Physical Digital Convergence

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Abstract

The physical-digital convergence will broaden in scope. People will freely go back and forth between physical (real) and digital environments, and between offline and online without being aware of the borderlines. Restrictions in time, space, and ability will be relaxed; therefore, new value will be created.

Keywords: smart cities, self-driving cars, digital business

1. Transition to smart cities

The United Nations estimates that the world population will be 11.2 billion in 2100 (medium variant projection), approximately 1.5 times the population of 7.3 billion in 2015 [1]. Although some advanced countries can expect an increased population via the influx of immigrants, a majority will face a dwindling population. To take efficient measures for expansion of social infrastructure and the growing demand for energy in regions where population will increase, and to avoid the risk of excessive infrastructure in regions where population will decrease, the focus on future urban planning should be shifted from physical and technological measures, which support social infrastructure through construction, to digital measures through ideas and design, which complement the infrastructure through improved utilization density and rate.

For example, traffic jams can be eliminated by using advanced traffic signal control, ridesharing, and the implementation of self-driving cars. Power shortages can be addressed by the implementation of smart grids and demand response systems. In addition, the combination of remote monitoring and preventive maintenance will likely lead to a reduction in maintenance management costs and increased longevity of aging tunnels and bridges. In smart cities, physical infrastructure and digital information will be used in combination to optimize infrastructure.

Automobile manufacturers and information technology companies are currently testing self-driving cars on the road, or will soon reach this milestone. Technological development has preceded rule formulation until now. However, the U.S. Department of Transportation has already published its own guidelines for self-driving cars, with the United Nations following to establish international standards. Although it will still take time to establish effective international rules, self-driving cars could be in practical use in the near future. Commercialization of autonomous, self-driving car technology will likely reduce individual ownership of automobiles. Buses will no longer need to run on specific routes according to a schedule, and there will no longer be a distinction between buses, taxis, shared cars, or rental cars. The transportation system itself is expected to transition to a more flexible model where vehicles are run on demand. Urban planning will also shift toward self-driving cars and efficient vehicle dispatches.

In the area of agriculture, the expansion of agricultural production is essential to support needed increases in food demand associated with increasing populations. It is anticipated that digitization will lead to a stabilized food supply. For example, sensors are already measuring temperature, humidity, and soil conditions. Similarly, drones are spraying fertilizers from the air and monitoring crop growth. In addition, unmanned farm machines are plowing land and harvesting crops. Because the leading cause of poor crop growth is weather, farms are also using mesh weather forecasting data for optimal soil management. Improvement in the accuracy of harvest prediction models also enables the pre-arrangement of storage, transport, sale, and processing of crops, with an expected benefit of reduced wastage. Digitization efforts are also beginning to take place in the fishery and livestock industries.

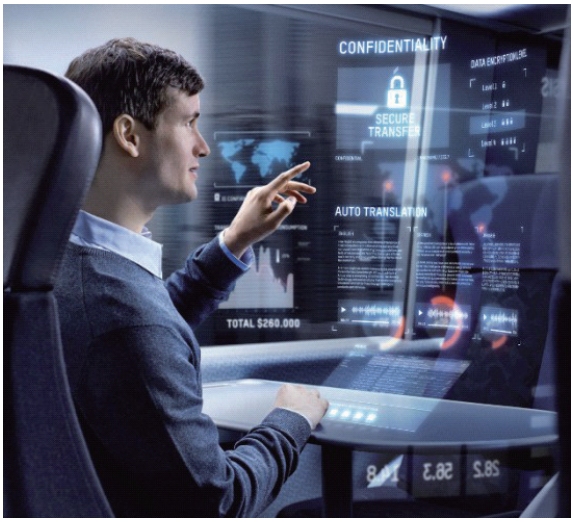
2. Changes in the relationship between machines and humans

The relationships between humans and machines are changing. In the past, users interacted with machines according to the requirements of the machines. Nowadays, intuitive interfaces are being introduced in machines that make interactions with them similar to interactions with other people. Humans will increasingly provide instructions to machines using postures and facial expressions (image recognition) as well as words (voice recognition). Technology making it possible to identify an individual without examining the face has also recently been developed, and the recognition rate of major voice recognition software now exceeds 90%.

