Analysis of Human-Robot Interaction at the DARPA Robotics Challenge Trials

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In December 2013, our team conducted a study of human-robot interaction (HRI) at the Defense Advanced Research Projects Agency (DARPA) Robotics Challenge (DRC) Trials, held in Homestead, Florida. The competition was designed to test the capabilities of humanoid robots in disaster response scenarios with degraded communications. Each team created their own human-robot interaction methods to control their robot, either the Boston Dynamics Atlas robot or a custom-built robot. Of the fifteen competing teams, eight participated in our HRI study. The study was approved by the Institutional Review Board at the University of Massachusetts Lowell.

While the evaluation of robot competitions is limited by the need to allow teams to compete without interference, such competitions provide a unique opportunity to directly compare a relatively large number of systems designed for the same task. The findings of such studies can lead to the development of improved robot systems, allowing the community to learn the lessons of many teams at once and in comparison to one another, rather than reports of individual results.

During the event, we observed the participating teams from the field (with the robot) and in the control room (with the operators), noting many performance metrics, such as critical incidents and utterances, and categorizing their interaction methods according to number of operators, control methods, and interface automation. The control room configurations are shown in figure 1. We found that the number of operators had an influence on team performance: the more successful teams had fewer operators than the other teams.

In our analysis, we decomposed each task into a series of subtasks, different from the DRC Trials official subtasks for points, to gain a better understanding of each team's performance in varying complexities of mobility and manipulation. Each team's interaction methods have been compared to their performance and correlations have been analyzed to understand why some teams ranked higher than others. For example, we found that a lower amount of effort needed to control the robot system led to better team performances.

In this talk, we will discuss lessons learned from this study and present design guidelines for HRI with humanoid robots. We have found that, in general, the guidelines for human-robot interaction for unmanned ground vehicles still hold true: more sensor fusion, fewer operators, and more automation lead to better performance. We will also discuss what we expect to see in the future of the DRC as well as other applications of humanoid robots.

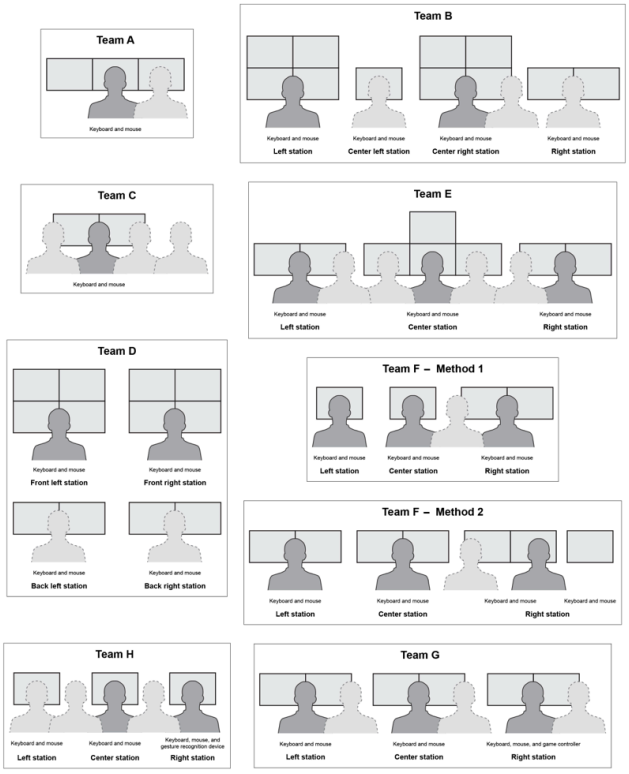

Fig. 1. Graphical representation of interface displays and team composition during the DRC Trials. Dark figures were primary operators during tasks; gray figures were supervising or secondary operators.

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References

[1] H. A. Yanco, A. Norton, W. Ober, D. Shane, A. Skinner, and J. Vice, "Analysis of human-robot interaction at the DARPA Robotics Challenge Trials," *Journal of Field Robotics*, to appear.

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