# Appearance Sampling for Obtaining a Set of Basis Images
# for Variable Illumination

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Previous studies have demonstrated that the appearance of an object under varying illumination conditions can be represented by a low-dimensional linear subspace. A set of basis images spanning such a linear subspace can be obtained by applying the principal component analysis (PCA) for a large number of images taken under different lighting conditions. While the approaches based on PCA have been used successfully for object recognition under varying illumination conditions, little is known about how many images would be required in order to obtain the basis images correctly. In this study, we present a novel method for analytically obtaining a set of basis images of an object for arbitrary illumination from input images of the object taken under a point light source. The main contribution of our work is that we show that a set of lighting directions can be determined for sampling images of an object depending on the spectrum of the object's BRDF in the angular frequency domain such that a set of harmonic images can be obtained analytically based on the sampling theorem on spherical harmonics.

**Publication**

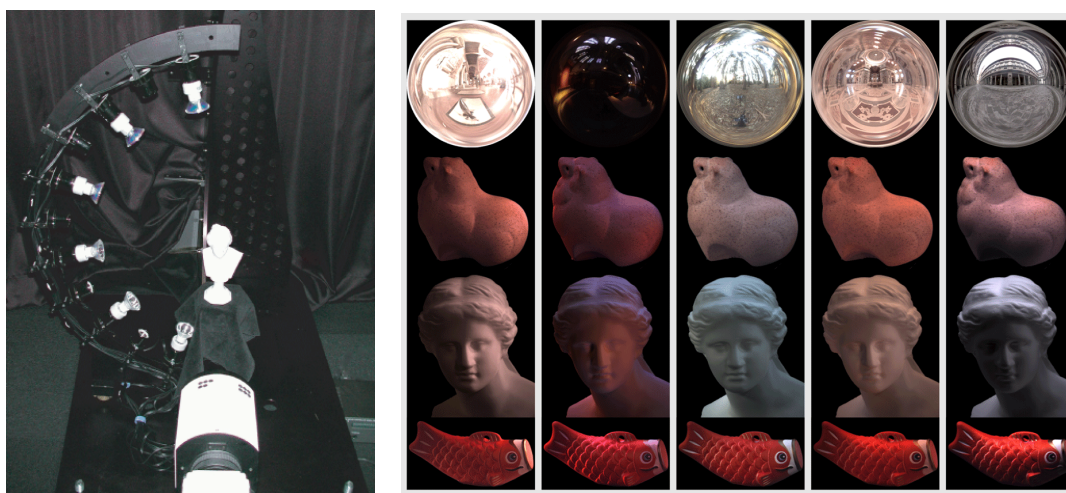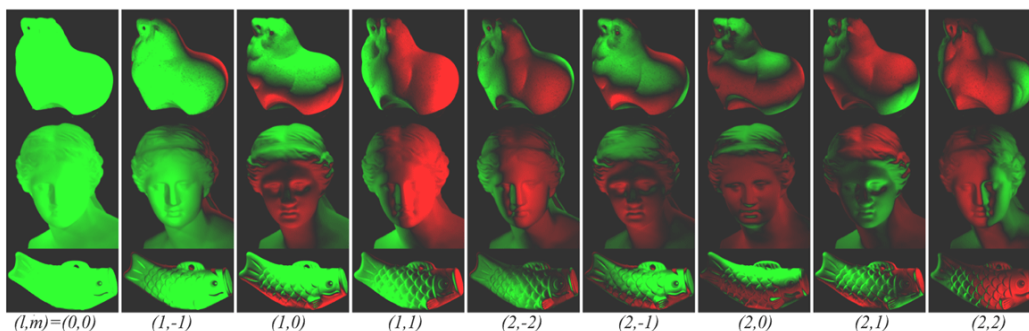**Image acquisition set-up**     **Synthesized images of objects under natural illumination**



$(l,m)=(0,0)$   $(1,-1)$   $(1,0)$   $(1,1)$   $(2,-2)$   $(2,-1)$   $(2,0)$   $(2,1)$   $(2,2)$

**Obtained basis images**