FEATURE EXTRACTION FOR NON-TEXTURED OBJECT RECOGNITION USING A STEREO CAMERA

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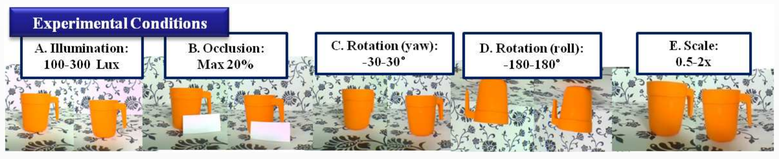
Abstract

Recognizing object is one of the central issues in computer vision. There are a bunch of features available for object recognition such as shape, color, and texture. Among these features, **texture** particularly turns out useful to distinguish object in natural scenes. It is robust to changes in illumination and scale, occlusions as well as view point variations. However **recognizing object which lacks of textures** has been rarely touched. This work presents a novel solution to extract the features for recognizing object which has limited texture information, such as cup, door, plate and bookcase, **using a stereo camera.** Considering that very few textures are available to represent this type of object, we instead make use of the two different source information: **color** and **three dimensional (3D) scale** which is based of **high-curvature points.** In our experiments, the proposed method has been tested in several challenging datasets in which **various condition changes, such as illumination, occlusion, scale, and rotation,** are incorporated. As indicated in the experiments, by using the result of non-textured object feature extraction, high recognition precision has been achieved. The proposed approach also demonstrated more robust recognition ability in **non-textured objects in natural scenes.**

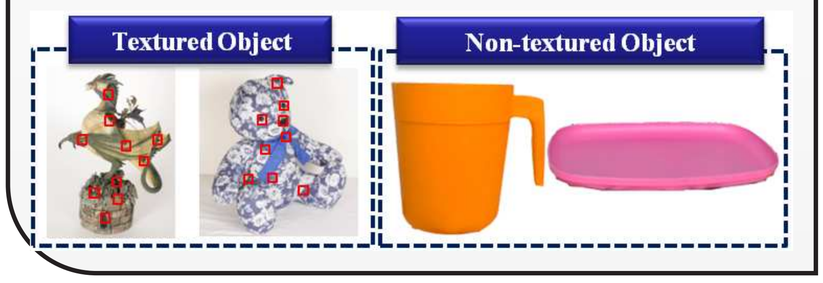
Motivation

Object Recognition Challenges

1. Various Conditions
   : View point variation, Illumination, Scale, Occlusion



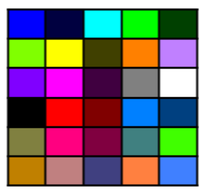
2. Non-textured Object
   : Lack of texture information



