From Internet to Robotics - An Update

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The CCC effort on road-mapping for robotics was launched by early 2008 with a goal to generate a broad roadmap for the field. To enable this the effort was divided into 4 topical areas: Manufacturing & Logistics, Healthcare and Medical Robotics, Service Robotics and Blue Sky Research. The first 3 workshops were application/market driven whereas the last one was focused on emerging trends. For each workshop 2-3 senior researchers were asked to serve as organizers and moderators for discussions.

For each workshop a mixture of industrial and academic researchers were invited to a two-day meeting with the objective to identify challenges, strategic considerations, possible solutions, and provide the key information for formulation of a roadmap. Two workshops took place by June 2008 and another two were organized by August/September 2008. In total more than 100 people have participated in the workshops and there has been a healthy balance between industry and academia. The workshop results have been written up in topical reports (20-30 pages each) by the workshop organizers. A synthesis meeting across the 4 topical areas was organized by December 2008 with participation of workshop organizers only. The reporting style has been harmonized and a synthesis report is currently in preparation. The year 2009 is dedicated to distribution of the roadmap to agencies and industries. Turning the roadmap documents into a form that is suitable for presentation to a wider public is another on-going effort. The roadmap documents have been made available to all workshop participants for comments and feedback. In addition the document are released to the broader community for feedback.

In manufacturing it is evident that the main applications have been large-scale production of entities such as cell phones and cars whereas small-scale production has received limited attention. It is further evident that processes such as logistics and material handling have significant potential for use of robotics, but so far little attention has been devoted to such applications. There is a need to consider new methods for easy programming of robots, and further integration of sensory information to enable robust and safe operations. Less than 5% of all industrial robots today use sensors as part of the primary control system.

Medical robots are today widely used for prostate surgery and are also gaining momentum for cardiac procedures and hip replacement. The main motivations are faster recovery, improved quality and a reduced risk of any side effects. The potential for medical robotics is very significant. Related to healthcare there is also the use of robots for rehabilitation as it enables a higher degree of customization to individual patients and faster initiation of training. In addition the engagement with robots is sometimes easier than interaction with humans due to privacy and scheduling considerations. Wider adoption of healthcare robotics calls for new methods in machine learning, human robot interaction and flexible mechanisms for physical interaction with humans.

Service robotics has two aspects: professional and domestic. Professional robotics involves

for example agriculture, forestry, mining and harbor automation. The number of people involves with agriculture and related industries is decreasing while the demand is increasing and there is a need to further automate the industry to remain competitive. For domestic services there is a need to provide cleaning, surveillance, life sign monitoring, remote video, etc to assist people in their busy lives, but also to provide key functionality to enable people to remain in their homes as mobility and mental capabilities are reduced with age. In service robotics it is characteristic that users have no or very limited training and the systems must be intuitive / easy to use. In addition there is a need for flexible integration with existing technology (a scalable integration strategy). Finally there is a need for navigation and flexible perception to allow deployment in natural environments (homes).

In emerging technologies that are several opportunities as sensing become ubiquitous, more flexible mechanisms are designed and new technologies such as nano become available. The access to complex computing with a limited footprint allows deployment of AI in new settings. The use of machine learning and new types of interfaces with a high degree of connectivity opens entirely new opportunities for use of robotics. Not to mentioned new actuation methods.

Robotics in general is characterized by a significant economic potential and has research opportunities across the entire spectrum from basic to applied. There are clear short-term opportunities in areas such as medicine and manufacturing and at the same time there is a potential to create an entirely new industry for cognitively endowed robots with richer interaction with the world.

Follow-up actions:

As a follow-up to the CCC workshops several different things are happening.

- A congressional caucus has been organized and it is expected that the final CCC report will be presented to the caucus during March 2009.
- The transition team asked for a brief report on robotics, and a 4 page summary was provided to them at short notice
- There are currently several discussions on strategies for implementation of aspects of the roadmap. Possible avenues include:
    - Integration with the NSF Cyber Physical Systems Program
    - Engagement with an effort by NIST to define new technologies for manufacturing
    - Engagement with DARPA to consider new opportunities in robotics such as mobile manipulation
    - Discussions with NIH about use of robotics in medical procedures (beyond prostate and cardiac) and possible uses of robotics in healthcare procedures.
- Presentation of the roadmap to the Office for Science and Technology Policy

Several companies have also expressed an interest to consider how they can engage in a broader effort on robotics across United States.

Concluding remarks:
Over the last year a significant momentum has been built up in robotics in terms of definition of a research agenda that is both basic and applied. The agenda has an opportunity to build an entirely new industry in the United States. In a climate of a new administration there is an opportunity to truly change how robotics research is pursued and how results are transitioned to economic results. It will be essential to utilize the year 2009 to capitalize on the momentum and the new opportunities.