Series: New Recording Technologies for Broadcasting

# Technology for High Transfer rate on Magnetic Recording Disks for Broadcasting System

Mayumi Kawana, Imaging & Storage Devices Research Division

We are researching recording system for Ultra High-Definition video, like those of the Super-Hi-Vision (SHV).These days, there are various storage devices such as hard disk drives, optical disk drives, video magnetic tapes, and semiconductor memories. Hard disk drives are commonly used for video storage, because they are low cost, large capacity, and high-transfer rate. However, the transfer rate of hard disk drive must be speeded up in order to record the SHV signal without compression.

## Relationship between Transfer Rate and Linear Recording Density of Hard Disk Drives

In a hard disk drive, digital signals are recorded in concentric tracks on magnetic disks. Each recording track contains magnetic recording bits that are individually polarized in two directions perpendicular to the disk surface, thus forming a series of binary codes (Fig. 1). The density of magnetic bits on the circular track is referred to as linear recording density. Higher linear recording density can lead to higher data transfer rates. A linear recording density of at least 1,500 kbpi (bpi = bit/inch) is required to record SHV images.

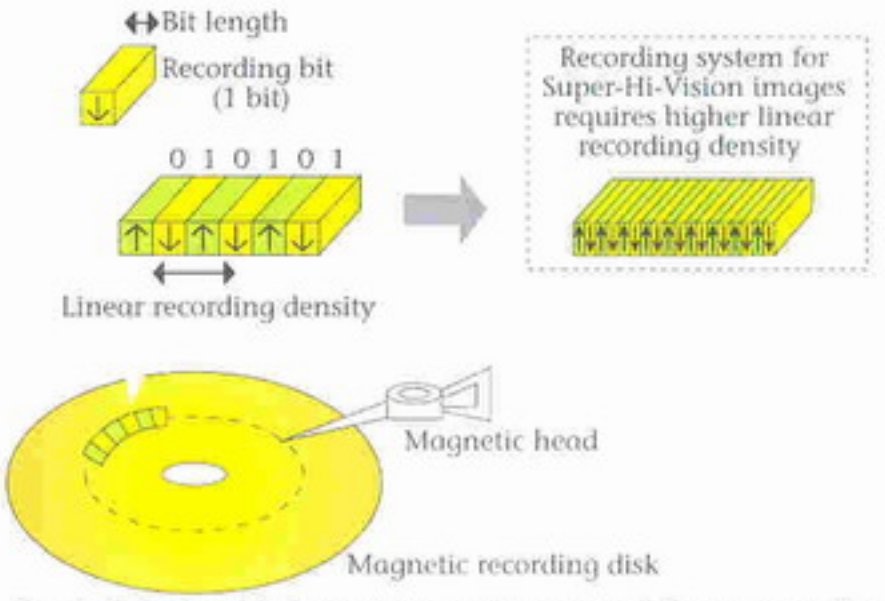



Fig. 1: Relationship between transfer rate and linear recording density of hard disk drives