Technologies have advanced to a level close to human capacity. Some predict that 50% of web searches will use images and voice by 2020. It is also expected that control of household appliances, reservations for restaurants, and orders to e-commerce stores will be achieved by talking naturally to a smart home device. (Even switches and panels will disappear from household appliances). A household communication robot will not only be able to engage in conversations with a user but also to detect emotional changes or symptoms of an illness based on voice patterns, enabling it to mitigate discomfort. A robot that can detect changes in the user's body conditions immediately and notify healthcare staff will significantly help senior citizens to lead independent lives.

Companies and their customers are starting to use a service called chatbot, which uses text (written characters) and voice to communicate naturally. Applications of chatbot are expanding from travel reservations and shopping to taxi dispatches. Currently, users need to call different chatbots that meet their needs, and communication is mostly text-based. However, in the future, it is predicted that virtual assistants will converse with users using natural language, while controlling separate chatbots.

Individual authentication will no longer require cards or passwords. Instead, touch and conversation will allow for the detection of finger and voice prints, biometrically authenticating an individual. The era of humans adjusting to machines is being transformed into an era where machines adapt to humans. Autonomous self-driving cars can be considered an example of machines adjusting to humans. With a natural interface, the digital divide, which stems from not knowing how to use machines, will probably also disappear in the future.



3. Relief from restrictions

The spread of remote healthcare and telecommuting can be regarded as evidence of the convergence of the physical and digital worlds, which has enabled services to overcome the restrictions of time and space to come to humans. Whereas simple images and audio were used to overcome distances in the past, environments artificially created by virtual reality (VR) technology and telepresence will make the experience more realistic. Augmented reality (AR) technology, where the real world and digital information are superimposed in real time, and mixed reality (MR) technology, where virtual objects are combined with the real world, are also gradually coming into use as well. Although the need for a head-mounted display was a bottleneck to the spread of VR, smartphones can now easily provide the experience. The main uses of VR are currently entertainment-related such as games. However, VR is starting to be used in the fields of education, sports training, simulations, telework, and remote support. AR is also more common in game applications and is now starting to be more widely used in areas including tourism, events, promotions, construction, and interior design. Applications focused on agriculture and fishery are also expected.

Wearable terminals, which measure and record biometric information and track physical activity, can, if worn at all times, capture health conditions. This technology may lead to the early detection of factors leading to illness and/or changes in symptoms,

enhancing preventive medicine. The relationship between medical professionals and patients may change. The attitude toward healthcare may also change from people seeing a physician when they feel sick to having ongoing monitoring and communication.

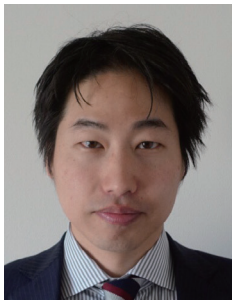
4. Transformation to digital business

The convergence of the physical and digital worlds is accelerating the transformation of companies to a digital form of business. In the past, humans made all business decisions. However, in digital business, machines, things, and other business components will also make appropriate decisions. For example, if the delivery of parts is delayed in a factory that has advanced Internet of Things technology, the machines and things in the factory may decide to switch production lines to manufacture different products. Humans would react based on this decision. There is a high probability that existing organizations and systems cannot optimize the benefits of digital business. As a result, not only the company, but the industrial structure itself will probably change.

These changes will also transform the overall social system. As gaps exist in the ability to adapt to rapid changes, new social disparities may arise. A gap between global and in-country rates of change may lead to economic imbalances. Accordingly, it may be necessary to start building a culture through education that tolerates more rapid changes.

Reference

[1] United Nations, Department of Economics and Social Affairs, Population Division, "World Population Prospects: The 2015 Revision, Key Findings and Advance Tables," 2015.



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