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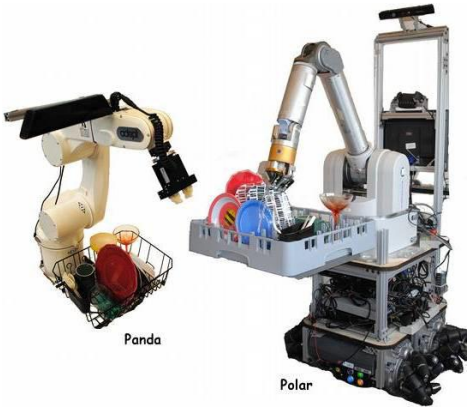
CS35L Review

Having a Robot as Janitor

Many people consider cleaning a chore, but it no longer has to be! That is, if the robots designed by Cornell's Personal Robotics Lab become mainstream. Two of Cornell's newer robots, PANDA (PersonAI Non-Deterministic Arm) and POLAR (PersOnaL Assistant Robot), were designed just for the task. And these robots are capable of cleaning up vast amounts of objects in all sorts of environments, be it the kitchen table, bookshelf, or even the refrigerator.

So how does the robot work? Equipped with a Microsoft Kinect 3D sensor and a robotic arm that can be angled to grasp differently-shaped objects, it follows a clever algorithm. In short, the robot takes in the environment as an input, breaks down that image into pieces that represent objects and possible placement sites, and then determines which objects fit in which sites. Lastly, it follows through by utilizing the robotic arm.



First, the Kinect 3D sensor captures the surroundings into many small image chunks and "stitches" it together to form a 3D image. This is the foundation upon which the robot works on. Next, a built-in computer breaks up the entire image into blocks, based on inconsistent color or shape. The point is to form blocks that can be translated into a single object. With each object block, the computer compares it to a database of objects the robot has been trained with or has seen before, matching it to the closest fit. It has now successfully distinguished an object! The same process is done for the placement sites, where the robot chooses potential target locations that are stable and well-fit for the object's shape.

Finally, for each object, an ideal placement site is chosen. The robot simulates a graphic of moving that object and follows through mechanically with its robotic arm. Compared to robots in the past, which could only move a single item onto a simple and flat space, PANDA and POLAR constitute a breakthrough in technology. Not only are they capable of moving multiple objects to complicated placement sites, but they can also be trained by researchers and learn on the field. When placing an item, the robot has to decide on the three S's: stability of the placement, semantics (whether the object by nature belongs there or not), and stacking of similar items. For semantic preference, as Cornell grad student Yun Jiang mentions, the robot is able to avoid putting a shoe into a refrigerator or onto a table. To ensure that the robot knows where objects should belong, researchers can feed example images of placement sites, labeled either appropriate or inappropriate.

Cornell University's computer science division did an excellent job with the algorithmic coding. POLAR, shown in the online article, could identify and place objects it had seen before with 98% success. For new items, the rate dropped to a still-high 80% chance of success. Despite its excellent performance, the robot can still have a few problems. For example, it can still break

fragile items occasionally, such as ceramics. The robots also tend to have more problems with objects like clothes, where the shape is somewhat ambiguous; it is much harder to determine its nature, and unfortunately, the camera depends heavily on shape. PANDA and POLAR could possibly be improved by using a higher-resolution 3D camera so that the item's shape could be more sharply defined. Researchers could pre-program the robot with example models of objects so that there are better and closer matches. The robotic arm could also be armed with touch feedback to confirm that the object is stable prior to its release.

The application of these robots is solid, and it is clearly a viable method for cleaning up enclosed environments. The robots are capable of throwing away trash (such as empty cartons), placing containers into the refrigerator, or loading books onto a bookshelf. I myself would not

mind having one of these around the house for basic clean-up duties. In my opinion, PANDA and POLAR are absolutely brilliant inventions. However, the robots are far from limited to casual use. Such technology can be used to help make the lives of disabled people easier. They could be used remotely to deal with hazardous waste, reorganize and restock supplies in a warehouse or store, etc. Furthermore, the algorithm could possibly be applied for collecting samples from other planets or even setting up explosives or traps for military purposes.

Searches for recent advancements in robotic technology (on Google Scholar, for example) shows that there are many interested in the cause. Computer scientists from the United Kingdom have researched how robots can read in their environment. People from Atlanta, Georgia and even Japan have also looked into the robot learning process based on their human environments. While the work done by Cornell computer scientists is not exactly unique, it is certainly a big step forward in technology. It is exciting to see the progress scientists have made in the world of artificial intelligence.

Works Cited

Steele, Bill. "A robot learns how to tidy up after you." Cornell Chronicle 21 May 2012. 1 June 2012. <http://www.news.cornell.edu/stories/May12/PlacingNewObjects.html>.

Jiang, Saxena et al. *Learning to Place New Objects in a Scene*. Cornell University. 2012. Web. 1 June 2012.

Note: No DOI was provided or could be found via CrossRef/Google Scholar.