ParisTech REVIEW

Robotics series – 4 – Robots in everyday life

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technology adoption

Robots will soon be able to read texts for us, engage in conversations, clean our windows, deliver packets and parcels, prepare our pill-boxes and even help us get back on our feet should we fall, or have difficulty just getting up. We had them first in the military sector, then carrying out industrial chores, now we see a new generation coming, prepared to do household chores, maintenance work, leisure activities or engage in educational activities. Whether they be macro-, or nano-, humanoid or dronoid, these robots are about to become our future companions. So, where do we stand today?

This article is the fourth of a series dedicated to robotics, which will be published within the next three months.

There are some unmistakable signs out there today. In 2013, Google Inc. acquired the eight main American and Japanese robotics companies, in just one fiscal year! In December 2013, the last acquisition for the year was the emblematic Boston Dynamics, who designed and created the robot Big Dog for the US military and the first in early 2014 is Nest, the current world leader in domotics and smart objects. Google has not been outspoken as to the reasons for these massive investments but we can at least offer a few plausible deductions to explain matters.

If we admit on principle that Google is present in every future market segment, we can likewise admit that robotics is one such sector and that Google foresees this as a promising and profitable market slot. It also implies that Google is taking robots seriously enough as to position them among the company's core activities, which may be summed up in the term "connectivity." The company doubtless considers that robots, like smartphones, can be commercialized as product or service platforms. Even if this cycle is too recent (and too opaque) to be analysed as a strategy aimed at the public at large, there can be no doubt that in the long run Google intends to see us all adopt robots at home.

But the Mountain View giant is not alone in seeing robotics as a key future sector. We can note the more discrete, but nonetheless symptomatic, massive public support in the USA, in Asia and Europe, which indicate the recent focus in policy to finance robotics research. In the USA, we have the National Robotics Initiative: 38 million $US for next generation robot projects. Brussels, on behalf of the EU, has just announced that the Commission with 180 enterprises and research establishments have just launched – under the aegis of euRobotics – the most important and ambitious civilian robotics research project in the world. This initiative, acronym SPARC, encompasses manufacturing processes, agricultural activities, health-related

acts, transport civilian safety and domestic applications. The result will hopefully be to see Europe's share in the global robot market rise to 42%. The European Union will be investing 700 million euros and the research establishments participating in euRobotics, some 2.1 billion euros together.

As Raja Chatila, senior research scientist at the CNRS-ISIR (Institut des Systèmes Intelligents et de Robotique), sees it, the media buzz often appears as a makeshift, jump-the-gun, spokesman for an otherwise undeniable reality: "Clear-cut technical and scientific progress has enabled robots to become increasingly operational. But, as yet, we cannot talk about households equipped with personal service robots, in the same way as we refer to households equipped with numerous domestic appliances. Truly domestic robots are not yet on the market. They are less present in real homes than in the professional robot exhibitions, such as Irec in Tokyo, the CES in Las Vegas or Innorobo in Lyons, France."

A robot in every home?

What we observe in 2014 is an ambivalent situation: on one hand the scene is totally empty, while on the other we can wonder if robots are not already here. A great many robotic entities exist in our daily language, whether they are real objects or just immaterial (such as stock exchange trading software packages) that are ranked as robots. Moreover, the very definition of robots is still subject to discussion. To facilitate our expose, let us assume a fourfold characterization: robots have a material existence inasmuch as they are endowed with perception (via sensors), can make decisions (via appropriate use of processors) and can undertake physical actions (using integrated motors).

But even this extended definition does not cover every robotic aspect! To illustrate, should we conclude that a refrigerator (with the same basic functionalities – the thermometer serving as sensor, the thermostat as a decision-taking component, the compressor as the integrated action taking motor) is a robot? "The answer is yes, or at least every bit as much as a driverless metro carriage or an automatic pilot in an aircraft" says Raja Chatila who adds that "it would, however, be too simplistic, too systematic. As I see it, robots can exist only when the environment represents complex parameters. Refrigerators, for example, have no effect on their surrounding environment. Metro carriages move in a linear, deterministic manner. Automatic pilots need only integrate wind parameters and the aircraft's 3D position coordinates." For Chatila and others, the definition of robots can be seen as an extension of complex situations. The more complex, the more arduous the milieu, the harder is their assigned perception task. The range of options increases as do the possible action courses.

