Impact Objectives

- Ensure the safe and secure introduction of wireless communication in hospitals
- Enable telemedicine systems and regional patient information sharing
- Develop ICT systems that meet the needs of medical and welfare staff

Wireless healthcare

*The work of **Professor Eisuke Hanada** and **Professor Takato Kudou** has been a driving force of innovation in medical technology. Here, they discuss their focus on manipulating wireless communication systems to assist medical efforts*

Professor Eisuke Hanada

Professor Takato Kudou

What are the primary research interests and aims of the Hanada Laboratory?

EH: The work of the Hanada Laboratory can be divided into two parts. At Saga University, we are working to develop applications that can be used in medical settings, based on scientific analysis of data gathered on site at a variety of medical institutions. In addition, I work in close cooperation with various faculties of our own and other universities (such as Professor Takato Kudou), with researchers in government laboratories, and with company researchers. The main focuses of our activity are the electromagnetic environment of medical settings, creation of guidelines for the appropriate introduction of wireless communication, identification of problems that can occur at the time of introduction and employment of wireless technologies, and research based on electromagnetic field simulation before the introduction of various technologies. We do not only study radiated electromagnetic fields, but also factors related to the quality of the electricity supplied to medical devices, grounding, and other elements of the electromagnetic environment.

How did you come to establish the Hanada Laboratory?

EH: The beginning of this line of research was in 1993 when I was working at Kyushu University Hospital and my mentor became interested in the investigation of electromagnetic interference with medical devices. My work in those days was mainly the management of the hospital information system and the network of Kyushu University Hospital.

Before coming to Saga University, I worked in the medical informatics departments of two university hospitals: Kyushu University Hospital and Shimane University Hospital. In those positions, research activities were conducted in cooperation with industrial entities and other universities that had sophisticated equipment. I am happy to say I have continued these relationships into the present and expect to continue them long into the future.

Why is electromagnetic interference such an important issue in hospital environments and how can it be tackled?

TK: The introduction of practical uses for wireless communication technology is rapidly progressing in Japanese hospitals, bringing great benefits to both the patient and hospital. The effectiveness of wireless communication is reduced by anything that interferes with transmission of the waves, which causes communication to completely stop or to not arrive at the necessary strength, or that prevents the required transmission speed from being obtained. The written standards of the IEEE802.11 series (currently the most widely used wireless LAN standards) specify changing the transmission speed according to the received signal intensity. To guarantee the required transmission speed, it is necessary to eliminate or minimise electromagnetic noise in the same frequency band.

What do you enjoy most about developing ICT systems for use in the healthcare sector?

EH: Our greatest joy is seeing the improvement of patient care that can be gained through our efforts. This includes increasing the time that medical staff and care workers have to work face to face with their patients through our contribution to improvements in work efficiency and safety when using our systems. The introduction of wireless LAN has greatly changed the job flow in hospitals. Information can be input at anytime from anywhere and can accurately reach all interested parties almost instantaneously. Although we have not yet reached our targets, we are proud that the results of our research have proved helpful and practical to hospital staff. ●

Gather your data, beware of noise

*At **Saga University**, the **Hanada Laboratory** and its collaborators have plunged into the world of wireless communication in medical devices, developing novel systems for real-world application in hospital environments*

It is becoming increasingly standard for large hospitals with a wide variety of patient services to digitalise patient information and accounting systems. As a result, demand for wireless communication is increasing. Wireless medical telemetry systems are made up of devices that automatically gather and transmit data, and have become an extremely important asset in clinical settings.

These setups allow the monitoring of people and environments. For example, wireless medical telemetry systems enable the vital signs of patients to be continuously monitored, whether they are bedridden or mobile. This information is then uploaded to the server, where it can be accessed instantly by relevant physicians and medical staff. Alternatively, temperature, humidity, lighting within patient rooms, air quality in sterile zones, internal pressure of piping and so on can all be supervised, if necessary. These kinds of systems collect critical data that not only improve patient conditions but also save lives.

It is essential that the electromagnetic fields these systems rely on to collect the most accurate and useful data possible are appropriately managed. However, this is something of a challenge. The electromagnetic environment of a hospital differs greatly from that of a typical home or office. If wireless communication in a medical telemetry system is installed in a hospital incorrectly, allowing for interference (known as noise) and disconnection, the lives and wellbeing of patients could be in danger.

Today, use of wireless devices by hospital staff is common

INNOVATIONS ABOUND

At Saga University, the Hanada Laboratory seeks to introduce wireless communications in a way that allows them to be safely and efficiently utilised in the hospital environment. Led by Professor Eisuke Hanada, the lab has emerged as a pioneering force in the field of telemedicine. Its ultimate goal is the development and operation management of ICT systems that meet the needs of medical and welfare staff.

Past developments of the lab include a multimedia communication system. Initially designed to enable hospitalised children to participate in school activities with their students and teachers, the technology ended up being used to give physicians real-time access to dermatology specialists at Shimane University Hospital when they were working in remote hospitals where no dermatologists were available. The system has since been expanded to provide study sessions with university hospital specialists to more rural areas.

