NANYANG TECHNOLOGICAL UNIVERSITY

Robotics Research Centre

Motion Planning for Task Manipulation & Handling

Project Motivation & Objectives

This project focuses on autonomy and flexibility in task manipulation when handling small objects (in centimeter scale). Pick-and-plug task for very small and semi-transparent objects were conducted, with the following aims:

a) Precise and reliable object pose estimation.
b) Precise calibration in-between sensors and robotic manipulator.
c) Motion planning.
d) Human-in-the-loop operation.

Methodology

Our system involves one UR3 robotic arm and a Kinect (version 2) camera. We have fixed the camera externally in a looking-down position.

Object Pose Estimation: SURF features, convexity features and contour features, are used in the proposed methodology, to provide a precise and stable estimation of the object pose. The proposed methodology is compared with respect to VICON pose estimation system (which uses an industry standard marker-based tracking technology), and is found to provide more precise and accurate result.

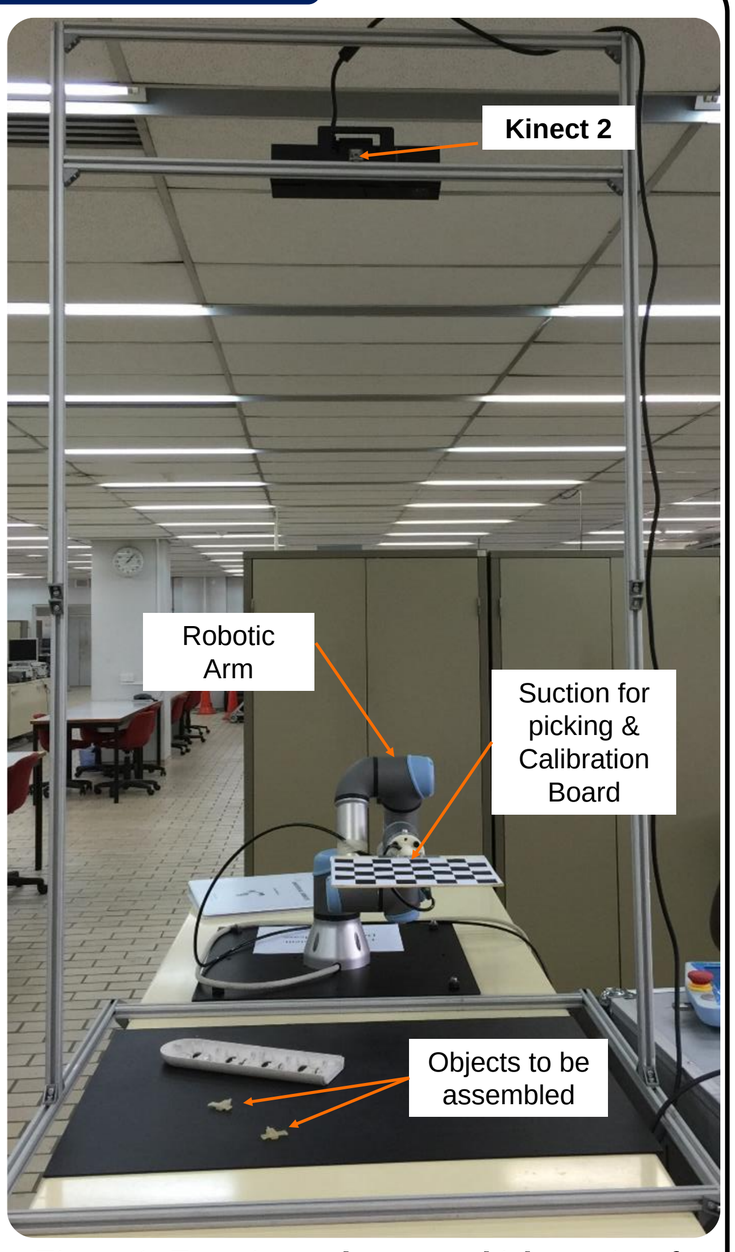

Figure 1: Experimental setups, which consist of a Manipulator with a pneumatic end effector, and a Kinect 2.

