It is always interesting to read articles about robotics in non-robotics magazines or hear people talk of the changes in the field. Quite often, when people realize that I write about the history of robotics, I invariably hear the comments “I remember when robots ...” or “Robotics has really changed since ...” I sometimes answer with “The times, they are a changing,” and give them a short synopsis of my thoughts on the subject. The print and TV media has certainly expressed their ideas on the subject of robotics and the many changes over the years.

The August '11 issue of National Geographic featured an article entitled “Us and Them — Robots Get Real.” The article went on to state that “sophisticated robots may soon cook for us, fold our laundry, even babysit our children.” In the June issue of Control Engineering, an article entitled “The Changing Face of Robotics” mentioned the extremely popular FIRST robotics competitions as a way to entice young people into the fields of science and technology. The article went a bit further to speak on the emergence of mechatronics, new delta-style pick and place industrial robots, and autonomous UAVs and UGVs.

The non-technical media has taken notice on just how rapidly robots have entered our lives and are changing the way that we live. This column centers on how robotics has changed over the years, so these types of articles always catch my eye. The IEEE Spectrum magazine recently headlined: ‘Next Big Thing in Silicon Valley: Robotics?’ Are we at some amazing turning point in this science? Are the strictly computer and semiconductor manufacturers moving into robotics and automation, or are these key industries spawning these new companies? Is the heartbeat of robotics innovation moving from the east coast areas of MIT in New England and Carnegie Mellon in Pittsburgh to the birthplace of microprocessor-based computers — the San Jose area in California? I believe it is a bit of all three.

Other rapidly growing areas of technology such as Austin, TX and the Research Triangle Park in North Carolina are riding the latest boom, though an article in July’s Fortune by David Kaplan is warning of a potential ‘Tech Bubble 2.0.’

Robot Industries Shift Away From Michigan And The Auto Manufacturers

Let's step back several decades and view the state of robotics at the start of this new industry. The big push in robotics in the '60s, '70s and through the '80s was industrial robots and their implementation in the booming automobile manufacturing industries centered around Detroit. My employer (Rockwell) asked me to study how robotics could be used in the aerospace industry. I went to the yearly robot conferences that were sponsored by Robotics International of the Society of Manufacturing Engineers. RI/SME is based in Dearborn, MI and produced robot conferences and exhibits that alternated each year between Detroit and Chicago. Hundreds of robot manufacturers — both large and small — were scattered around the suburbs of Detroit and nearby Canadian cities. The exhibit halls in Detroit and Chicago were crammed full of robots: industrial, educational, experimental, and whatevers. Thousands of professionals, members of the media, university researchers, and some who were just interested in looking at what was new roamed the aisles, looking at the future. Local TV news crews conducted interviews with manufacturers of especially cool looking robots, and maybe a noteworthy spokesperson such as Joe Engelberger. If it had anything to do with robots, it was at one of these RI/SME conferences either as an exhibit or the title of one of the technical sessions.

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Most of the speakers were from the manufacturing sector, either representing a robot manufacturer and touting the many unique applications that their products could perform, or the user segment from industry that spoke of the positive ROI (return on investment) and time savings of using robots. News people rarely interviewed those of us in the other robot interest groups. In the early ‘80s, the exhibit aisles were filled with various sizes and styles of robots, most from US companies. Soon, the large Japanese companies began to show their superior robots and, by the ‘90s, most of the American companies manufacturing industrial robots were either bought out by Japanese, Swedish, or German robot manufacturers, or just quietly faded away into oblivion.

My interests were primarily robotic applications for the space industry and for actual in-space deployment such as space station applications and Mars/moon rovers. There was a core group of us from other companies and industry groups that gave talks on non-manufacturing robot applications. Some of the manufacturers of the early home robots (such as RB Robot, Heathkit, and Androbot) were shunned a bit as they did not fit the mold of a ‘real’ robot. Our special interest group presentations were well attended, but nothing like the large groups attending the industrial robot sessions.

