

# Classification of Photometric Factors Based on Photometric Linearization

Y.Mukaigawa (Osaka University, Japan), Y.Ishii, T.Shakunaga (Okayama University, Japan)

## Purpose

- (1) Classification of photometric factors
- (2) Improvement of the original photometric linearization

### Input images:

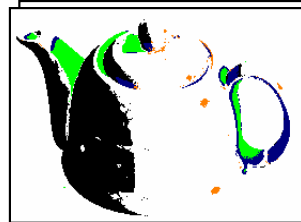
- taken under various lighting directions
- fixed camera

### Assumption:

- no 3-D shape information
- no lighting direction information
- no surface reflectance information



Input image set



Result of classification

### Factors:

- Diffuse reflection
- Specular reflection
- Attached shadow
- Cast shadow
- Undefined

## Classification

### Photometric Linearization Method (ICCV2001)

- A set of input images



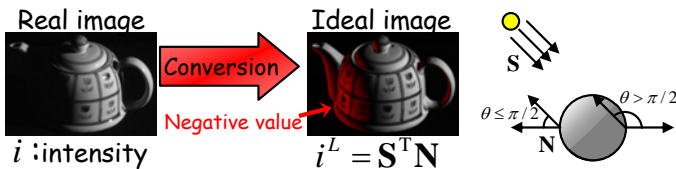
- Linear combination theory (Shashua 1992)

$$i = c_1 i_1 + c_2 i_2 + c_3 i_3$$

arbitrary illumination      three base images

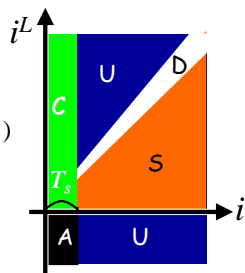
- Lambert model
- Parallel ray

- Conversion to satisfy the linear combination



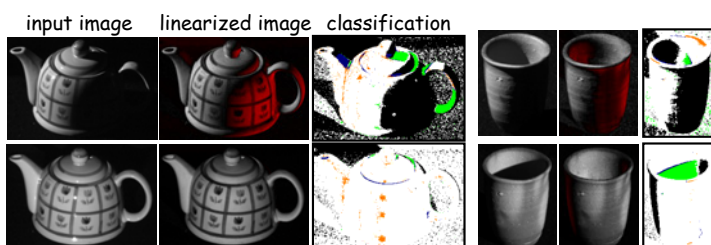
### Criterion for Classification

- Diffuse reflection:  $(|i - i^L| \leq T \times i) \cap (i \geq T_s)$
- Specular reflection:  $(i - i^L > T \times i) \cap (i^L \geq 0) \cap (i \geq T_s)$
- Cast shadow:  $(i^L < 0) \cap (i < T_s)$
- Attached shadow:  $(i^L \geq 0) \cap (i < T_s)$
- Undefined: otherwise



### Experimental Results

Input: twenty-four images of various lighting directions



Glossy ceramic pot having complex shape

Japanese ceramics

## Improvement of Accuracy

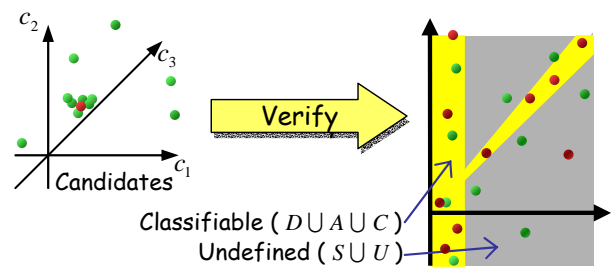
### Key Idea

If the photometric linearization is correct, all pixels are never classified into "undefined".

### Verification Based on the Classification

1. Calculate many candidates by random sampling. (coefficients of the linear combination)
2. Verify the candidates based on the criterion for classification.
3. Select the most suitable candidate which has the maximum Support.

$$Support = \sum Classifiable \quad Classifiable = \begin{cases} 1 & \text{if } (DUAUC) \\ 0 & \text{if } (SUU) \end{cases}$$



Taking the reason of outliers into account

### Preprocess for Photometric Stereo

Twenty-four images of a marble sphere including shadows and specular reflections.

