents the relationship between an input pixel value and measured luminance.

In usual photometric compensation methods, the registration of the procam is achieved with a gray-code projection, which provide a one-on-one pixel correspondence.This registration is insufficient because the pixels of the projector and camera are spatially different. Instead of that, the sub-pixel registration of the phase-shift pattern projection is quite effective for precise modeling of the response function. When we measure a pixel luminance, the input values of the pixels related to the measured pixel are effectively used for compensating high-contrast parts of target textures.

In addition, diffused light from neighboring pixels is also a negative factor to degrade the compensation. Therefore we extend the response function as follows. Eq.1 is an original response function at pixel (s, t) whose input value is $i_{s,t}$. Measured luminance as Eq.2 adds simply the neighboring effect with ratio $k_{s',t'}$. However, the solving of this function depends on the neighboring pixels. So we practically use approximated Eq.3 with the assumption that color and response function of the neiboring pixels are quite similar. $k'_{s,t}$ is previously measured for each target surface.

$$\begin{aligned} Resp(s,t) &= Lumi^{max}_{s,t}(i_{s,t}/255)^{\gamma} + Lumi^{min}_{s,t} && (1) \\ Lumi(s,t) &= Resp(s,t) + \\ & \quad \sum_{s',t'} k_{s',t'} Resp(s+s', t+t') && (2) \\ &\simeq (1 + k'_{s,t}) Resp(s,t) && (3) \end{aligned}$$

Figure 1 shows the results of our compensation method. An image is projected on a general curtain with high-contrast patterns. From Figure 1(c), the patterns are almost compensated and we cannot perceive them. Compared with the gray-code registration (Figure 1(d)) including 15 iterations, our proposal (Figure 1(e)) can well reduce the effect from the high-contrast patterns only with the one-shot compensation.


a) original image b) without compensation


c) compensated with our proposal

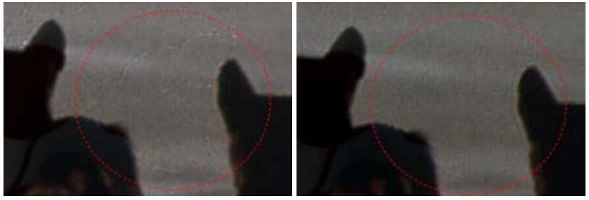
d) gray-code e) phase-shift pattern

Figure 1: *Results of photometric compensation with our proposal.*

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References

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