At home, robots with high levels of autonomy are still few and far between. The emerging (but as yet splintered) personal robot market is being pushed by vacuum cleaner robots that account for most sales. These robots can avoid numerous obstacles, surface changes, can identify empty spaces, can record several paths and return to the charging station when the battery gets low. The clear leader in the field here is Roomba, a star product sold by the American company iRobot.

What conclusion should we draw regarding Roomba's success in terms of culture? Human beings, having given due thought to the question, now willingly accept to delegate a job that otherwise hurts your back muscles. Add to this that families have nothing to fear from a robot vacuum cleaner. It would appear that the appliance has returned to the Czech language etymological meaning of the word "*robota*" i.e., a meanly task. There is a long gap however between a vacuum cleaner robot and a humanoid companion that could teach you a foreign language. Moreover, the further domestic robots depart from their original context, that of slaves, the more they are difficult to accept… And yet, as domestic purpose assistants some of

the functions that today's robotic engineers and scientists hope to see are close to fantasy: if we readily imagine vacuum cleaner robots and lawn-mowers, what about "compassionate" robots (as companions, or pets), assistant robots for persons with reduced mobility, educational robots, robots to play games with or robotized domestic monitoring systems.

The rapid growth of a personal robot market is still something akin to futuristic claims. But what, if anything, could slow down development? The first stumbling blocks which we now describe are not only technical in nature but also carry cultural overtones.

