Title	In pursuit of fusion of ICT and control technologies to realize a smart infrastructure system : in order to create a network environment that is comfortable for all "things"
Sub Title	
Author	池田, 亜希子(Ikeda, Akiko)
Publisher	Faculty of Science and Technology, Keio University
Publication year	2018
Jtitle	New Kyurizukai No.27 (2018. 1) ,p.2- 3
JaLC DOI	
Abstract	
Notes	The Research
Genre	Article
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO50001003-00000027-0002

The Research

Associate Professor Ryogo Kubo is featured in this issue, whose field of research focuses on the development of information and communication technologies much needed in this era of IoT.

In pursuit of fusion of ICT and control technologies to realize a smart infrastructure system

In order to create a network environment that is comfortable for all "things"

The term "Internet of Things" (IoT) is becoming the talk of the town these days. "IoT" refers to a state in which all "things," not limited to information/communication appliances such as computers and smartphones, are connected to the Internet. If a full-fledged IoT society becomes a reality, our lives are very likely to be far more convenient than ever. To realize an IoT society, we must overcome a number of technological challenges. Dr. Kubo is moving forward with his studies, regarding fusion of ICT and control technologies as the key to the solution of problems.

I want to create a system that benefits society

One approach that Dr. Kubo takes is to apply physics of electrical circuits, electromagnetism and so forth to systems useful in society. In its nature, electronics is a field of study that is always conscious of putting its research results into practical use. As such, its research targets almost anything that is driven by electricity, from computers and robots through to home electronics. Coming into highlight of late are electric vehicles (EVs) and automated driving of EVs is being discussed and studied as a matter to come soon. Given these circumstances, electronics is increasingly gaining in importance.

As a frontline researcher in this field, Dr. Kubo is intent to realize a smart infrastructure system by fusing ICT and control technologies.

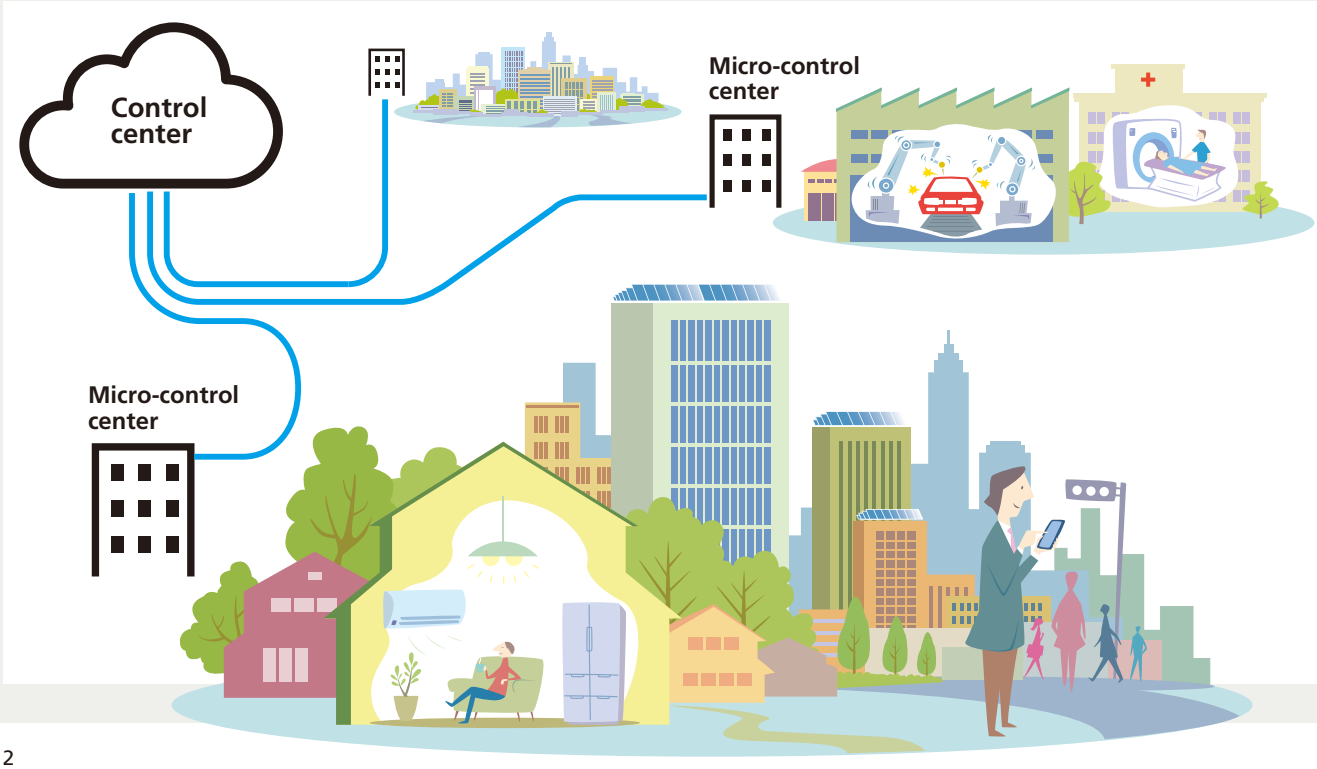
What is known as "IoT" is recently coming to the fore as a development in which all things are connected to the Internet thereby making our daily lives convenient. But IoT is not so easy to realize as it appears because countless things connected to the Internet vie and interfere with each other for the limited network resources. As a solution to this problem, Dr. Kubo reasons that a "smart infrastructure system" must be developed – a system in which all things are allowed to work in harmony (Fig. 1). According to Dr. Kubo, the keys to solution is fusion of "information and communication technologies (ICT)" for network-based exchange of information and "measurement technologies" to control pieces of information thus obtained.

