INSIGHT Practical robotics

Time for robots to get real

Drop the gimmicks and robotics will really take off, says **Helen Greiner**

FROM robotic slug-killers to dancing humanoids, there's a lot of media buzz around robots. But the roboticists behind such ventures need a serious reality check.

As a founder of iRobot Corporation, based in Bedford, Massachusetts, and CEO of robotics start-up CyPhy Works, it's clear to me that merely engineering "cool" robots does little to advance the field. If robotics is to succeed like computing, what matters is making practical robots that do jobs well and affordably – factors that tend to get lost as people fascinate over the latest autonomous party pieces.

The importance of focusing on practicality struck us during iRobot's formative years in the 1990s, when we were engineering robots as toys, oil-well surveyors and commercial cleaners for industry-leading firms. Why? Companies would only pay good money for practical designs that performed reliably.

Roboticists who don't focus on practicality, ruggedness and cost are kidding themselves. Simply put, people don't want outlandish machines in their homes. Before iRobot introduced the Roomba vacuuming robot in 2002, focus groups imagined it would look like the Terminator pushing a vacuum cleaner – and told us they would not accept such machines in their homes. But when we showed them that Roomba was small, light and friendly, they loved it.

"Roboticists who don't focus on practicality, ruggedness and cost are kidding themselves"

Another benefit of practicality was seen last year, when iRobot's military robots, originally deployed in Afghanistan to defuse improvised explosive devices, proved very useful to the human teams dealing with the nuclear emergency at the Fukushima Daiichi power plant in Japan. As a result, many in Japan have questioned the nation's research focus on singing, running and dancing humanoid robots. It looks like change is afoot there.

This is to be welcomed because at this point, attempting to duplicate human intelligence or the human form robotically is a wrong-headed approach. We already have about 7 billion humans on the planet and we are really good at what we do. To sell humanoid robots they would have to be better than people – and that is just not realistic yet.

Software standardisation, around the Robot Operating System and Linux, for instance, will help developers focus on the practical. This is a tremendous move because engineers, particularly in research universities, won't have to start coding from the ground up to build their own robots. Instead, their challenge will be to build software packages small enough to run on affordable processors, and robots that avoid the common embarrassment of being wimpy and underpowered with limited usage time.

By focusing on bringing robots to market, innovators will be able to put the industry firmly on the commercially viable, world-changing track it deserves. ■

Tell me a story and I'll make you a movie star

BOXIE may look like a cardboard version of Pixar's Wall-e character, but the robot's job is to make movies rather than star in them.

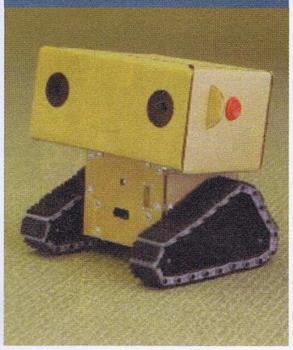
Designed to wander the streets shooting video, the diminutive droid seeks out people and asks them – in a cute human voice – to tell it an interesting story. The video clips are then edited into a documentary film in the normal way.

"The idea was to create a robot that was interesting enough for people to engage with it," says Alexander Reben, who developed Boxie at the Massachusetts Institute of Technology's Media Lab.

The robot, which appeared at the ACM Multimedia Conference in Scottsdale, Arizona, in November, has an ultrasound sonar to detect and avoid walls, and a heat sensor to tell it when it's found a person.

It then asks questions, including a request to be picked up and shown around, say a lab or mall. Over a few days Boxie collected about 50 interviews, which the MIT team turned into a 5-minute film.

The team was right to focus on perfecting Boxie's social skills, says Chris Melhuish of the Bristol Robotics Laboratory in the UK. "Future smart machines will need such social intelligence to interact naturally, utilising appropriate gestures, body pose and non-verbal communication, for instance." Paul Marks ■