The Hanada Laboratory has also developed several ICT systems for real-world use by medical staff. One medical device management system uses radio-frequency identification (RFID) tags to sense the location and use of medical devices. Data monitoring of whether a device's electromagnetic field is turned on or off allows for more efficient allocation of resources after analysis. Another system they have produced is a sleep condition supervisory system, which allows the location, posture and movement of patients to be recorded by nine sensors located in different positions underneath their mattresses. The group has also developed an injection mixing support system, which actively provides (as opposed to records) information for medical staff. This system was created to give the most up-to-date information on patient injections (i.e. quantity changes, mixing time and other instructions) and so consolidate and ease the jobs of nurses responsible for administering injections.

CRUCIAL PLACEMENT

The Hanada Laboratory's focus is not limited to merely developing ICT systems; it is equally concerned with their proper installation and management. When devices rely on electromagnetic fields to transmit patient information, it is important to prevent interference from electromagnetic noise produced by other devices inside and outside the hospital. As Professor Takato Kudou, one of Hanada's collaborators at Oita University, explains: 'Because of the large number of patients and the importance of maintaining life with medical devices in areas where critical care is given, careful monitoring and continual effort to improve the electromagnetic environment and ▶

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protect against electromagnetic disturbance is especially important'.

When studying the installation of wireless medical telemetry systems and their associated antennae, the Hanada Laboratory has identified several electromagnetic noise sources that disrupt the telemeters' own electromagnetic fields. For the most part, significant disruptions arise from objects within the hospital. For example, telemeter antennae are frequently installed in ceilings next to LED lamps, and in many cases are far too close to them. In addition, the circuit boards of some LED lights operate within the same frequency band as medical telemetry systems, interrupting telemeters' electromagnetic fields and impairing the data they are collecting.

Installation next to lights is not the only risky field disruptor. Hospitals are increasingly using metal in their architecture. From passageway doors to countertops, the metal found in hospitals reflects and therefore disrupts electromagnetic waves. On top of this, microwave ovens and refrigerators from in-hospital stores or coffee shops may all have a hand in electromagnetic field noise creation.

SAFETY MEASURES

Hanada and his team have demonstrated that, for wireless medical devices to perform to their full capacity without substantial risk to patients, their location must be extensively considered. The researchers have identified several important factors. For example, medical telemeter antennae must be appropriately placed in ceilings with respect to other fixtures. Adequate distance from electromagnetic noise sources must be assessed scientifically and adhered to by installers.

In addition, for each wireless medical telemetry system, electromagnetic field propagation simulation should be carried out and the necessary strength and reach of electromagnetic signals needed for devices to operate should be assessed. Thus far, simulations carried out by the lab have yielded excellent results.

The Hanada Laboratory is also looking into materials and techniques required in electromagnetic shielding for the management of electromagnetic fields. One promising technique includes band-stop shielding, which buffers wireless LAN signals.

Hanada emphasises that there must be close collaboration among the different sections of the hospital responsible for the network, equipment and facility management. It is impossible to effectively manage medical telemetry devices with a disjointed system.

LOOKING TO THE FUTURE

Having carried out such extensive research on the topic of electromagnetic field maintenance, the Hanada Laboratory is now taking steps to ensure that hospitals know how to maintain a healthy electromagnetic system. 'We are currently engaged in the creation of national guidelines for the safe introduction and employment of wireless communications in hospitals,' Hanada reveals. 'To achieve this, we are working in cooperation with the Ministry of Internal Affairs and Communications of Japan and various academic societies.'

The lab is also planning to continue its work with RFID tags in medical settings as well as explore the use of artificial intelligence (AI) for medical applications. While this area is still in its infancy, the researchers hope to eventually use AI to increase work efficiency and for diagnosis and treatment. The Japanese medical system, like many in the world, is straining to meet the demands of an ageing population. A decrease in Japanese birth rates accompanied by the greying of society has decreased the potential pool of health workers. By using technology appropriately in medicine, it may be possible to increase the quality of human invention and improve patient outcomes. ●

Project Insights

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COLLABORATORS

- Professor Takato Kudou, Oita University
- Dr Kai Ishida, National Institute of Information and Communications Technology
- Professor Takashi Kano, Graduate School of Health Care Sciences, Jikei Institute
- Professor Minoru Hirose, Kitasato University

CONTACT DETAILS

Eisuke Hanada
Professor

T: +81 952288586
E: hanada@cc.saga-u.ac.jp
W: http://www.ai.is.saga-u.ac.jp/~hanada/index-e.html

BIOS

Professor Eisuke Hanada was born in Tokyo, Japan, in 1963. Since 1992, he has worked at Nagasaki University, Kyushu University Hospital and Shimane University Hospital. Since 2014, Hanada has been working at the Saga University Faculty of Science and Engineering as a Professor.

Professor Takato Kudou was born in Oita, Japan, in 1963. From 1990 to 1994, he was a Research Associate of Kyushu University. In 1994, Kudou moved to Oita University, where he is currently working at the Faculty of Science and Engineering as a Professor.