

RoboCup 2010



6. Template Matching

Template Matching

Goal:

- Finding small parts of an image which match a template image
seam image: I_S , template image: I_T
- **Feature-based:**
 - Derive and search features (edges, corners) in I_S and I_T
 - Advantage: Faster in case of large images
- **Template-based:**
 - Uses entire template (pixel values):
Move I_T over each point of I_S and calculate
sum of products / sum of absolute differences / correlation
 - Use position with the highest score
 - Advantage: more robust when no strong features are
detected

Computational effort

Example:

- Source image size: 2000x1500 pixels,
- Template size: 200x100 pixels
- Comparisons of pixels:
- $(2000-200) * (1500-100) * 200 * 100 > 50 * 10e9$ operations

Speed improvements:

- Downsample I_S and I_T by the same factor (multi-resolution / image pyramids)
- After detection of optimal position, use original image and detect template in the local neighborhood

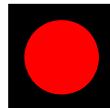
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Quality Improvements

- Use a suitable **color space**: e.g., do not use a gray scale image if you want to distinguish red objects on a green background
- Smooth image (Gaussian) in case of **noise**
- Define a **suitable template**:
e.g., think about the background color



marker on robot:



- Do you need invariance to scaling and rotation?
 - Keep the distance between camera to objects fixed
 - Use rotation invariant templates (circle)
- Luminance changes?
 - Use correlation instead of pixel differences

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Metrics

- Sum of absolute differences

$$SAD(x, y) = \sum_{i=1}^{T_{WIDTH}} \sum_{j=1}^{T_{HEIGHT}} |I_S(x+i, y+j) - I_T(i, j)|$$

- Sum of products

$$SP(x, y) = \sum_{i=1}^{T_{WIDTH}} \sum_{j=1}^{T_{HEIGHT}} [I_S(x+i, y+j) * I_T(i, j)]$$

- Correlation

$$cor(x, y) = \frac{\sum_{i=1}^{T_{PIXEL}} (T_i - \bar{T}) * (S_i - \bar{S})}{\sqrt{\sum_{i=1}^{T_{PIXEL}} (T_i - \bar{T})^2 * \sum_{i=1}^{T_{PIXEL}} (S_i - \bar{S})^2}}$$

T_i / S_i : value of pixel i in template / source image