Hand-eye Calibration: A state-of-the-art calibration algorithm, known as dual quaternion method, is used for calibration in between external camera and robotic arm. Researchers are conducting tests to minimize the error of the calibration.

Studies are also done to learn the acceptable error range to satisfy the task. Further studies will be done in the area of 'Motion Planning' and 'Human-in-the-loop operation'.

Principal Investigator:
Prof Low Kin Huat
Team Members:
Dr Arnab Sinha, Dr Zhu Haifei,
Mr Kok Yuan Yik, Dr Sun Guangbin

Results

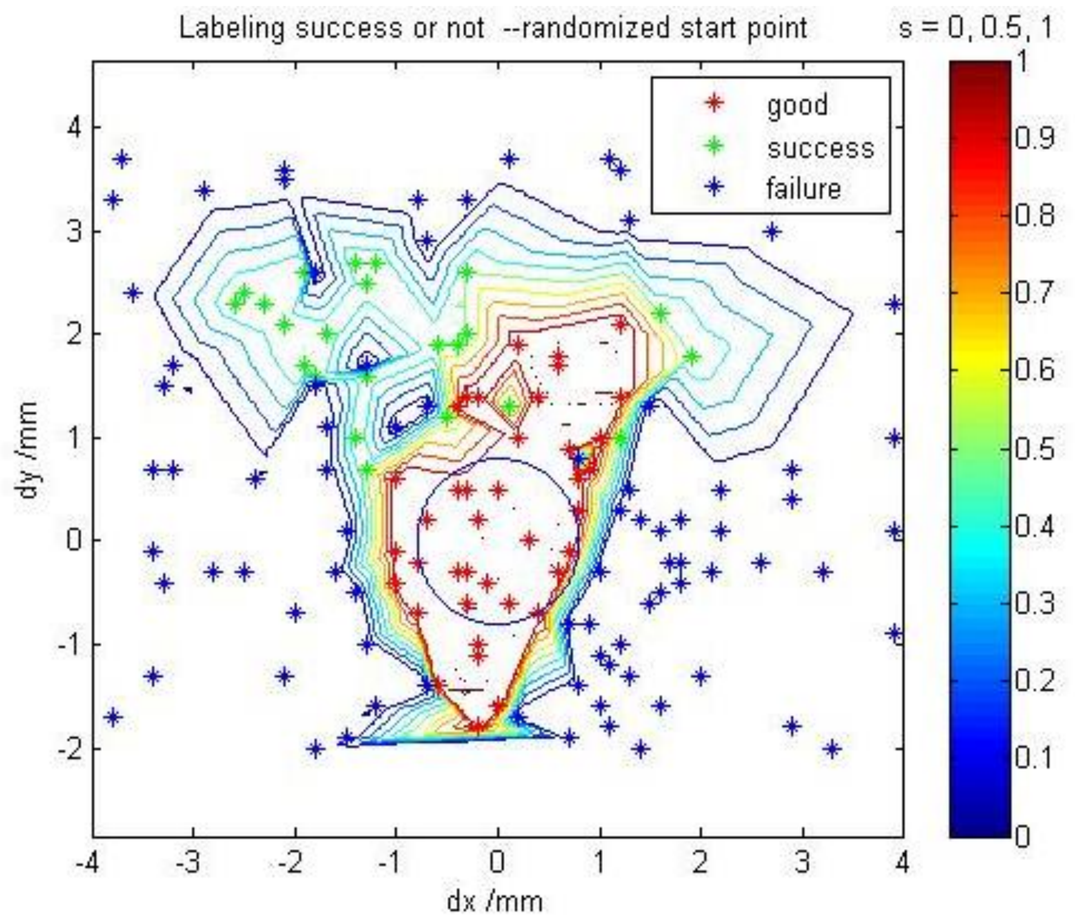

Figure 2: Uniform distributed noise added to the robot to get the acceptable error for start point. It shows that the acceptable error to satisfy the task for start point is 0.8 mm.