Eliminating "delay" – a major problem standing in the way of IoT

"What problems are involved in IoT? Let's consider industrial robots, for example. In a factory, specified groups of parts assembly robots take turns to perform their specified tasks in a specified order. If they fail to work in harmony, parts assembly operations will be a mess," remarks Dr. Kubo.

In order for more than one robot to work together, the first robot is given an instruction by a computer via a network to do a certain job. In the next step, the computer confirms (measures) that the job has been performed as instructed and then gives an instruction to the second robot for the next job to be done. Measurement and control enable repetition of this sequence of steps to make assembly work progress. What will happen if a delay occurs

Fig.1 Smart infrastructure system that supports the IoT era



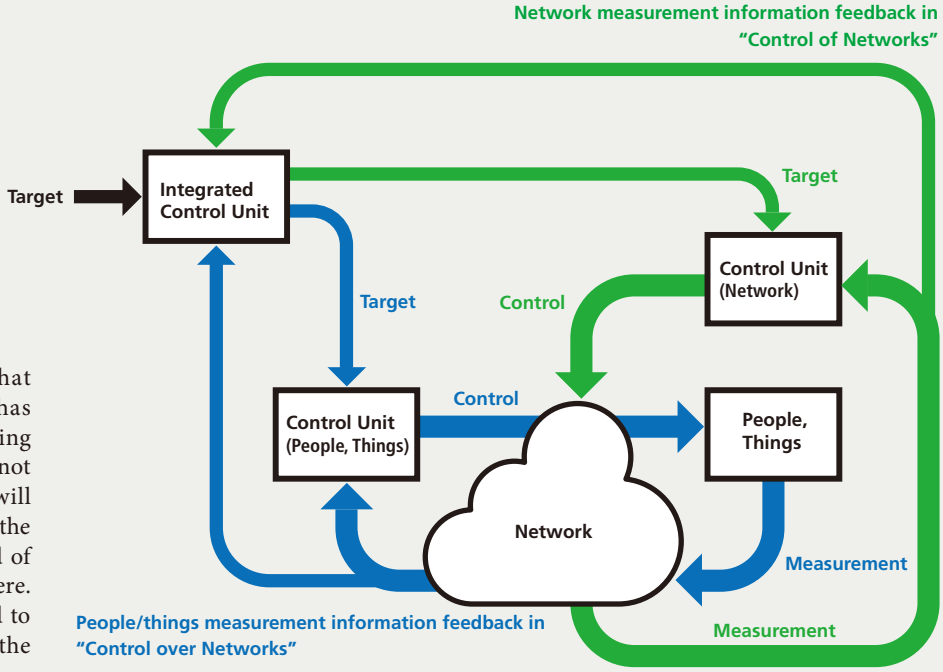


Fig.2 Fusion of ICT and control as envisaged by Dr. Kubo

with confirmation of the signal that conveys the message that the job has been performed as instructed? Judging mistakenly that the required job has not been performed yet, the computer will issue the same instruction again. But the job has actually been done. This kind of error will bring the operation nowhere. Such a communication lag is referred to as "delay," which is regarded one of the greatest problems the IoT era will face.

"As a matter of fact, researchers have discussed delay-associated problems over the years. In fact, some assumed a certain amount of delay beforehand and programed it in the computer to control the robot. However, this is far from a final solution to the problem," maintains Dr. Kubo. Instead, he thinks that problems involved in the current mega-networks must be resolved from the bottom up.

One possible approach is to introduce local control as shown in Fig. 1. "For example, consider an intersection where collision accidents occur frequently, and vehicles passing there are to be brought under collision avoidance control via a network. Installing a small-capacity micro-control center near the intersection will suffice since this control is needed only within a very small area of the intersection." Generally speaking, when transmitting a piece of information over the Internet, it once goes to the main control center in the network and then comes back. Naturally, the greater the distance the information travels for a round trip and the more devices it passes through, the greater a delay will become. In actuality, however, there are many pieces of information that need not go to the main control center. These pieces can be dealt with by setting up micro-control centers well short of the route. Controlling from nearby is sure to be the fundamental solution to delay in communications.

What is fusion of ICT and control?

However, you cannot say that this alone resolves all the network-associated problems of the IoT era. What is truly needed here is the fusion of ICT and control technologies as proposed by Dr. Kubo (Fig. 2). With the ability to specifically control individual things, this technological fusion can bring to a close problems arising as a result of various things intertwined with each other.