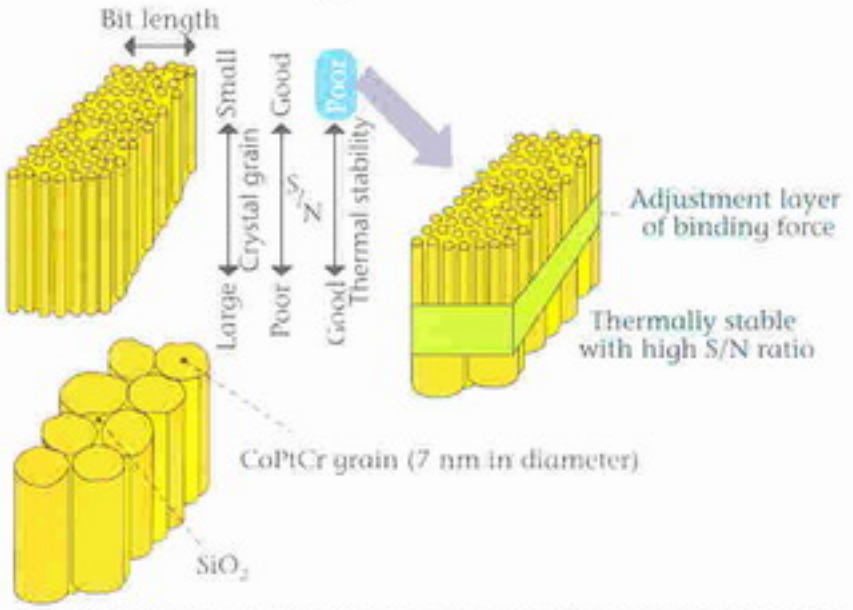



Fig. 2: Structure of thermally stable recording bit with high S/N

## A realization of the magnetic recording disk at bit length of 15nm.

Today's hard disk drives typically use disks with a layer of magnetic CoPtCr alloy particles that are clustered together and magnetically separated by non-magnetic $SiO_2$ (Fig. 2). To achieve a high linear recording density and an excellent signal to noise ratio, the particle size should be reduced. However, the recording bit can be inverted by the effect of heat, when grain size is miniaturized. To prevent this, we have sought to control the binding force among the particles by varying the material composition and film structure, and we have confirmed that it is possible to use smaller particles to produce thermally stable recording bits. In fact, we have produced prototype magnetic disks, and have observed the state of surface magnetization with magnetic force microscopy. We confirmed the recording bit length of 15 nm, which translates into a linear recording density of 1,650 kbpi (Fig. 3). With the aim of realization of a recording system for Ultra High-Definition video, we advance the research of the speedup of the magnetic recording disk.

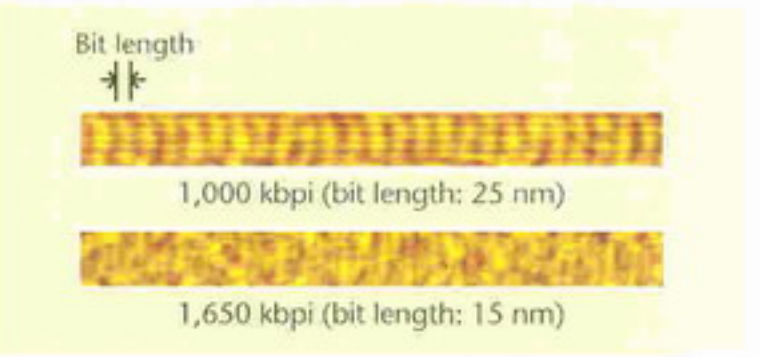



Fig. 3: Magnetic recording patterns on disk surfaces with linear recording density of 1,000 kbpi and 1,650 kbpi.

# Research and Development of New Microphones

One of the focuses of research at STRL is on developing new microphones capable of picking up previously unrecordable sounds and suppressing loud background noise to make the target sounds stand out more clearly. Two examples are introduced below: one has a super-wide frequency range and is capable of recording very high frequency sounds, and the other can cancel out background noise and clearly record the target sounds, even in noisy places.

## ●Super-wide-range Microphone

Technological advances have made it possible to record and transmit sound frequencies exceeding 20 kHz, a range that is simply not covered in conventional digital recording systems, and work is well under way on the development of audio equipment that will be able to handle high frequency ranges of up to 100 kHz. Since it has become customary to archive broadcast programs for future reuse, the ability to record content with as wide a frequency range as possible will be desirable. Despite the growing need for broader sound frequency ranges in broadcasting, however, there have to date been no professional recording microphones that have developed a narrow-actually support those ranges. To address this deficiency, we set out to develop a super-wide-range microphone.

While microphones covering frequency ranges of up to 100 kHz already exist, they are specifically designed as measuring instruments and are not suitable for hi-fi recordings that require greater sensitivity and superior signal-to-noise (S/N) ratios. Our new microphone uses an innovative design architecture which, coupled with a rigid lightweight diaphragm material, has enabled a much larger diaphragm than before, thus reducing the noise level to less than one fourth of conventional high-range microphones. We have already completed an omnidirectional super-wide-range microphone, and are now working to develop a unidirectional model essential for recording music.