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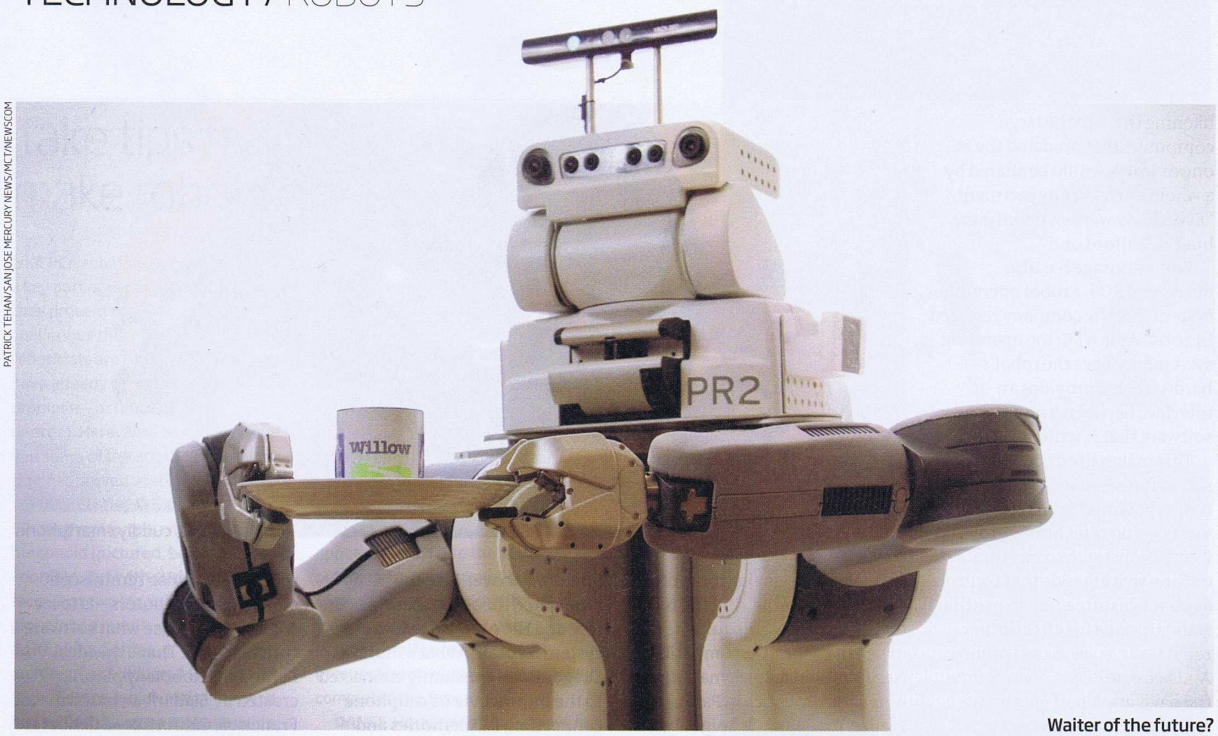


PATRICK TEHAN/SAN JOSE MERCURY NEWS/MCT/NEWSCOM

Waiter of the future?

The next robot revolution

Software is about to haul robots out of the lab and into our homes, just as it did with home computing

Celeste Biever, Menlo Park, California

TED LARSON walks to the front of the crowded room and lays an ordinary-looking smartphone, encased in a black plastic cradle, flat on the table.

It's show-and-tell at the Homebrew Robotics Club (HBRC), the informal nerve centre of Silicon Valley's robotics community and the heart of a technological revolution that is about to haul robots out of the lab and into our lives.

Larson strokes a finger across the phone's touchscreen and an animated face appears. One end of the phone then rears up as the cradle splits into a pair of legs, allowing the phone-robot to wander around, cooing when people "tickle" it and taking photos of faces using its inbuilt camera. "It's a transformer!" laughs one delighted hobbyist. "It's Skynet," breathes another.

They may both be right. Larson, who runs a robotic toy and gadget company called Ologic, believes roboticists like those in HBRC are on the cusp of a breakthrough. Just as software transformed computers from dull accounting tools to can't-live-without devices, it is about to do the same for robotics. HBRC is an off-shoot of Silicon Valley's Homebrew Computer Club, which dates back to the 1970s when it counted Apple's founders Steve Jobs and Steve Wozniak among its ranks.

"I feel like robotics today is where computing was in the 70s," says Andrew Ng of the AI lab at Stanford University, California.

The software robot revolution would shift the way we think about robots. No longer would they be purpose-built objects with preset functions. "Now the emphasis is more on the software," says Mark Yim, a roboticist at the University of Pennsylvania's GRASP lab in Philadelphia. This could be just what is needed for robots to become the must-have devices we all rely upon.

The HBRC meeting was at Willow Garage of Menlo Park, California, the six-year-old company that is driving much of the software revolution. Willow Garage's major contribution has been the PR2: wheeled robots 1.5 metres tall with boxy torsos, two long, jointed arms with pincer hands, and a pan-tilt camera for a head. They are widely regarded as the most advanced general-purpose robots ever built.