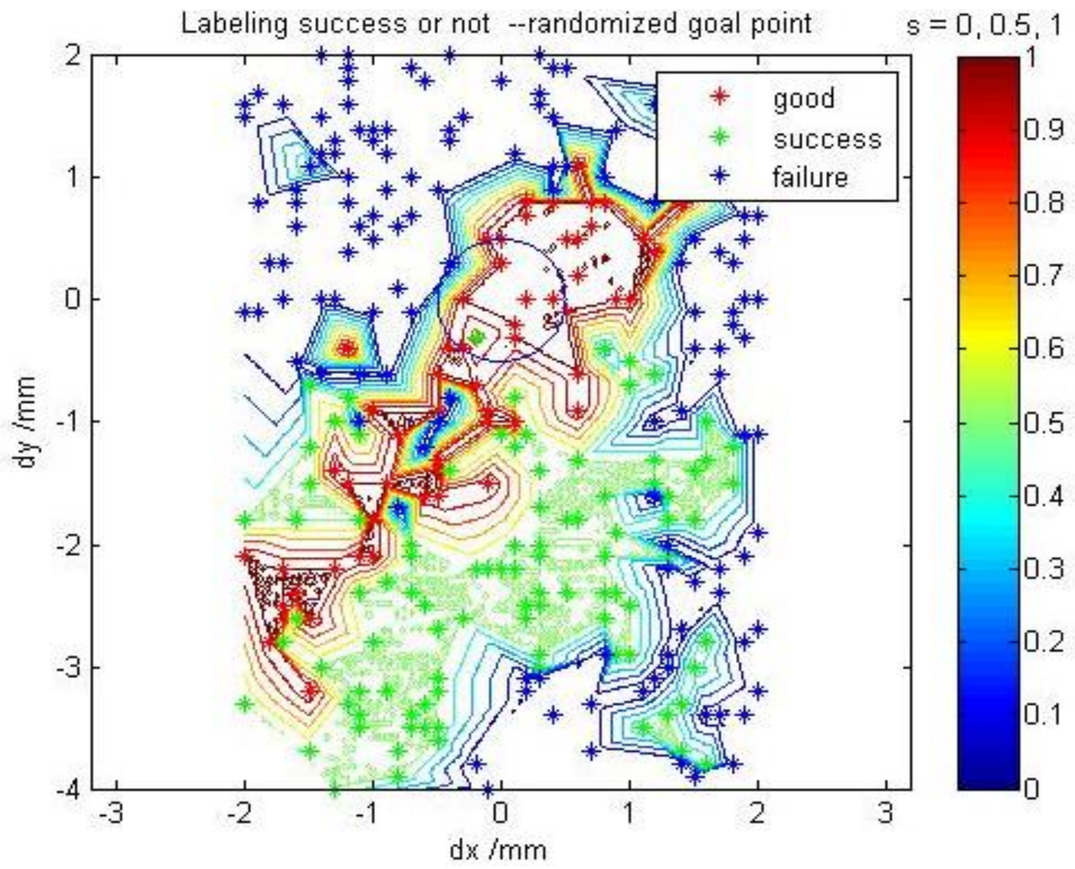

Figure 3: Uniform distributed noise added to the robot to get the acceptable error for goal point. It shows that the acceptable error to satisfy the task for goal point is 0.5 mm.

Conclusion

By far, this project has shown the possibility of using commercially available low cost camera to recognize small objects. It is found that the system is able to do task alongside human worker and is able to assemble small object with the help of vision sensor. This enables a simple and quick calibration when setting up camera and manipulator.

Funding Agency : Agency for Science, Technology and Research (A*STAR)