Some of my presentations on space station robotics managed to keep most of the group of 50 or so people from falling asleep, but it was the presentations from Odetics and their six-legged, human-sized robot that really kept a 100 or more people on the edge of their seats. The Odetics Odex 1 from around 1983 is shown in Figure 1 and was one of the most interesting robots that I’ve ever seen. Standing a bit over five feet tall, this robot was shown climbing out of the bed of a small truck, and then turning and lifting the back of the truck off the ground. It was designed as a possible hazardous duty robot, working in nuclear power plants and the like, but the marketing aspect never generated any sales. It was ahead of its time.

National Service Robot Association Has Difficulties In The Late ‘80s

After a period of several years highlighting only the industrial robot sector, the RI/SME began to realize that the other segment of robotics was garnering a lot of interest and attention. This ‘other’ segment included service robots, military robots, police robots, UAVs, and types of robots that defied definition. Several of us got together to form the National Service Robot Association (NSRA) and Doug Bonham of Heath was elected chairman. Heath was the manufacturer of the very popular Heathkit Hero (Heath Educational RObot) series of robots back in the ‘80s and Bonham was the ideal board chairman. To this day, any of the Hero educational robots are sought-after collector’s
items as it was one of the products that changed the face of experimental/hobby robotics.

Figure 2 shows the later version of the Hero — the Hero 2000. Also, based also in Ann Arbor, MI — the home of the Robotic Industries Association — the NSRA had great initial enthusiasm but garnered little industry support. As did the RI/SME, the NSRA seemed to shrink to oblivion, though the parent group (RIA) is still active and presents many conferences and exhibits around the country.

Microsoft’s Kinect Gives Robot Builders A New Goal

Robotics has changed in the past decades. Powerful and cheap computing power coupled with some amazing new sensors have given robot designers new directions and applications for service robots that were not only unavailable decades ago, but unthinkable. Electronic Design’s April issue featured Willow Garage’s PR-2 on the cover with the associated article “Robot Revolution” addressing how ‘Cooperation Leads to Smarter Robots.’ Desktop Engineering’s July issue featured an article entitled ‘Mobilizing Toward a Robotics Revolution’ that delved into intelligent robot sensors, in particular, the Microsoft XBOX Kinect shown in Figure 3. This amazing device has taken the intelligent body motions without the need for a wired hand controller.

For years, artificial intelligence was limited to a handful of basic sensors to deliver a perception of the robot’s world to its processor. Ultrasonic and IR sensors could reach out and detect obstacles that might affect the robot’s path. Passive sensors could detect sound, light, and even understand a human’s speech for control. Inventors attached web cams and other visual imaging devices to allow a robot to perceive the outside world. Stanford University’s AI Lab had built the ‘AI Lab Cart’ shown in Figure 4 and ‘Shakey’ in the ‘70s and ‘80s — robots that used crude vidicon camera vision systems to navigate. The results were amazing for the time but lacked usefulness compared with today’s technology. Over a decade later, Sony’s Aibo of the ‘90s was capable of recognizing human faces, and robot experimenters soon applied this technology to their creations.

Kinect Is An Ideal Intelligent Vision System For A Robot

It was not until Microsoft introduced the $149.95 Kinect peripheral for their Xbox-360 that robot builders with a limited budget could now create a machine that would make sense of human motion. On November 4th of last year, Microsoft released the Kinect, and Xbox gamers jumped on it like bees on a picnic watermelon. So did robot experimenters. Just as the Scarecrow and Tin Man in the Wizard of Oz felt they needed a brain or heart to finally be accepted as intelligent entities, robot builders wanted their robots to have a true, functional vision system. This group of experimenters saw this new product as a dream come true for their creations — at least as far as the vision part goes.

By March of this year, Microsoft had sold over 10 million of the devices...
— far out-selling Apple’s i-Phone and i-Pad launch sales. The device was a natural for hackers. When an ex-Microsoft employee offered $3,000 for the first person to hack the system, it was hacked within days of its launch. You-Tube has a slew of videos of Kinect-powered robots. The photo from the IEEE Spectrum Magazine in Figure 5 shows a Kinect-controlled Quad Rotor AAV. You can see the four whirling rotors protected by the yellow ‘fences.’