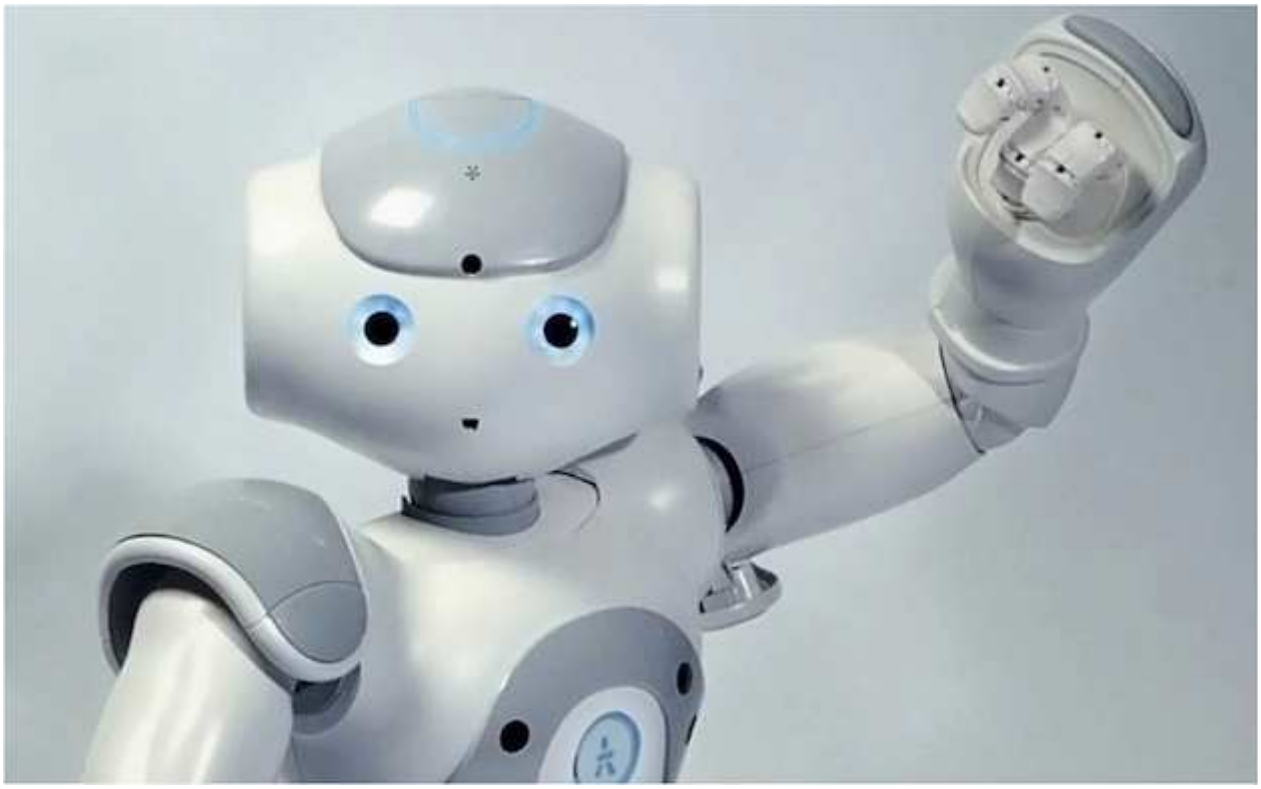
Cultural stumbling blocks

Long before robots invade our living rooms, so to speak, they had already entered our imagination. In the Western world, where they were integral actors in our myths, literature, cinema, arts and video-games, they were most often portrayed as technological monsters capable of replacing, if not destroying, mankind.

In this sense, robots have a singular, objective attribute: their automat nature which alone seems more threatening than autonomy or self-sufficiency, which we may see at some distant horizon in time. Today what is worrisome is not so much a possible robot revolt, but more their technical incapability to think and come up with decisions. Civilian drones (pilotless planes) are already very popular a san leisure activity, as we can see with hundreds of thousands of "AR.Drones" sold by the French company Parrot. But when a Texan company is awaiting the commercial go-ahead from some security company to produce Cupid, a Taser drone capable to directing an 80 000V discharge from above the target, we then realize the blind, sheer level of danger that a robot could embody and maybe (mis)use. This fear that automats might one day win the day against our consciousness is reinforced by our Western dualistic cultures, explains Jean-Claude Heudin, Director of the Internet and Multimedia Institute at the University Leonard de Vinci (Courbevoie, West Paris): "In the West, artificial life has been an exclusive privilege of the Gods since Antiquity. By transgressing this interdict, Man suffers the consequences. Whereas our Western culture makes a clear distinction between God and Man, between Body and Spirit, between Man and Nature, between Artificial and Natural worlds, Shintoist Japanese culture only recognizes continuums. Robots in Japan are seen as entities that will save Humanity."

Video: The Cupid Taser Drone

If in addition we bear in mind that the Japanese sees souls in objects, no wonder they are very attracted by having robot companions and to illustrate this we need only quote Paro, a companion seal developed by the NIAIST, Japan (National Institute of Advanced Industrial Science and Technology which proved very useful in post tsunami stress relief work. Paro looks like a seal, but of course the companion can be made to look like a human, facilitating insertion in our daily lives. Moreover, Japan is the most advanced nation when it comes to humanoid robotics: Honda's Asimo or various successive humanoid robotics project (HRPs) platforms are there to support this assertion.



Nao

Developments such as these aims above all other considerations at making a technological demonstration, all the more relevant that uses for humanoid robots are not yet fully reviewed. The Japanese are not alone here. The Japanese company Aldebaran Robotics (the R&D works for which is carried out in France) had already acquired experience and notoriety with Nao, a humanoid capable of interacting with humans, of moving, of recognizing people and objects. There are currently more than 5 000 Naos spread over 70 different countries, mainly used for research and educational studies, the next model, called NAO Evolution, launched in June 2014, was designed to "anticipate on development of brand-new applications for an audience that will include enterprises and content editors." But the robot that is attracting most interest today is the so-called emotional robot Pepper, developed by Aldebaran Robotics for the Japanese mobile phone operator Softbank. Pepper is 1.20m tall, has a 'belly' in the form of an iPad and moves on roller wheels (a legged option was not adopted, to keep the price down to about 2000 dollars). Part of Pepper's intelligence resides in network interactions which allow for easy enrichment. The CEO of SoftBank, Masayoshi Son, believes that Pepper can make people happy. As we await its arrival in the market, a certain number of models welcome customers to the SoftBank agency outlets in Tokyo!

In the Western countries, humanoids do not, as yet, fascinate the public at large. For David Filiat, lecturer at the French engineering school, ENSTA ParisTech, in the Department of Computer Sciences and Systems Engineering, "the real stumbling block still lies in the much needed technologies."

