

## **Workshop on Science and Technology Challenges for Robotics**

Robotics Science and Systems, 2006  
Friday, August 16, 1:30-4:30

### **Goal**

The workshop brought together leaders in academia, government and industry to identify and articulate key scientific and technological achievements in robotics, the main challenges confronting the community, and the key milestones for the next decade.

### **Background**

Over 4 decades have passed since the installation of the first industrial robot, and the first robotics research conference was held over 2 decades ago. A recent study at [www.wtec.org/robotics](http://www.wtec.org/robotics) provides a good summary of the state-of-the-art in robotics research and development. While the industry surrounding industrial and service robotics is only \$10B world wide, the impact of robotics science and technology goes well beyond this industry. Contributions of the robotics community ranging from algorithms for dynamic simulation and motion planning to designs for vehicles and robot platforms have had a significant influence on industries that are not identified with robotics. Students trained in robotics are attractive to both civilian and defense industry. Most universities, colleges and even schools have made or are making significant investments in robotics because of the intellectual foundations of the field. And yet funding for both basic and applied research in this field is low, with the exception of applied research directed toward defense and security applications. The workshop will engage members of the community to identify and articulate key scientific and technological achievements and milestones for the future. Possible outcomes of the workshop include the establishment of a world-wide network in robotics, a decadal survey of robotics research, and a roadmap for investment in robotics.

### **Format**

The workshop consisted of short talks and panel discussions by representatives from academic institutions, government agencies and industry.

### **Organizers**

George Bekey (USC), Vijay Kumar (UPenn), and Matthew Mason (CMU)

## **Panel Discussions**

The panel discussions centered on the following questions:

### National Networks Panel

1. What is the vision for robotics research in your country/continent?
2. What are the drivers for growth?
3. What are the resources (funding) for research?
4. How do we improve resources for research?

### Robotics Industry Panel

1. What are drivers for growth?
2. Are the resources (funding) adequate? Why not? Assuming the answer is no, how do we grow these resources?
3. Do we need a community wide strategy on where robotics research ought to go? Are there milestones you would suggest?
4. Would it help to establish a national network to promote robotics?

### Beyond Robotics Panel

1. What are the new directions for growth?
2. Can we plan a roadmap for robotics research (and therefore for investment)?
3. Are there milestones we should focus on? [Name one!]
4. What are the opportunities for increasing resources for research?

### Perception of Robotics in Washington

1. What are the key scientific achievements of the robotics discipline?
2. Is robotics losing its identity as a discipline?
3. Would it help to establish a national network to promote robotics?
4. How do we improve resources for research?

### Next Steps Panel

1. Is there a common overall vision on what robotics is: the intellectual agenda and breadth; on where robotics is going; on new technologies and applications? If not, do we need to develop this overall mission?
2. Should we attempt a decadal survey that will identify achievements of the past decade and milestones for the next decade (Robotics 2010)?
3. Is there a need for a national network in robotics? How should we fund this?

## **Summary**

There was an enthusiastic response to the workshop with over 85 participants. Discussions had to be cut short because of time constraints. This could clearly have been a two-day workshop. There were many

volunteers who were ready to take on more responsibilities to promote the discipline.

While the opinions of the panelists and other participants differed, there were many issues on which there was consensus.

- 1) The impact of robotics needs to be measured along at least three different dimensions: (a) intellectual; (b) social; and (c) economic. Any study of the impact of the field and attempts to plan for the future must take these axes into account.
- 2) There needs to be an effort to assess the state-of-the-art in robotics to establish a baseline for the field. This is essential to plan for the future of the discipline. The WTEC "state-of-the-art of robotics in the US" workshop was a step in the direction, but the main achievements and broader impacts of the field were not highlighted in this study.
- 3) While there appeared to be immediate consensus on the need to establish a baseline, there was much more debate on the question of whether or not we need to establish a roadmap for the field. In the end, road mapping was felt to be necessary despite the potential for making mistakes during the process.
- 4) Robotics needs more visibility. It was clear that everyone felt the field would benefit if there were a concerted effort toward this end. But it was less clear how to do this.
- 5) There needs to be a concerted effort to see what has worked well within the European and Australian research communities. While there are important lessons to be learned from the Japanese and Korean research communities, it is less clear that these lessons can be translated to the U.S.
- 6) The need for patience was stressed repeatedly. U.S. funding agencies and venture capitalists do not recognize robotics as a field that merits basic research. While this may be also true in other fields (the NAS study on competitiveness was cited repeatedly), it is particularly true of robotics.
- 7) The main accomplishments of the field (Mars rovers, surgical robots, tactical mobile robots) were stressed.

## **Appendix: Agenda for the Workshop**

1. Introduction, Vijay Kumar
2. Challenges and call for action, George Bekey,
3. Broader Impacts, Matt Mason
4. National Networks
  - The European Network, Henrik Christensen (Georgia Tech) [EURON, Roadmap, Research agenda]
  - Robotics Research Network in Australia, Hugh Durrant-Whyte (ACFR)
  - Japan and Korea, Junku Yuh (NSF)
5. Robotics industry
  - Mobile robotics, Jeanne Dietsch(Mobile Robotics)
  - Autonomous Navigation, Jim Ostrowski (Evolution Robotics)
  - Autonomy in vehicles, Jim Marsh (Lockheed Martin)
  - Automation, J. Dugan (Kiva Systems)
  - Software for robotics, Stewart Tansley (Microsoft)
- 10 minute break
6. Beyond robotics
  - Artificial Intelligence and Robotics, Lynne Parker
  - Cars and Driving, Sebastian Thrun
  - Integrative Biology and Robotics, Dan Koditschek
7. Perception of robotics in Washington
  - Vladimir Lumelsky (NASA)
  - Jing Xiao (UNC)
  - Rich Volpe (JPL)
  - Eric Krotkov (Griffin)
8. The next steps
  - Mark Cutkosky (Stanford)
  - Jeff Trinkle (RPI)
  - Greg Chirikjian (JHU)
9. Wrap-up

A draft of a brief report by the workshop organizers will be available here shortly.