> **"We care about turning robots into a software problem - software is what makes devices hum"**

Willow Garage reasons that by providing such capable hardware, roboticists are freed up to focus on the software. "We care about turning robots into a software problem," says CEO Steve Cousins. "Software is what makes devices hum."

At the GRASP lab, researchers have created software that allows the PR2 to identify and read signs, as well as predict the movement of people and navigate efficiently around them. And at the Georgia Institute of Technology in Atlanta, a PR2 has been used to help a quadriplegic man move objects around his house, control a mouse and even scratch his face.

PR2s are rare and expensive, however, costing $400,000. "PR2 is like a mainframe," says HBRC president Wayne Gramlich, ›

likening them to the large computers that predated the PC, one of which would be shared by a whole university department. "Everybody wants a mainframe but can't afford one."

Willow Garage has also developed ROS, a robot operating system that the company released in 2009. As in a PC, the operating system manages the robot's hardware and provides an interface between it and any new software that is written for it.

This makes life easier for robotics researchers, says Ng. It is now possible for someone who wants to focus on human-robot interaction, say, to concentrate only on writing code that controls a robot's gestures, and to use the standard code for all the other robot tasks, such as navigation. And because ROS is open source, the navigation part gets better and better, as researchers who are interested in navigation improve it before adding their modifications to the central software bank.

ROS has also accelerated innovation by stopping roboticsts from repeating each other's work. In the past, there was no standard operating system so many researchers had to write their code from scratch. Now, with so many people using ROS, it's easy to share applications.

Still, ROS isn't quite as easy to write for as the major computer operating systems. And the robots that run ROS are still quite expensive. The ROS-compatible Nao (pictured below), made by Aldebaran Robotics in Paris, France, for example, might be considered cheap by researchers but still costs around $15,000 – rather more than your average PC.

That's where Larson and his smartphone robot comes in. "We think cellphones are going to be the new way to make the next hot robot," he says. The creation he debuted at the HBRC meeting is called a Phonedox and runs on Google's Android operating system.

He points out that phones are now "powerful computers" that come with an operating system and sensors that can be used to a robot's advantage, including a camera and gyroscopes. His money is on telepresence as the killer app: video chat software could turn a cellphone or tablet on a chassis into a cheap remote-controlled physical avatar of yourself that attends meetings.

Cynthia Breazeal and colleagues at the Massachusetts Institute of Technology, who study the social and emotional aspects of robotics, are also banking on cellphones. They recently created DragonBot, an inanimate fluffy orange dragon that turns into a robot when a cellphone is inserted (pictured above). Like the Phonedox, the screen becomes the face and the Android operating system its brain. What's more, as DragonBot is constantly connected to the internet via its cellphone connection, its memories and "personality" can be stored in the cloud, on a remote server.

As well as freeing up a robot's limited computing resources, the cloud also allows them to communicate with one another, making each individual more intelligent.

"Cellphones are going to be the way to make the next hot robot - their sensors make them promising"

This is how Carlos Asmat sees it. He's a robot app developer in Montreal, Canada, who is part of the team behind Myrobots.com, which launched last month. Described by Asmat as a "Facebook for robots", the site allows registered robots to post updates such as temperature, whether it is stuck behind the couch, or noting the number of people in the house. Other robots could read these updates and then use the information to guide their own actions. For example, a vacuum cleaner robot might deduce there had been a party and clean.

Another way to make robots more useful – also reminiscent of personal computers – is to let consumers choose what software runs on them. That's the idea behind the RobotsAppStore, created by Elad Inbar, based in San Francisco, California – a deliberate echo of the app stores that currently exist for smartphones.

At the moment, the site is open for developers to upload the apps they have created and so far more than 200 have been uploaded, says Inbar. These include an app that turns the Nao into a storyteller for children and one that can enable the Nao to recognise when a pet's dish is empty and refill it with food.

When 500 robot apps have been uploaded – and approved – then the site will be open to consumers. Inbar believes that apps are the key to turning robots into useful devices because people can choose for themselves what they do with them, and because they allow the same robot to be used for a number of different things.

