Object Tracking of Mobile Robots

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I. Introduction

This project proposes a mobile robot which is designed to track and capture a tiny and moving fast creature, like mice or cockroaches. The robot is based on a Pioneer 3DX mobile robots moving on the ground. Though the Pioneer 3DX is bigger and slower than our target, it is the smallest robot we can use in lab. First, we give a picture with the particular object. After training an object-classifier, we need a Kinect to identify the object as target. Once the target is identified, we control the robot to reach the target, then capture or drive it away.

II. Related Works

An important thing is to identify the object and get a precise goal. In this semester, we use a tool ,Camshift, in opencv instead of training a classifier(libSvm) to detect objects automatically. We use Camshift to circle our target in sight, so that the robot can calculate its target.To make sure that the target position in real world matches the position which the robot targets, we have to use camera calibration to get focal length. Pioneer 3DX has a useful library for controlling so we can use it to make the robot action more smooth.

III. Equipment and Resource

Hardware： Pioneer 3DX, Kinect Xbox 360, Laptop

Software： Camshift in opencv, Aria 2.7.5.2 library, openNI driver

Reference:

[1]Kinect Calibration Toolbox (http://www.ee.oulu.fi/~dherrera/kinect/)

[2] Course of Robotics (https://ceiba.ntu.edu.tw/1011robotics)

IV. Detection

There are 3 parameters impact the tracking results in Camshift. We choose a tuple of parameters so that Camshift can track a small enough object. The Camshift function will return a tracking window and we take its central point as position of the object. Assume the central point of camera is origin, the x axis is respond to horizontal and y axis is respond to vertical in real world.

V. Calibration

We use Kinect Calibration toolbox to calibrate RGB and depth cameras of the Kinect sensor. We take 70 RGB and depth photos respectively of a checkerboard and use the toolbox to calibrate the color and depth cameras simultaneously. Then we get calibration results of the two cameras, including focal lengths and principal points. We then use the information to execute coordinate transformation between in the image obtained by the Kinect sensor to real world.

VI. **Control**

After transforming coordinate from camera to real world, we can know the target's position relative to robot's. Two parameters which we use are rotational angle and distance from camera to target. A naive method is going straight after rotating, but it won't act smoothly. To make it act smoothly, we shorten the reaction time. The robot can recalculate the angle it should rotate and move in per 100 milliseconds and the built-in function in Pioneer library supports rotating and moving at the same time.

VII. **Conclusion**

In this project, we have introduced and realized a primary applicable mobile robot to provide objects tracking, including choosing a specific object, calibrating the images from Kinect, and approaching the objects we chose. Our robot is able to spot the red object and detect the distance with Kinect.

Since the limitative distance of Kinect, we set the robot to go straight toward the red marker and stop before it when the distance between Kinect and marker is 50 cm.

If the robot loses track of the red marker during obstacle avoidance motion, it becomes blind and needs to search the marker again in order to go back on track. However, Camshift can't stop detecting objects. Therefore, the robot might mistakenly detect the obstacle and follow it. This part is one of drawbacks we need to improve in our future work.

A live demonstration will be given in class on 18 January 2013.

VIII. **Future Work**

For future work, the functions will be expanded to automatically detect a particular object and track it. That is, no artificial intervene act need to be done. Therefore, this robot can be use as a security (to patrol around and detect invaders), follower (to follow a kid or a pat when you are not home) or house keeper (to eliminate or expel bugs and mouse). The global information becomes vital for a robot serving in the scenario; hence SLAM will be added to the functions. All necessary maps will be provided to our robot. As a result, a red marker would be unnecessary. Honestly, this project is just in the very beginning stage.