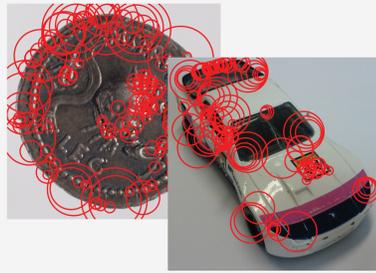




## Motivation

- Powerful local image descriptors are insensitive to certain image transformations like rotation, scaling or blurring
- We focus on **insensitivity to illumination changes** on **NON-FLAT, TEXTURELESS OBJECT PARTS**



	FLAT, TEXTURED OBJECT PARTS	NON-FLAT, TEXTURELESS OBJECT PARTS
Illumination effects	Only <i>monotonic brightness changes</i>	More complex and challenging effects like <i>local changes of brightness and edge polarity</i>
Descriptor performance	Can be handled by common image descriptors	Can not be handled by common image descriptors

## Methodology

### 1. Extraction of pixel-wise low level features

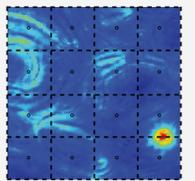
- Even Gabor filter responses at  $N$  orientations  $\theta_i$  and  $M$  scales  $\omega_j$
- Even Gabor filters are effective for capturing smooth / isotropic as well as non-smooth / anisotropic surface characteristics under illumination changes [Osa07]
- Normalization on a per-pixel level to deal with locally varying brightness changes

$$\tilde{F}(\mathbf{p}, \theta_i, \omega_j) = \frac{F(\mathbf{p}, \theta_i, \omega_j)}{\sqrt{\sum_{i=1}^N \sum_{j=1}^M F(\mathbf{p}, \theta_i, \omega_j)^2}}$$

$F(\mathbf{p}, \theta_i, \omega_j)$ : absolute response of Gabor filter with rotation  $\theta_i$  and scale  $\omega_j$  at position  $\mathbf{p}$

### 2. Spatial pooling

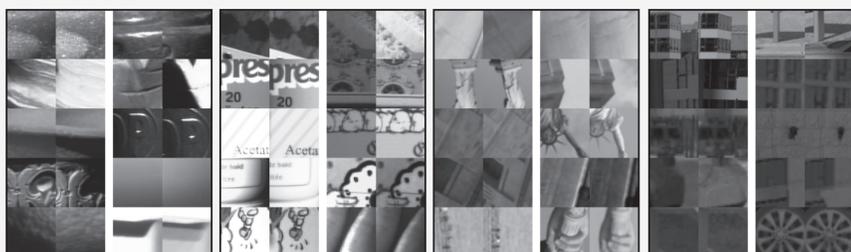
- SIFT-like squared  $4 \times 4$  grid with bilinear weighting



## Experiments

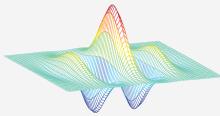
- Evaluation:** ROC curves generated from descriptor distances on sets of true and false patch pairs

### Datasets:



Textureless objects from ALOI [Geu05]    Textured objects from ALOI [Geu05]    Liberty [Bro11]    Virtual World [Kan11]

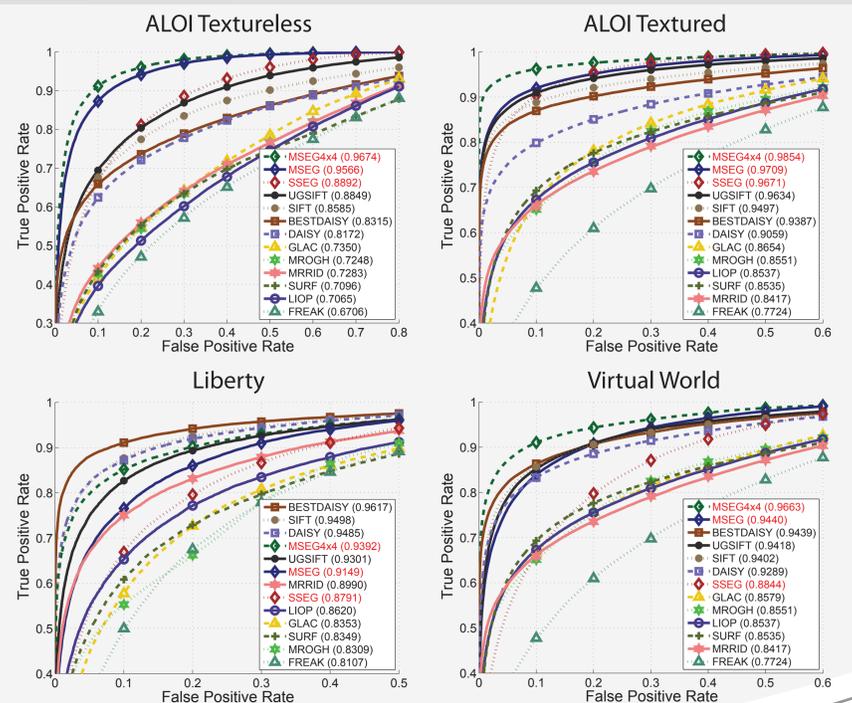
- Gabor Filter Parameter Selection:** higher frequency and orientation resolution than 2nd derivative of Gaussian



### Descriptors:

- Single-scale without spatial pooling (SSEG)
- Multi-scale without spatial pooling (MSEG)
- Multi-scale with spatial pooling (MSEG4x4)
- SURF [Bay08]
- DAISY [To10]
- MROGH [Fan12]
- MRRID [Fan12]
- FREAK [Ala12]
- GLAC [Kob08]
- BESTDAISY [Bro11]
- LIOP [Wan11]
- SIFT [Low04]
- UGSIFT [Low04]

## Results



## Conclusions

- Comprehensive evaluation of current image descriptors for scenarios with strong illumination changes that induce complex appearance variations
- Proposed Gabor-based descriptor outperforms other descriptors, especially on textureless surfaces

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