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Robots – the age of adaptive robots

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A new industrial revolution is underway prompted by a new generation of robots. Powered by new digital technologies, robots are now seeping into areas that require more sophisticated and adaptive skills, like logistics or even customer-facing services.

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We are living amidst an unprecedented speed of technological advancement, called the digital revolution. Robots, being the bridge linking digital to the physical world, are the physical manifestation of this ongoing revolution. Another industrial revolution is underway prompted by a new generation of robots. The previous industrial revolution was about adding brute force to where it was needed like farming or manufacturing. This wave of new robots will add cognitive capabilities as well, in turn expanding the reach of where and how robots can be used. Powered by new digital technologies like artificial intelligence, robots are now seeping into areas that require more sophisticated and adaptive skills, like logistics or even customer-facing services.

Smarter, sociable and softer robots are coming

Robots have been part of our society for close to a decade. A recent article written by fellow regular LG CNS blog contributor, Clive Gifford, gives a brief history of how robots came about. These machines were the basis of the Industrial Revolution of the 19th century, which brought about unimaginable productivity enhancements as well as a fundamental shift in how the modern world functions. However, traditional robots have been very limiting as to what they can do. They are

- Nonflexible, often programmed to do one task only. Each movement is highly engineered and thus prone to error even with a small change in the environment.

- Dangerous, due to their focus on efficiency and speed. Often they need to be caged or physically segregated from humans to prevent accidents.
- Rigid and hard, not fit for dealing with sensitive and softer objects. Hence the adoption of these traditional robots is concentrated in hard and tough goods, like automobiles, machinery, and electronics.

Recent technological revolutions are shifting these limitations, changing the landscape of manufacturing as well as service industries.

With the rise of Artificial Intelligence (AI), robots are transforming from single-purpose, pre-programmed machines to multi-purpose, adaptive workers. The same methodology that was used by the computer program Alpha-Go to find the optimal way to win in Go is being used for building a robot's brain. Instead of being given explicit instructions on the next actions, it is given a goal and datasets to figure it out on its own. Robots with artificial intelligence will be able to find the most efficient way of completing a task on its own. This combination also means that humans no longer have to design spaces especially for robots – the robots will learn how to adapt to the pre-existing environment it is put in. With sensor costs falling, there no longer is a need to engineer the robot's surroundings to ensure that the robot is "served" proper inputs, and also robots will be able to work alongside people without hurting them. It also means one robot can carry out multiple tasks instead of perpetually being tied to one task. Rethink Robotics[1] is a company leading this new trend with its low-cost robot Baxter and more industrial-grade Sawyer. Their products are collaborative and re-trainable robots which, with the power of artificial intelligence, are able to learn new tasks through tactical training. It is also inherently safe to work alongside with as it learns to be aware of injuring humans. Another major robotics company, Fanuc[2], is also demonstrating the power of AI in robots. They have managed to train its robotic arm to do tasks that are known to be difficult for robots, like picking up objects from a jumbled box, through reinforced learning[3]. The video demonstration shows that overnight, the robot was able to reach the precision level of an actual human worker.

In addition to that, robots will be able to stay connected to a network and work as one. Robots can easily become members of the Internet of Things, where sensor and software information is shared, enabling real-time monitoring and larger scale contextual awareness. The new generation of smarter robots, being more flexible and adaptive, makes adding or replacing robots easier since they can share the knowledge. For example, once the Fanuc robot learns how to pick and move items, it can share that knowledge to a fleet of other robots, stationed in various locations inside a factory, or even globally, to other factories that also need to pick and move items. In fact, KUKA, another major player for industrial robots, is teaming up with Chinese telecom company Huawei to develop a deep learning AI network for industrial robots[4]. Combining robotics technology with cloud computing and mobile technology, the plan is to create a platform where industrial robots could share knowledge and improve productivity through deep learning.

The advances in technology are not only in software, but also in hardware (or, rather "not-so-hard" ware). A new field of robotics is emerging, that can overcome problems caused by a robot's traditional rigidness. Called "soft robotics," engineers have devised ways of making

controllable robots with soft materials using pressure (pneumatics) instead of bolts and gears[5]. Scientists came up with this new field inspired by how biological beings, especially octopuses (or, completely boneless mollusks) move. The resulting “soft robots” closely resemble a biological being, rather than a rigid machine. Actual muscle tissue is also being experimented with to develop a “biological robot”[6]. Experts imagine a future where hard and soft robots work together, compensating each of its counterpart’s weaknesses. A good example is how an agricultural firm, Taylor Farms[7], is using Soft Robotics Inc.’s[8] robots to pick and pack produce items[9]. As produce items are soft and prone to damage if handled by a hard robotic clasp, Soft Robotics found a compromise, attaching a “soft” gripper to the end of a traditional “hard” robot that navigates quick and efficiently where the gripper should go. The end result is a robot that can gently pick up even the softest produce, like tomatoes, without damaging them, but with the efficiency of a robot[10].

