Implementation of 3D Object Recognition Based on Correspondence Grouping

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I. Introduction and Problem Formulation

PROBLEM

In the status quo, the robot has a camera that can be used for many purposes. These include self-localization in a map, detecting certain colors, and other functions. However, one of the biggest flaws of the current robot is the lack of ability for the robot to recognize objects. The robot's camera could "see" a simple basketball with its camera but have no idea what it is, because to the robot, it is all just numbers. Thus, we will attempt to solve this problem with pre-rendered images of 3D objects and have the robot have the ability to see and "recognize" the object.

APPLICATION

There are many applications to this project. It could also be used to teach people the names of certain objects. Someone who wants to learn English could use one of these robots to learn the names of certain objects from the robot. However, the most possible application of this program is that it provides a good starting ground for possible future robot developments. If the robot can recognize a basketball, it could show on screen the word "basketball" or just have the robot "know" it is a basketball and determine another action such as "throw it".

TASK

The task is to give the robot the ability to "see" a 3D object, have it search for a in its memory and actually return what the object is onscreen. For example, if we added a basketball 3D object in the robot's memory, the robot should have the ability to see, recognize the basketball, and show on screen the "basketball".

II. Related Work / Previous Experience in Robotics

In this group, all three of us (Kevin, Jeffrey, and Jamison) have little to no experience with robotics outside of CS 309. Jeffrey worked closely with friends who were on the robotics team, but he himself was not an actual member of the team. Kevin was in an introduction to robotics class in middle school that mostly built robots with the help of instruction booklets, but did not pursue robotics in high school. Jamison joined a robotics club in high school for about half a

year, but the team later disbanded. As a result, we have little related work nor previous experience in robotics.

From CS 309, we all have basic knowledge of programming on Ubuntu with C++, ROS, and Terminal commands. We also have basic knowledge of both v2 and v3 robots from the computer science lab, know how to turn on the robot with Terminator, ROS, and how to drive the robot from a certain location to another location. We also have knowledge about RVIZ and how to get the robot to locate itself. Most importantly, we have some experience with camera controls on the robot thanks to one of our assignments, which will be crucial to this project since we will need to utilize the robot's camera to "recognize" pre-rendered images.

III. Proposed Approach / Software

The current approach for our proposal is to implement in the code in the Point Cloud Library (PCL) into a ROS Node. This node will allow the robot to examine and attempt to recognize segmented objects. This node will have to work in conjunction with the robotic vision. Our group will need to get visual data of the robot looking at an object so we will be able to test if the node was properly implemented. We will have a couple of 3D made and put onto the robot. The robot will compare objects orientation and modeling to the stored 3D models. We will then have the robot output the name of the model, when the robot has been able to identify an object with the stored 3D model.

IV. Proposed Evaluation

The robot with our implemented software will repeatedly undergo three tests to determine the current state of the 3D object recognition:

- **Controlled Environment Test:**
  The robot will be placed inside a room and given objects shaped near exactly like the pre-rendered 3D model images (test objects) and attempt to recognize said objects using the images. The test objects will be placed in front of the robot one at a time to prevent it from becoming confused about which object to recognize and send output about. There should be no other objects besides the test objects within the controlled environment. If successful in recognizing nearly all the test objects, our software implementation can be considered to be at a basic level of functionality.

- **Basic Hallway Test:**
  The robot will be placed into a hallway and be told to navigate to the end of it while attempting to recognize test objects that are placed in front of it along the way. Other extra objects may be placed alongside the test objects as desired. The robot should be able to wheel itself over to its destination after recognizing more than half of the test objects. If so, our software implementation is at a semi-viable state of functionality.

- **Room Test:**
  The robot will be placed into a room with various objects placed around it that must include both test objects. The robot will slowly spin around once, displaying the objects it has been able to recognize as each test objects enters its view. A name count must be maintained by the robot to check if the number of test objects it recognizes matches with

that of the number of test objects placed in the test. If this stage of the evaluation is successful, our software implementation has reached a viable state of functionality.

All of these tests will be done in the GDC AI Labs to prevent any physical damage to the robots during movement as well as keep the number of extraneous factors affecting the robot to a minimum.

V. Timeline

Date	Milestone
April 3	• Decide what the project is • Turn in the project proposal • Take feedback and revise plan as needed
April 10	• Start creating pre-rendered objects in Blender
April 17	• Assign properties to rendered objects • Begin coding robot's visual recognition of objects
April 24	• Begin testing robot's ability to recognize objects
May 1	• Start final report
May 8	• Make sure that limited bugs exist • Working functionality to some extent • Have the final report near completion and ready to revise
May 11	• Turn in final report

VI. Expected End Results

By the end of the project, we expect the robot to able to pass the two of the three evaluation tests, namely the Controlled Environment Test and the Basic Hallway Test, having reached a point where it is able to recognize more than half of the test objects it is given. While passing the Room Test is a possibility, it may require more time than what was given in order to have it consistently succeed in doing so. Corrections and work done in the future, however, would help our software implementation to reach that stage.