Let's explain it a little more in detail. To move a thing via a network, we need to control the target first and measure its result, then use it as feedback for the next control task (see blue arrows in Fig. 2 "Control over Networks"). Meanwhile, it is also important that the network itself, which moves that thing, is working in an optimal condition. To make it possible, loops for measurement and control are provided (see green arrows in Fig. 2 "Control of Networks"). ICT and control are already fused together in both the blue and the green. In addition, harmonious interaction between ICT and control further ensures that things can move in an optimal condition via the network.

As shown in Fig. 1, the control center and micro-control centers play these vital roles.

Arrival of a comfortable network society

What the fusion of ICT and control technologies can do is far-reaching.

Let's look at an example here. Given the limitation to network resources, it is impossible to transmit all pieces of data fast at a time. We humans sense virtually no delay in transmission if it is a matter of less than one millisecond. Tasks that actually require such a minimal delay are very few – only the above-mentioned car collision avoidance control at an intersection, operation of sophisticated medical equipment, and some other cases do.

In other words, when all things are connected to the Internet and need to work in harmony, we must sort out those requiring sophisticated control from others. This is necessary because it will enable the limited network resources to be reasonably distributed to suit individual things.

Dr. Kubo thinks that "things" connected to the Internet via IoT also include people. He continues, "When using a smartphone to download a piece of information, there always is a person at this end of the smartphone. As a service provider, it's only natural for it to please customers." But what annoys it is individual differences in customers' likes and dislikes. Even though a piece of information has been downloaded at the same speed, some are happy with it and others not. If we can allot network bandwidths to individual smartphones flexibly after accurately determining such differences, we will be able to maximize satisfaction of smartphone users.

There are also other benefits. If we apply that technological fusion to a power network, energy-saving and efficient control of electric power will be possible while maintaining comfortability at the same time. In the event of network trouble including those caused by cyber attacks, we will also be able to make the right decision where to disconnect the network, thereby to minimize the damage.

When time comes for all things to work in harmony on the Internet, you may find the network control technology envisaged by Dr. Kubo playing major roles there.

(Reporter & text writer : Akiko Ikeda)