2016 Spring :: 16720 Computer Vision :: Final Project

Real-Time Pose Estimation of Model-Based Rigid Object

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Objective

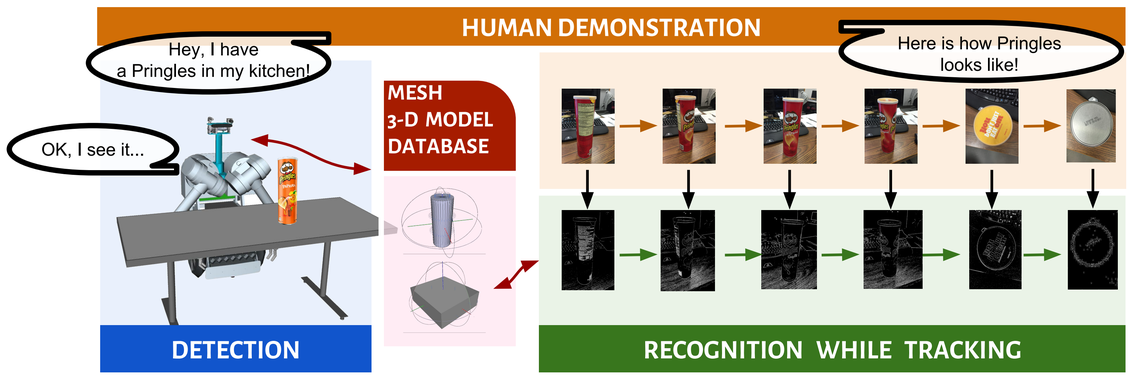
Object detection and tracking stand as a fundamental but crucial problem in robotics field. In this project, we would like to introduce a real-time framework of model-based object recognition and 6-DoF pose tracking in the applications of manipulation and learning-by-showing using low-cost RGB video stream de

Platform and Device

- Robotics Operation System (ROS)
- WebCam 1.3Mpx iBuffalo BSW13K10H 1.3M

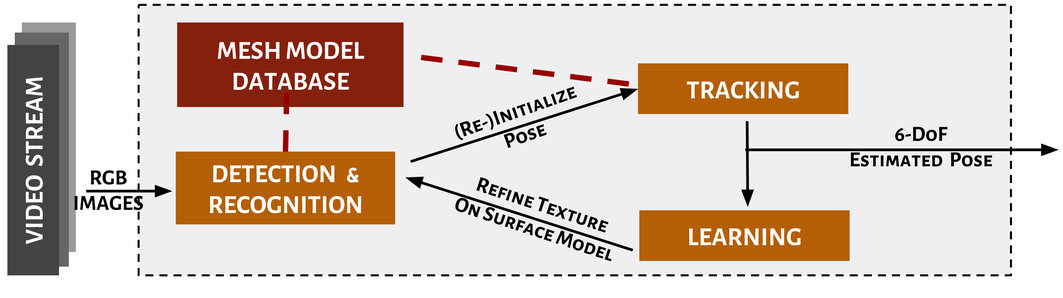
Problem Formulation

- **Scenarios :** Human placed a new object in kitchen. A Robot first detect the object, then register texture to surface model with estimated pose (tracking) when human demonstrate object's detail to robot.
- **Assumptions :**
  1. Known mesh models for given basic-shaped rigid objects. (eg. cuboid and cylinder)
  2. We focus on "Recognition with Tracking" phase
     (i.e. assume known initial pose of object)



