Amazon Picking Challenge 2015

Peter R. Wurman, Joseph M. Romano

■ *At the Amazon Picking Challenge, 26 teams competed on their ability to pick items out of warehouse shelves. While the first year was largely focused on basic competencies, there are clear ways AI techniques can help make these systems more capable and robust.*

The first Amazon Picking Challenge (APC) was held at the 2015 International Conference on Robotics and Automation in Seattle Washington, May 26–27. The APC follows in the footsteps of other robotics competitions, most notably RoboCup and the DARPA challenges, by posing a real-world environment in which robots must perform humanlike tasks. The APC's focus is on one core — but extremely important — area of robotic competency: manipulating objects in the world.

The competition scenario was a Kivalike warehouse in which the robot had 20 minutes to pick items off a shelf and put them into a plastic tote. The 12 bins on the shelf were stocked with 25 products that posed a range of perception or manipulation challenges. Each bin had one target item. A robot received a base score of 10 points for successfully picking the target item, with bonus points for cluttered bins or difficult items. Participants could lose points by picking a wrong item, damaging, or dropping items (figure 1).

Amazon organized the competition and provided $26,000 USD in prizes and $70,000 USD in travel grants. Several competitors also had technical or financial support from hardware vendors. Twenty-six teams, representing 11 different countries, made the trip to Seattle. A wide variety of robots were represented, including most of the commercial vendors and several custom-made devices. An abundance of end effectors were exhibited, including grippers, pincers, spatulas, and suction cups.

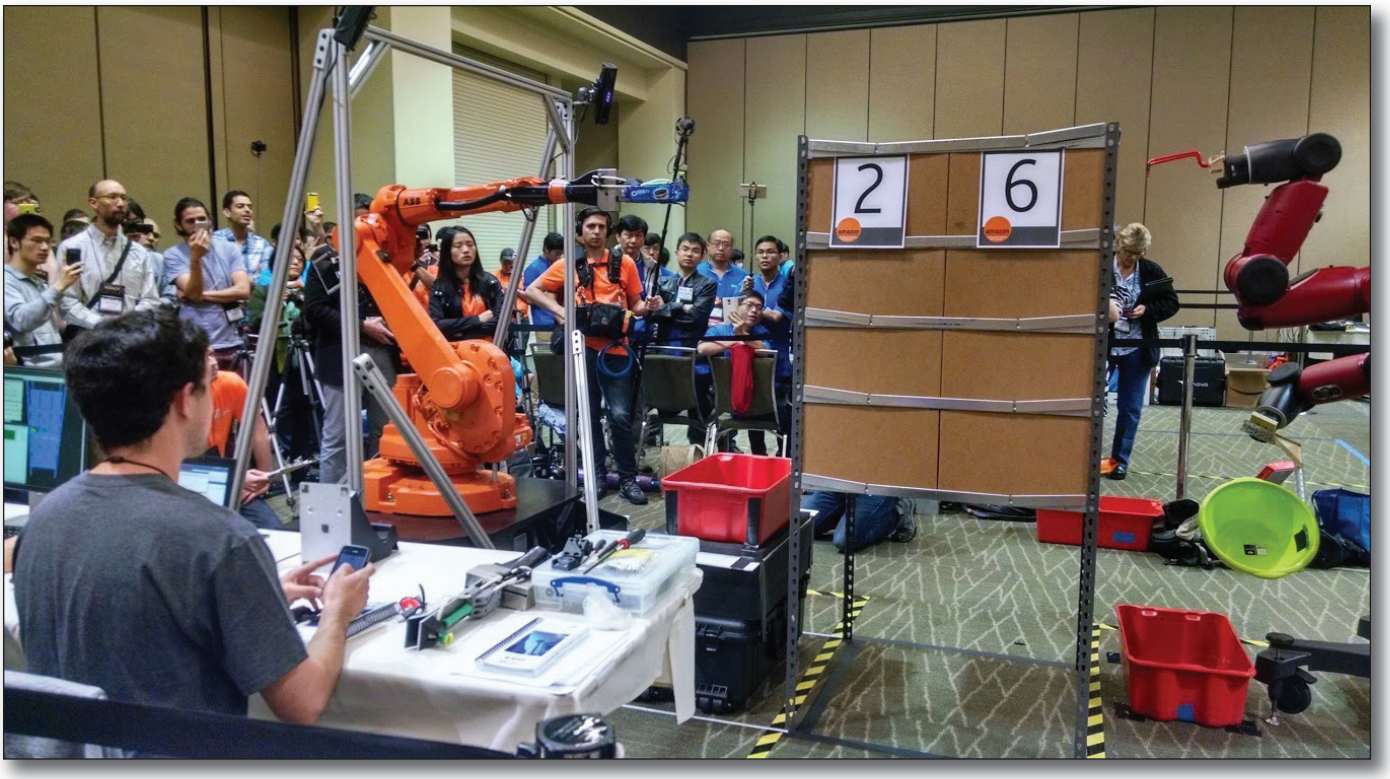

Figure 1. The Amazon Picking Challenge in 2015.

The competition was won by RBO from the Technical University of Berlin who picked 10 items and scored 148 points. MIT placed second with 7 items generating 88 points. Third place was Team Grizzly from Dataspeed Inc. and Oakland University with 35 points. Many other teams looked promising during the setup period but for various reasons failed in their official 20-minute trial. The causes of failure included last minute code changes, problems adjusting to the exhibit hall lighting, and modeling errors. While most of the robots were stationary, it is interesting that two of the top three were mobile.

In the first APC, the majority of the teams focused on traditional perception and robotics problems: identifying an object, figuring out how to grasp it, and then computing joint motions to accomplish the desired trajectories. Little task-level feedback was in evidence; most robots could not sense if they had successfully picked up the target item, and would execute the rest of the removal motion with an empty hand. While everyone had a sense-plan-act architecture, there were few monitor-react loops.

In future APCs, with bins more realistically full, there is greater opportunity for AI techniques to play a role. As in an actual warehouse, items could be stacked, obstructred, or completely obscured within the bin. Further, items may look like each other, creating ambiguity that would need to be intentionally resolved. Planning and decision making under uncertainty are likely to be important techniques in making these technologies commercially viable.

Notes

For more information, see amazonpickingchallenge.org.

Peter Wurman is the technical cofounder of Kiva Systems, Inc., which was acquired by Amazon.com in 2012 and is now known as Amazon Robotics. As CTO, Wurman ran the Research and Advanced Development group at Kiva, from which he initiated the Amazon Picking Challenge. Prior to founding Kiva, Wurman was an associate professor in the Department of Computer Science at North Carolina State University. He received his Ph.D. from the University of Michigan in AI, and a BS from MIT in mechanical engineering.

Joseph Romano is a research scientist developing next-generation robotic platforms at Berkshire Grey Inc. in Waltham, Massachusetts. Prior to BG, Romano was part of the engineering team that brought Rethink Robotics Baxter Robot to life and part of the advanced research team at Kiva Systems (Amazon Robotics) where he helped design the Amazon Picking Challenge. He received his master's and Ph.D. from the University of Pennsylvania's GRASP laboratory focusing on algorithms for robotic tactile manipulation and virtual haptic rendering, and his BS at Johns Hopkins University working in surgical robotics. His interests span signal processing, control, and planning strategies that allow robots to accomplish delicate sensor-aware manipulation tasks.