The race for the manufacturing turf

The robotics market is expected to reach 135 BUSD in less than three years[11]. Even though factory automation has been around for quite some time, multiple barriers have remained – installing a robot has been and still is very costly, as the entire factory has to be redesigned to make use of the new equipment (including installing security cages, and making sure the robot receives unified standard materials to work on). Therefore most of the economic benefits of adopting robots in factory floors have been to big players who had the capital and volume to support the huge investment. Also the types of tasks robots could handle were limited to a few industries as robots could only do a limited range of motions, and deal with only hard and tough materials. In many geographies, then, manufacturing has been moving to find cheapest human labor instead of striving for automation and robotics.

This is now changing with the advance in technology as well as falling costs of robots. Shown in Figure 1, the cost of building and implementing robots are dropping. Like the cost of computers[12], robots are going through a similar virtuous circle. More businesses implement robots, creating a need to build platforms for development, which accelerates the development of more innovative robots, which in turn increases demand for robots. Modular development platforms like robot operating systems (ROS)[13] or code dictionaries[14] are taking off, making systems engineering as easy as developing a smartphone app. The dropping cost of robotic parts as well as the widespread use of 3D printers is also making the actual prototype development and manufacturing of robots easier. One representative case of foreseeing how the usage of robots will spread in the coming years is the case of drones[15]. Just a few years ago, drones were a hobbyist toy. But with technology becoming widespread and component costs going down, drones are now being discussed in the context of business essentials for agriculture[16] or delivery services[17], and at the same time security threats[18] due to its prevalence.

Figure 1. The falling cost of robots[19]

Advances in technology and cost are opening doors to smaller players, as well as new

industries. Being a relatively small-batch automaker, Tesla was able to implement flexible robots named Cyclops, Thunderbird, and Titan[20], which do multiple tasks like welding, riveting, and lifting the car. In a traditional automotive factory like that of Hyundai, there would be a dedicated robot for each function, making the initial capital investment greater. Handling food objects or flimsy materials like fabric was once an area where human hands were absolutely needed. With soft robotics, this is now changing. Economists even expect this will result in reshoring to some extent – bringing back factories to the country of origin, instead of offshoring manufacturing facilities to countries with relatively cheap labor[21]. Adidas recently succeeded in bringing back manufacturing to Germany with its fully automated robotic factory, more than 20 years after it initially ceased operations there to move production to Asia[22].

Preparing for the new wave of robotics is not only a task for individual businesses, but also national mission. Countries around the world are investing heavily in hopes of winning the new manufacturing "turf". According to a recent report[23], South Korea is leading this race, and is expected to lower the combined cost of human labor and robotics by 33 percent in 2025, through aggressive investment and implementation of robots. But the race is still neck-to-neck with major countries joining in with force. China is investing heavily on robots to maintain its position as the world's manufacturing center[24]. The Changying Precision Technology Company, a Chinese technology company, is leading the change and has recently set up a factory run almost exclusively by robots[25].The infamous iPhone manufacturing company, Foxconn, even reportedly replaced 60,000 factory workers with robots recently[26]. At the same time, western countries like the US and UK are also aggressively investing in robotics so they can bring back manufacturing facilities[27].

Service robots are also gaining traction as robots are now able to navigate and react to real life situations through advancements in AI. "Tug" is a hospital robot that delivers meals and pills, and collects dirty sheets and plates from patients. It needs no additional infrastructure and is able to navigate the hospital halls, even being able to take an elevator on its own[28]. "Relay" is a hotel robot that can deliver room service to hotel guests, enabling hotel staff to remain at their desks[29]. Still at its infancy, with tasks limited to simple logistics or cleaning floors (as the popular automatic vacuum cleaners, Roombas, do), service robots are expected to make leaps and bounds as machine learning develops further.

Another industrial revolution where benefits outweigh the drawbacks

Humans have gone through cycles of disruptive technologies replacing human activity, resulting in loss of jobs. It happened during the past industrial revolutions, when the steam engine and later electricity replaced millions of labor-intensive jobs across the globe. There is fear that the new generation of robots will bring about the same fate, threatening job security – even for jobs that require cognitive labor. It also seems like a losing battle, since human workers generally require a steady rise in salary to match inflation rates, while robots' operating costs only get cheaper and cheaper as their technology advances (See Figure 2).



Figure 2. Comparison of wages of human workers and operating costs of robots[30]

However there is no denying that the efficiency gained by implementing robots will benefit us, just as the steam engine and electricity have in the past. Also the jobs that are to be "given" to robots will be labor-intensive and often dangerous tasks that nobody would miss. "Many people die while building new ships," says Stephen Kim, CEO of TAS Global[31], producer of maritime robots. "For the next few years we will replace human labor in such areas and in the process will shorten and make the shipbuilding process more efficient." Similar to how we discuss our future with artificial intelligence,it is time the discussion changes from "man vs. machine" to "man with machine".

Further reading and references:

This blog is based on a broad range of articles, books and reports. Some of the more interesting ones are listed below.

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