Such a robot revolution may be even more powerful than that in personal computing because robots elicit different emotions. "Your computer, you don't get attached to it, don't feel compelled to use it or care for it," says Asmat. "By contrast, people get attached to their robot, people project their emotions on to their robot." ■

PERSONAL ROBOTS GROUP/MIT

Cute, cuddly smartphone

ALDEBARAN ROBOTICS

In search of a killer app

Take tips from the arts to make robots come alive

LIKE PCs, robots may soon become a key part of our everyday lives, but they present unique communication challenges that PCs do not. So roboticists are turning to people who have already solved many of these problems - actors, animators and dancers. Here, *New Scientist* brings you some of the artistic know-how that has proved useful.

MASKED THEATRE The 50-centimetre-tall, white plastic Nao humanoid (pictured, below left) looks adorable. But with such a plain, rigid face - just two big lights for eyes and a pinhole of a mouth - how does the bot do it? Julien Gorrias, a "behavioural architect" at Aldebaran Robotics in Paris, France, which makes the Nao, had solved the same problem in his former life as a masked actor by using expressive body movements. "The whole body was involved in making the mask live," he says. His insights have helped give Nao a tangible personality. "You have to feel like it is someone," he says. "Not a human, but someone."

CARTOONS Humans can often guess what another human is about to do. To investigate how to make its PR2 robot (pictured, page 17) similarly "readable", robotics firm Willow Garage of Menlo Park, California, enlisted the help of the Pixar animation studio. Pixar's animated characters seem to anticipate their own actions: staring hungrily at a piece of cheese before grabbing it, say, creates the illusion of a thought process that makes a character believable. When the team created animations of the PR2 carrying out a task, onlookers were more certain of their interpretation of the robot's behaviour if its actions portrayed forethought. They also described the robot as more approachable.

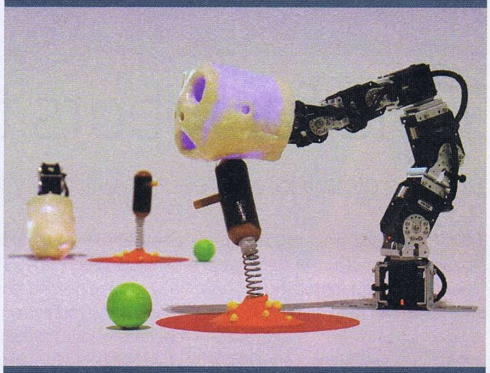
Similarly, animated PR2s that appeared to react to the task's outcome - a 30-year-old tip from Disney animators - rather than just standing there dumbly, were viewed as more intelligent and capable, irrespective of whether they actually completed the task.

DANCE Humans naturally move in subtly different ways depending on their emotions and intentions, but unravelling how we do this in order to program it into a robot is tricky. Luckily, choreographers have already done some of the work, thanks to a system for characterising human movement dreamed up by Rudolf Laban in the 1950s. Laban theory describes how the timing, strength and angle of a dancer's movement will convey a different inner intention or emotion. Willow Garage is using Laban theory to understand how well this translates when similar motions are executed by a large robot. Celeste Biever ■

ART MONTES DE OCA/PHOTOGRAPHER'S CHOICE/GETTY

OK, robot, now you try

ONE PER CENT



PAUL FUDAL/INRIA FLOWERS

Curiosity robots interact with public

Tucked away in a large egg at the Fondation Cartier art gallery in Paris, France, lurk five skull-faced robots that interact with the public. Programmed with artificial curiosity and language-acquisition algorithms, the robots explore how to change the behaviour of their human observers. They are part of a five-month experiment by Pierre-Yves Oudeyer at the INRIA research institute in Bordeaux, France, to look at how robots interact with one another and with humans.

33,177,600

The number of pixels in Sharp's new 8K TV, which was unveiled at CES, the world's biggest consumer electronics trade show, in Las Vegas last week

Phone starts the whites wash

Among the big hits at this year's CES were Samsung's Wi-Fi-enabled laundry machines. The washers and dryers connect to any smartphone through a downloadable application. The phone can then be used as a remote control, so the machines can be turned on and off while their owner is at work. A fridge that knows when food is going bad was also unveiled.

Internet for computers, not us

Websites designed to be read by computers rather than humans could make it easier to use data, says Stephen Wolfram, creator of "answer engine" Wolfram Alpha. In a blog post, he suggests that .data should join the likes of .com and .org as a new top-level domain, allowing organisations to share data in a standard form and creating a "data web" running parallel with the ordinary web. It would help price comparison sites search for the best deals, for example.

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