Xbox gamers saw the jewel that it was, but it was the robot experimenter community that dug into the amazing sensor and made it the center of their robotic creations. Universities around the world saw the Kinect as a replacement for previous complex systems that cost tens of thousands of dollars and did not work as well as the $150 Microsoft product. At first, Microsoft — as with most large companies — strenuously objected to the hacking competition but soon realized that making the device ‘open source’ would benefit everyone — especially them.

The Kinect enables control of the Xbox through “natural interaction” — a term trademarked by PrimeSense (Tel Aviv, Israel) — the company that developed Kinect’s underlying optical sensing and recognition technology that translates body motion into control commands. It works by projecting an infrared laser pattern onto nearby people and objects. A dedicated IR sensor picks up on the laser to determine distance for each pixel, and that information is then mapped onto an image on a standard RGB camera. The Kinect sensor has an IR emitter, a depth camera coupled with a standard RGB camera, and a built-in array of four microphones that track your full-body movements and respond to your voice.

The Kinect project started out as Project Natal after they bought another Israeli startup company (3DV for $35 million in early 2009). 3DV was a developer of 3D real-time depth detection digital cameras. PrimeSense and Microsoft examined technology from both companies and ended up using the PrimeSensor technology. Figure 6 shows one of the earlier, pre-Kinect PrimeSense-WAVI-Xtion systems. Note the similarity to the later Kinect configuration.

Figure 3 shows the simple layout of the Kinect sensor system and the three lenses. When the projected IR pattern from the emitter seen as the far left ‘lens’ hits a 3D object, the lines are distorted and this distortion is read by the depth camera (the camera to the right). This camera analyzes the distorted IR patterns and builds a 3D map of the room with all the objects and people in it.

The center camera is the color camera that is used to gather details about people and objects in the viewing area. Figure 7 shows an exploded, hacked view of the Kinect. From the bottom, you can see the four-microphone array, the three circuit boards, and the three cameras. I’m not going to elaborate on the aspects of Kinect as you can search the Internet and find dozens of sites explaining the device, as well as dozens of hacking sites and hundreds of robots using the Kinect.

Other Changes In Robotics Over The Years

There are many other technological breakthroughs that did not necessarily cause changes in the field of robots, but rather allowed these changes to occur. One might say that low cost GPS modules (such as the two Parallax GPS modules that cost $35 and $80 each) have allowed builders...
to make robots that can traverse outdoors and navigate fairly accurately. The Parallax 28146 module at $79.99 is shown in Figure 8, but there are many companies who offer similar modules for experimenters. Others have hacked inexpensive handheld GPS receivers for the same purpose, and hacking information is available on the Web. Needless to say, the accuracy is not what we might expect for a robot that operates indoors within a 10 foot square room, but GPS navigation is ideal for outside events such as the Robo-Magellan contests that have become quite popular across the country.

First envisioned by the Seattle Robotics Society, builders have constructed winning Robo-Magellan entrants for little more than a few hundred dollars in parts. Without the cheap CCD/CMOS laptop web cameras and GPS modules available to robot hobbyists today, robots such as these were unthinkable just 20 years ago outside of university and industry labs. Now, builders can toss in some next step ideas such as high power density LiPo and other battery designs, rare-earth PM and brushless DC motors, cheap microcontrollers, and a wealth of information available on the Internet. 3-axis gyroscopes and accelerometers make stable walking robots a possibility.

Closing Thoughts

This past June, President Obama announced the National Robotics Initiative — a program to develop next-generation robots for industrial purposes, healthcare, and other service robot applications. Robotics groups were enthusiastic about this news, but as various administrations in the past had proven with previous announcements about new technology, most will take a wait and see attitude. Will such an initiative prove to be a way for our industries to replace skilled technical and production people with brainless button-pushers? Are we, indeed, heading to another robotics revolution, as the non-technical media has touted for so long? Will these changes in sensor, computing, vision, and power systems technology create the changes in robotics that we are all striving towards? We’ll just have to wait and see. SV

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