2016 中技社境外生研究獎學金
CTCI Science and Technology Research Scholarship

Innovative methodology to 3-D Point Cloud Registration and 3-D Object Recognition of Randomly Stacked Objects

National Taiwan University, Department of Mechanical Engineering, 1st year PhD, **Dinh-Cuong Hoang**
Advisors: Prof. **Liang-Chia Chen** & Prof. **Hsien-I Lin**
In collaboration with: Dr. **Thanh-Hung Nguyen**

1. Research Focus

This research is concerned with the problem of multiple three-dimensional point clouds registration. A novel global registration method is proposed to accurately register series of scans into an object model underlying 3-D imaging digitization by using the proposed oriented-bounding-box (OBB) regional area-based descriptor. The OBB is developed to determine an initial transformation matrix and then refine it employing iterative closest point (ICP) algorithm. This key solution can resolve the difficulty in accurately merging two neighboring area-scanned data. In addition, we present a novel approach to recognize and estimate pose of the 3D objects in cluttered range images. The key technical breakthrough of the developed approach can enable robust object recognition and localization under undesirable condition such as environmental illumination variation as well as optical occlusion to viewing the object partially. Experimental results have preliminarily demonstrated the feasibility and applicability of the developed method.

2. Research Results

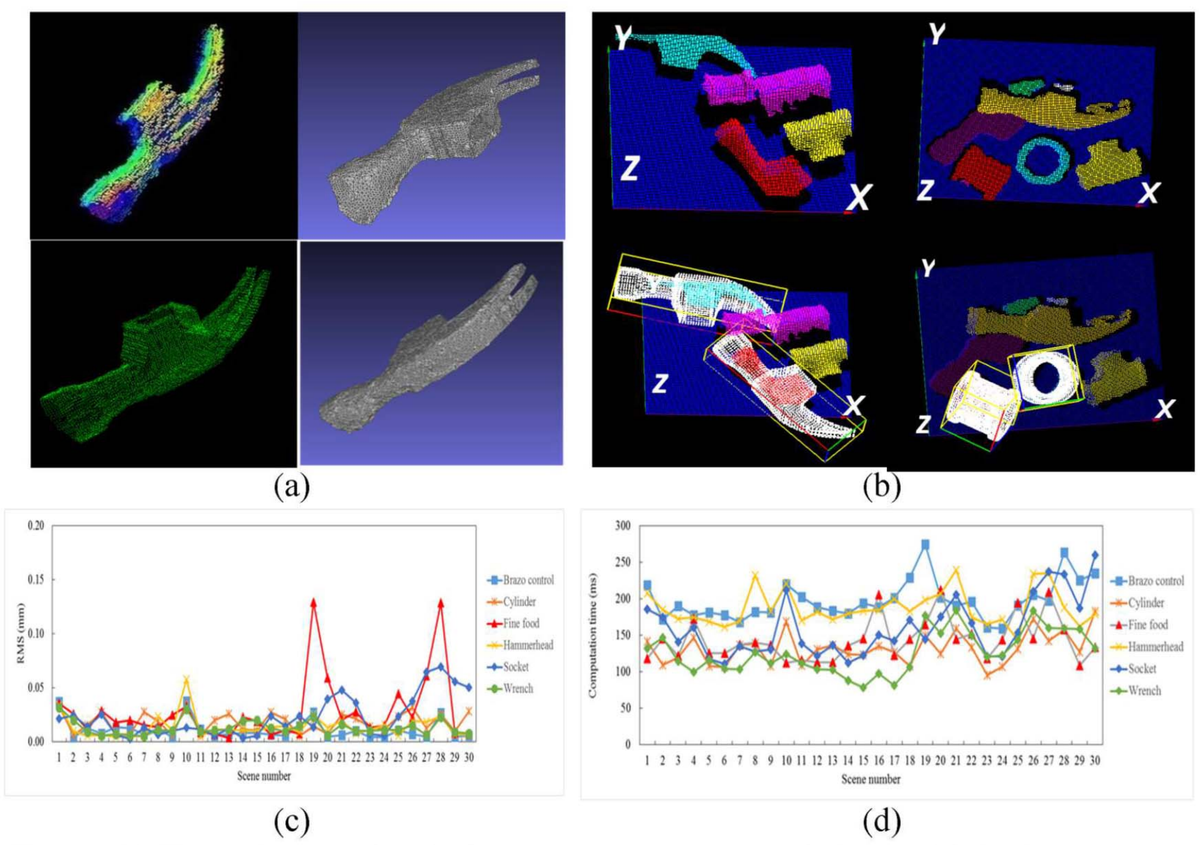

Fig. 1 (a) The point cloud and triangle meshes of scanned object; (b) Object recognition and localization results; (c) RMS errors of different types of the objects; (d) Computation time of the proposed object recognition and localization algorithm.

3D Object Reconstruction

Fig. 1(a) shows the scanned hammerhead model with some overlapping point clouds, scanned models after overlapped data being removed, and resulting a triangular mesh with 10,201 triangles. .The hammer was scanned by the NTU-3D probe and the system terminated after 8 scans. Each scan contains 20k points. The total time for 3D model generation of the Hammerhead was approximate five minutes. This includes the time for moving the robot while scanning, preprocessing, data registration and generating robot path.

3-D Object Recognition and Localization

A Sub-OBB based object recognition method and strategies by using the proposed oriented bounding box (OBB) regional area-based descriptor for solving automatic pose estimation problem was developed for randomly stacked objects presented by form of 3D point cloud. The experimental results reveal that the proposed method can accurately recognize and localize objects of interest in cluttered range images. The effectiveness and accuracy of the proposed 3D object recognition and localization have been tested on both simulation and real measurement data. The accuracy of the proposed method in the experiment with the simulation data is evaluated in terms of RMS, translation, and rotation errors. In the experiment, the RMS, translation, and rotation errors are not exceeded 0.15 mm, 0.06 mm and 0.005, respectively. The computation cost of the algorithm was favorable for in-line industrial operation.

3. Research Experience

Studying abroad in new environment brings me so many difficulties and challenges. During this time, I have worked hard to broaden my knowledge and my understandings in the area of 3D Machine Vision Technology, and learn how to control complicated equipment and facilities. Fortunately, I has received the great supports from my advisor and lab-mates in research work and life in Tainan. I have never thought that I could achieve such a fantastic result without their helps. I also would like to express my sincere thanks to my parents and my friends for their love and encouragement. Last but not least, I would like to thank you the CTCI Foundation for offering us an amazing honor to share our recent studies.

財團法人 中技社 CTCI FOUNDATION