Institute for Image Understanding and Knowledge-Based Systems

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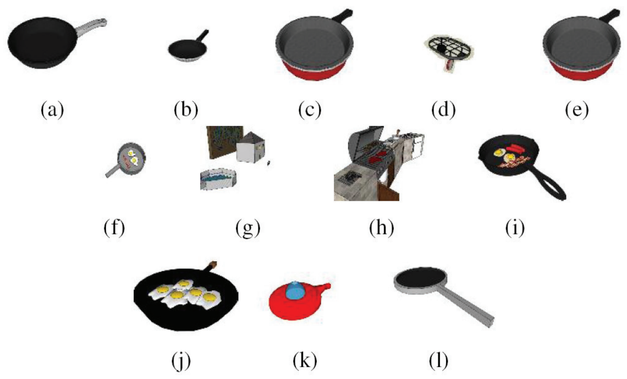
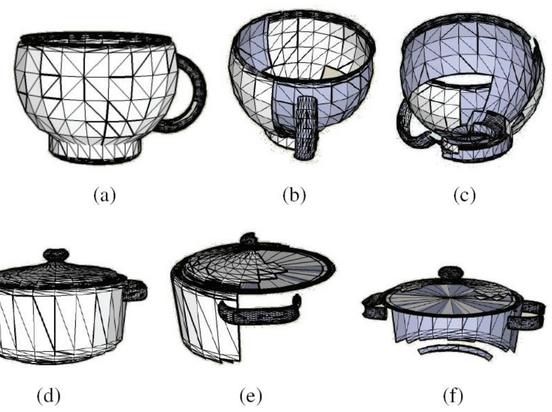
Acquisition of Dense 3D Model Database for Robotic Vision

Service Robots in real world environments need to have computer vision capability for detecting a large class of objects. We are developing techniques to utilize freely available 3D model databases, enabling robots to know the appearance of a wide variety of objects in human environments with special application to our Assistive Kitchen.



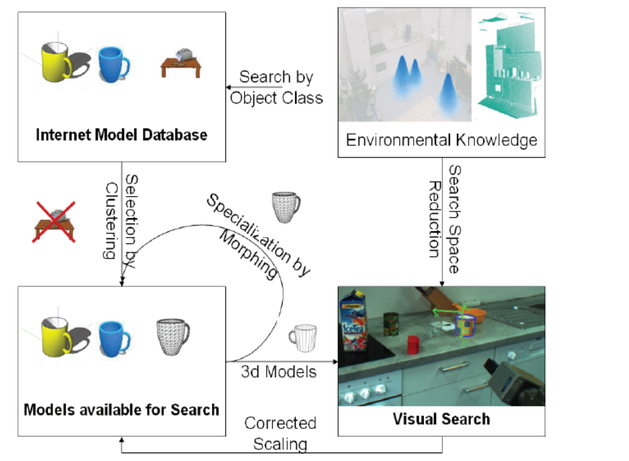
Step 1: Given some abstract instructions, and having extracted names of objects from those instructions, specify the name as a query on Google 3D Warehouse, download the resulting 3D models and perform automatic selection on the result to eliminate "outliers". In the figure on the left, (a) - (e) were obtained as "inliers".

Step 2: If only a few models are available for a particular query, automatically perform morphing on the obtained models, and select in-between models. Here, the first and last models are used to generate the three "in-between" models.

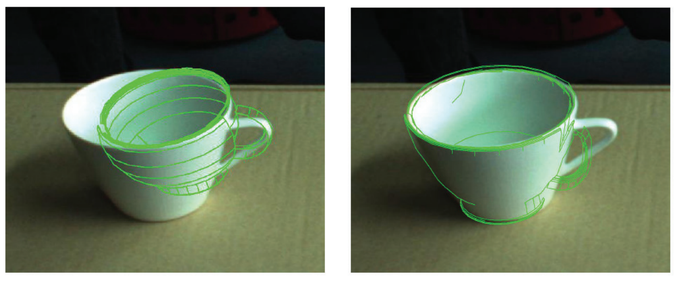


Step 3: Reduce the complexity of the model building phase for matching (against the scene) using visibility culling.

Step 4: Given these 3D object models, which will only match the objects in the environment to a certain degree and typically lack accurate size specifications, the robot looks for objects in the environment that sufficiently match these models.



Overview of the System



(a) Score = 0.486 (b) Score = 0.802

Here a morphed model is a better match for the real cup, than the original model.

(a) Left camera image. (b) Right camera image.

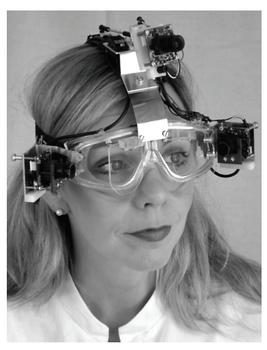
Utilizing stereo setup to localize object in 3D

Step 5: Present the found object locations to the user, and (under investigation) manipulate the object - utilizing the 3D object model to estimate a good set of grasping points.

3D Hand, Object, and Scene tracking in a Gaze-Driven Head-Mounted Camera

- for Human Activity Analysis

- to teach Robots, object manipulation and grasping point estimation



Utilizing a special camera setup, developed by Neurologists at Ludwig Maximillian University, we look at the scene in the direction of the gaze and the direction of the head.

Tracking the hand using Dr. Stenger's 3D hand model and a particle filter, as well as detecting known landmarks in our kitchen to localize scene, and detecting 3D pose of the object, and direction of gaze in the scene camera, we apply machine learning techniques to:
(1) recognize action primitives
(2) learn models that may be used by our Robot for manipulation and grasping point estimation of similar objects.

Publications:
[1] U. Klank, M. Z. Zia, and M. Beetz, "3d model selection from an internet database for robotic vision", Proc. of IEEE International Conf. on Robotics and Automation 2009
[2] M. Z. Zia, U. Klank, and M. Beetz, "Acquisition of 3d model database for Robotic Vision", Proc. of International Conf. on Advanced Robotics 2009
[3] Master thesis: M. Z. Zia (supervised by U. Klank and Prof. M. Beetz), "Inside-Out Activity Analysis using 3D hand, object, and scene tracking" , TU-Munich