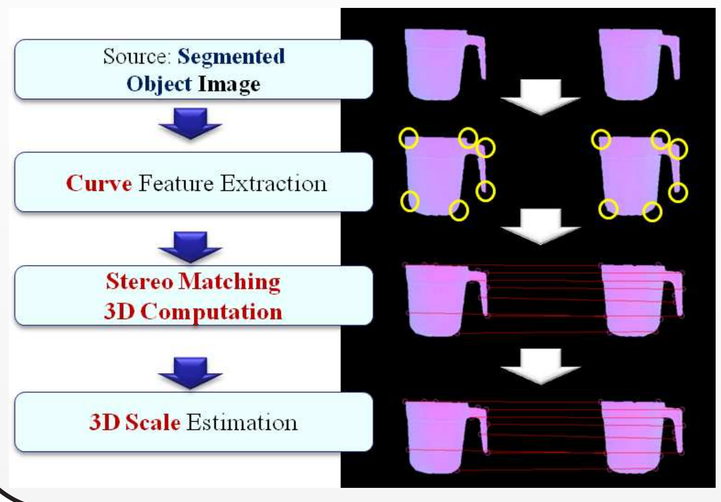
Non-textured Object Feature

Color Feature Extraction

- **Color clustering** : Find optimal partition based on the model color

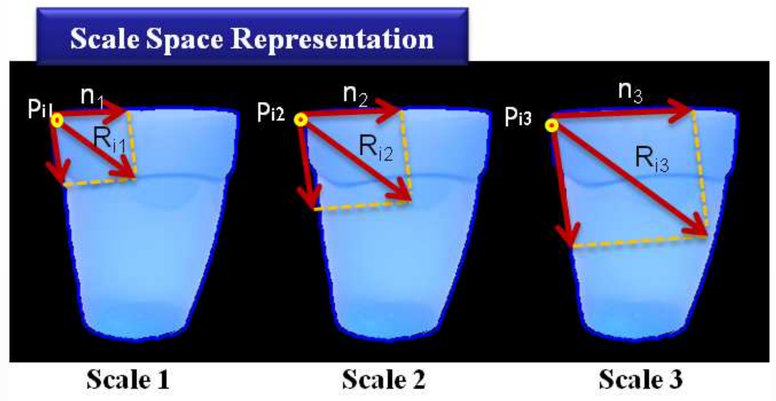


3D Scale Extraction



3D Scale Extraction

1. **Curve Feature Extraction in Scale Spaces**



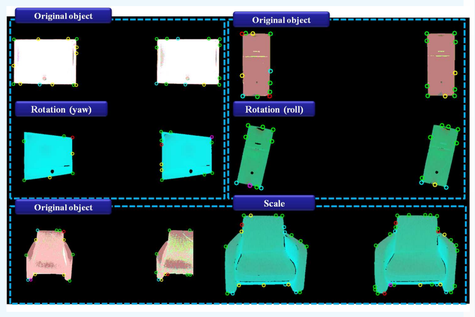
$$r_{ij} = \frac{||P_{i-n_j} - 2P_i + P_{i+n_j}||}{n_j},$$

r_{ij}: Normalized curve cost
$R_{ij} = ||P_{i-n_j} - 2P_i + P_{i+n_j}||$
i: Pixel point; j: Scale; $P_{ij} = (x_i, y_j)$
n_j: Scale space

2. **Curve Feature Selection** and **Stereo Matching**
   - Select the **heighest curvature point** from the curvature area by the r_{ij}
   - **Compute 3D position** by matching features between the left and right stereo images
3. **Maximum Pair-wise Features : 3D Scale**
   - Find **maximum pairs of features** using stereo matched individual features

Empirical Results

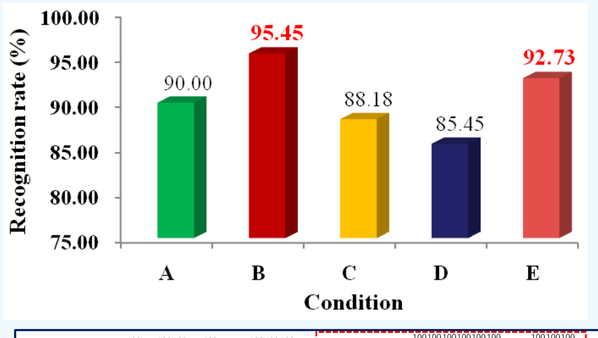
1. Feature Extraction

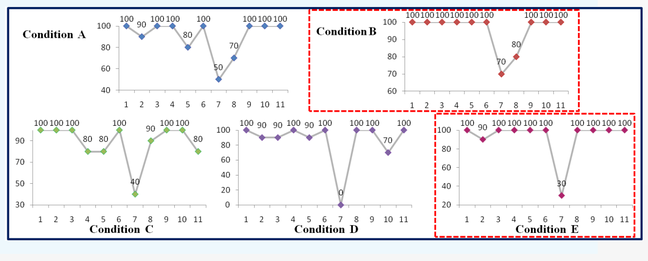


- Curve extraction invariance in condition changes

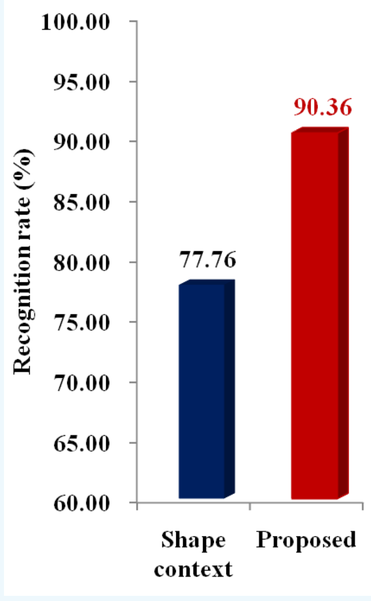
1-11: objects (cup,bottle,plate, kettle,door,chair,TV,table,sofa bookcase,refrigerator

2. Recognition(1) : Condition Changes





3. Recognition(2) : Comparison



Conclusion

- Non-textured Object Recognition
  : Important but **challenging task in natural scenes (lack of information)**
- **Scale Invariant Curve Feature Extraction**
  : Robust to **scale changes** and **rotation(yaw, roll)**
- 3D Scale Calculation: **Maximum pairwise feature**
  : Simple, Robust to **partial occlusion** and **scale changes**
- More than **90% recognition rate** under natural conditions : Problem - Similar scale object