Co-existing with humans

A technological status report on personal service robots demonstrates that a real change is taking place in the way robot functions articulate with the human world. Robots initially were imagined and developed as a replacement for men (to increase productivity, to explore 'inaccessible' zones), but are now seen in the research fields as a positive add-on or adjuvant. Service robots no long work in lieu of or against, but now work with humans.

Japan is the first country to adopt this stance, but the underlying reasons are less cultural than pragmatic: the country is facing serious issues of low natal rate and ageing of its populations. Aids to senior citizens is now seen as central application of service robotics. The projects here are almost boundless. The "My spoon" device produced by Secom aids elderly persons to feed. The same idea is embodied in Bestic, a motorized arm developed in Scandinavia with support from the European Union. Products like these have been on the market for a decade now, but with a high (discriminatory) price tag. Among these mono-task robots, we have the Toyota Mobile Chair (Mobiro) or the smart chairs (Labs AutoNOMOS) or smart prosthetics (JACO), leg replacement exoskeletons (REX) or re-education aid robots (Lokomat).

In this area of application, research scientists have great hopes to see remote presence assistance robot stations. Dispelling doubts, cognitive stimulation, remote socializing, remote medical consultations and diagnosis… A large number of projects are currently under way in Asia, in the USA and in Japan: Robosoft's Kompaï robot can carry out repetitive tasks (such as offering medicinal drugs at regular pre-set times), can interact with the 'patient', can detect anomalous occurrences and consequently issue a warning to external agents. In the USA, InTouch Health has developed RP-VITA, a remote presence robot that enables practitioners, nurses and families to take care of the patient or relative from a distance.

There can be no denying it, these smart aid devices have the opportunity to improve life-style and comfort for dependent persons and to facilitate 'patients' living at home – which is always the to-be-favoured option. But, for the time being, these robotic 'assistants' must be seen as complementary aids to a real presence. And we have already taken note that there is nothing quite so difficult as to set up a "natural" relationship between a robot and a human being. In this light, what could be more cruel than to abandon our ageing parents in the company of Kobian and his special sense of humour – the Kobian humanoid robot being specially programmed to make humans laugh? If robots can be encoded to master the most general components that lead to laughter (behaviour, context, exaggeration, etc.), what should we say about the personality of the human, in terms of age, background history and current state-of-mind?

Domestic robots are is their early teething phases, with functions and possibilities ranging from humour, to astute reactions, situational perception, adapted movement… But the fact is that the capability to interact with humans is the key axis of this area of robotic research.

In order to improve these social features, probably the surest path would be to endow robots with real learning protocols. A creature able to learn from its masters, with a generic capacity to easily recognize and identify objects in the near environment. This is the mission that underpins developmental robotics. Drawing on biology and psychology of human development, research teams round the world (especially in Europe) are analysing how best to give robots faculties such as curiosity and learning possibilities. The European project RobotCub, for example, is currently developing iCub, a robot that has the size of a 3.5 year old child. The design features and software are all Open Source.

However, applying a developmental psychology theory to robots calls for an in-depth study to make an as-yet little formalized theory operational. To quote again David Filliat (ENSTA Paris Tech), "infant inspiration is not one-way. In contradistinction, developmental robotics aims at validating both learning and developmental theories."

And this is where we see the true strength and gain of today's research efforts in the area of personal service robotics: it lies in our improved, in-depth knowledge about living matter. As we await to see them accepted and used by the public at large, the few models of personal

humanoid service robots have been acquired by universities and research establishments. Exchanges between robots and neurosciences are proving to be highly rewarding. If we are still a long way from human possibilities, robots are nonetheless capable of improving observation of human models. In paediatric psychiatry, Aldebaran Robotics' model Nao has been tested for the handling of autistic children, who show less fear to interact with a machine rather than with a human helper. Younger patients in this situation have even displayed hitherto unrevealed talents. In the best recorded case-studies, some patients have turned their attention to the helpers.

Far from being portrayed as either a heavily armed aggressor, or a clumsy servant, or being the tiresome gadget, or the pathetic clown, now we have personal service robots that show a totally unexpected facet – a capacity to facilitate inter-human relationships.

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