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Drones help farmers monitor the state of crops, from fields of wheat and corn to vineyards.

Breeding Robots

Creating a race of their own

In 2016, robots become mainstream. Moreover, they begin breeding, transforming many aspects of daily life.

Robots now are doing hundreds of human chores, from monitoring an elderly shut-in's mood swings to searching for lost hikers. In the months ahead, we'll become even more aware of their presence — and abilities — as more tasks, both simple and complex, become automated.

The new world of robots goes far beyond Siri and Cortana, the mysterious and savvy robotic inhabitants of our smartphones, or cars that drive and park themselves. Firefighters send drones — an increasingly ubiquitous form of robot — over burning buildings to provide an eyes-on survey of a fire so that, when firefighters arrive, they know where the fire is and if people are stranded on the roof or hanging out

of windows. Grape growers can send sensor-laden drones to aerially survey their vineyards to determine exactly which stands of vines are ready to harvest today instead of tomorrow.

YOUR PERSONAL ASSISTANT

However, robots' most widespread use in the immediate future will be as personal assistants. At

the University of Denver, Mohammad Mahoor is perfecting doll-like robots that coach children with autism to cultivate social skills. Robotic dolls also serve as companions to elderly persons, but take on more duties for them as well. Robots can monitor emotional affect to determine depression or even dementia; in the near future, robots will be able to hand a person the correct dose of a medication or crawl under the couch to retrieve something dropped.

One of robots' richest futures is in the surgical suite. Robots are being assigned surgical subtasks, including making incisions and stitching them closed. Often, the only reason to make a gaping incision in a patient is so the surgeon can reach the area of the body where a problem needs repair. Now, with robotically controlled surgical tools, a small hole or series of holes can be drilled near the site for small tools to enter the body and be guided by the surgeon using a joystick and hand controls. Making a small hole or incision to accommodate a robotically steerable needle enables physicians to deliver medicine to, or take biopsies of, body parts too hard to reach without a major invasive procedure.

To date, surgical robots have successfully operated on bone, such as in knee replacements. In 2016, robotic systems for operating on soft tissues, such as hearts and livers, will enter hospitals.

A fundamental driver of robots' expanded universe is their ability to learn. A technique called "deep learning" layers interconnected electronic neural networks that allow robots to learn as people often do: by trial and error, with the only feedback being the degree to which previous attempts have succeeded or failed. So far, most of the assigned tasks have been simple — screwing the cap on a bottle or putting a shoe on a shoe tree, for example. But other researchers are going further, teaching airplanes' autopilots how to fly safely out of unexpected emergencies. In late 2016, a robot able to handle the unexpected better than a human pilot will test-fly a US Air Force fighter jet.

Robots also show an astonishing power to learn in other ways. Ashutosh Saxena, a researcher at Stanford, leads a team that downloaded hundreds of Internet videos, showing how to boil eggs, into a robot's electronic brain. After "watching" the videos in its brain and absorbing the knowledge, the robot could boil an egg without human intervention or programming. One of Saxena's robots learned how to stack cups, then sent that skill over the Internet to a distant robot that then suddenly knew how to stack cups, too. **TJ**



Roboassist

Nao is a robot that coaches children with autism in social skills.



Intuitive Surgical

Robots are finding a home in surgical suites, where they enable surgeons to reach deep in the body without major invasive procedures.

TREND FORECAST

The synergy of robotics and artificial intelligence is leading to a near-term future in which robots assume an accelerating number of humans' rote tasks. But we already are confronting the reality that robots can learn and communicate faster and more efficiently than humans can. This is leading us to a future in which robots not only are self-aware, but also are able to design and build new robots more intelligent and capable than themselves. However, the Machine Intelligence Research Institute at the University of California at Berkeley is busy writing mathematical algorithms to make sure robots remain subordinate to humans.