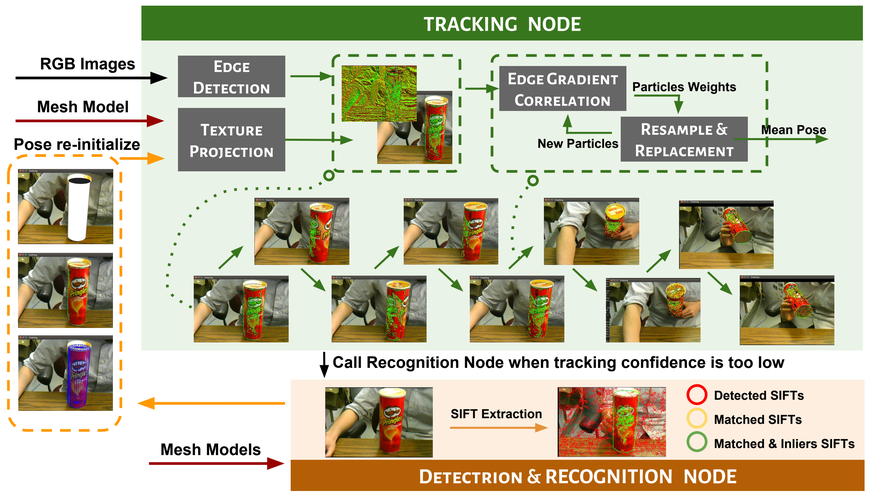
Framework Demonstration

- **Learning Node** : Given the estimated pose from **Tracking Node,** map texture informations (descriptors) from 2D image to 3D surface model, and encode them in a look up table with gpu acceleration.
- **Recognition Node** : Givne the geometric model (w/ or o/ textures), extract descriptors (SIFT) then find a most confidential pose in codebook.
- **Tracking Node** : Given the initial pose from **Recognition Node** along with geometric model, utilize edge-based monte carlo particle filter to track the rigid object.



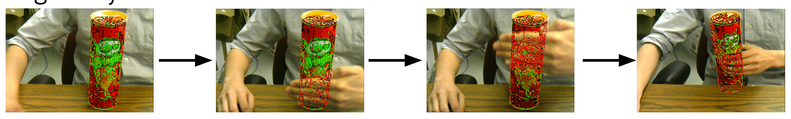
Recognition while Tracking

- WorkFlow Diagram

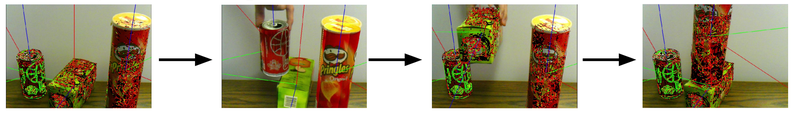


Experiments & Comparisons

- Singel Object w/ Occlusion Effect

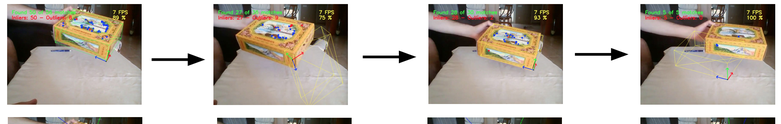


- Multi Objects Tracking

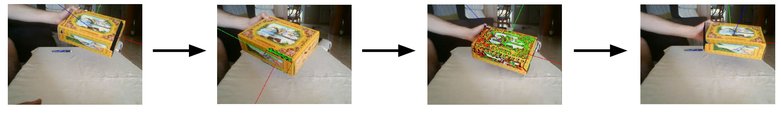


- Comparison w/ Opencv Tutorial Example (ORB + PnP w/ RANSAC + Kalman Filter)

OpenCV Tutorial



Introduced Platform



Conclusion & Future Works

- Performance of **Edge-based Tracker** increases when providing textures SIFT but still works if not provided.
- **Traker** is relatively fragile in fast translational change compared with rotational change.
- **SIFT-based Detector** shows fast recovery of new initial pose compared with OpenCV tutorial when losing track of the object.
- Bad alias effect happens during tracking when textures edges with projected error in previous learning phase.

Reference

[1] Mörwald, T.; Prankl, J.; Richtsfeld, A.; Zillich, M.; Vincze, M. BLORT - The Blocks World Robotic Vision Toolbox Best Practice in 3D Perception and Modeling for Mobile Manipulation (in conjunction with ICRA 2010), 2010.
[2] V. Lepetit and P. Fua. Monocular Model-Based 3D Tracking of Rigid Objects: A Survey, in Foundations and Trends in Computer Graphics and Vision, vol. 1, num. 1, p. 1-89, 2005.
[3] Asif, U., Bennamoun, M., Sohel, F.: Real-time pose estimation of rigid objects using rgb-d imagery. In: ICIEA. (2013) 1692–1699