## ●Rear-noise-canceling Microphone

High-quality program production requires sound engineers to pick up the target sounds clearly, even in noisy environments such as those encountered in sports broadcasting. In response to this demand, we

Kazuho Ono,
Senior Research Engineer,
Human & Information Science Research Division

directional microphone that effectively suppresses rear noise. The new microphone has as sharp a directionality as conventional narrow-directional microphones, while reducing the recorded rear noise level to one tenth or less. The microphone is used in broadcasts of sporting events with loud cheering, and in mobile broadcasting relays in which video crews follow the event on, for example, noisy motorbikes.

Fig. 1: Super-wide-range Microphone

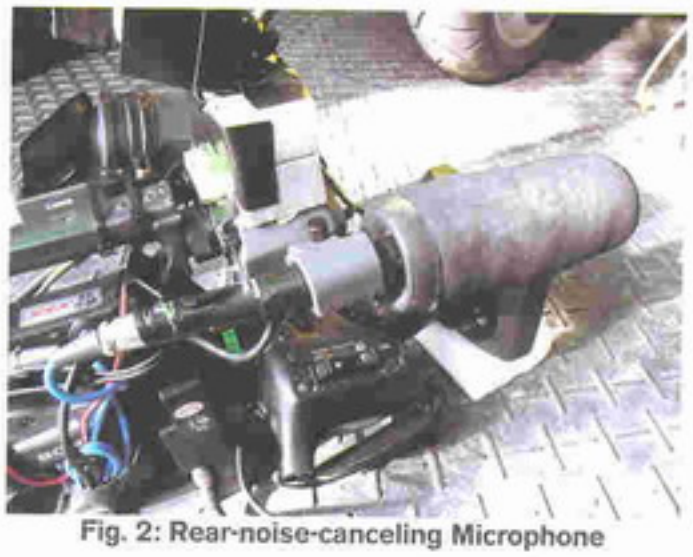


Fig. 2: Rear-noise-canceling Microphone

# Java Data Broadcasting
## - Aiming to realize high-functionality data broadcasting services

Akitsugu Baba, Principal Research Engineer, Advanced Broadcasting Platforms Research Division

STRL has been advancing research on Java data broadcasting as an advanced data broadcasting service platform. The goal is to use this Java data broadcasting to provide higher-functional, more attractive data broadcasting programs than those of the current Broadcast Markup Language (BML) system.

The BML data broadcasting transmits the BML documents describing how to present the information, such as news and weather information. In contrast, Java data broadcasting transmits software written in the Java programming language (Java applications), to be executed on a receiver (Figure 1). This allows a Java data broadcasting to offer advanced presentations and operations by the use of in-receiver software libraries and the Java applications being broadcast. Additionally we have developed methods[1] that enable a data broadcasting program to control how to present not just a piece of information but all the contents transmitted through the broadcast, and made it possible to provide unconventional new services (Figure 2).

### ●Flexible Presentation and Operability

Java data broadcasting is equipped with flexible presentation ability and operability that were not available through BML data broadcasting, including the rendering of arbitrary figures and shapes using vector graphics, and user operation using a mouse.

### ●Acquisition and Utilization of Received Broadcast Data

Other enhancements include a new function for the receiver library that acquires data contained in a broadcast content, such as video, audio, and subtitle data. This function can be used by the Java data broadcasting program to manage how to present and utilize the content. For example, it enables a user to tailor the font size and color to their preference, or to forward broadcast data to other devices on a network for data search and read-out.

### ●Joint Operation between Receiver and Devices on Home Network

We also developed a technology to discover devices connected to a home network, with the aim of incorporating the available functions of the device for operation and viewing. Some examples of this are the use of a device with a keyboard for entering text into the data broadcasting screen, the employment of a Braille device for presentation, and the request to a PC for executing high-load processing. A diverse range of viewing styles will also be realized through the application of on-network devices.

### ●Future Work

We will further our research and development of new services based on Java data broadcasting, along with the systems to support such services.

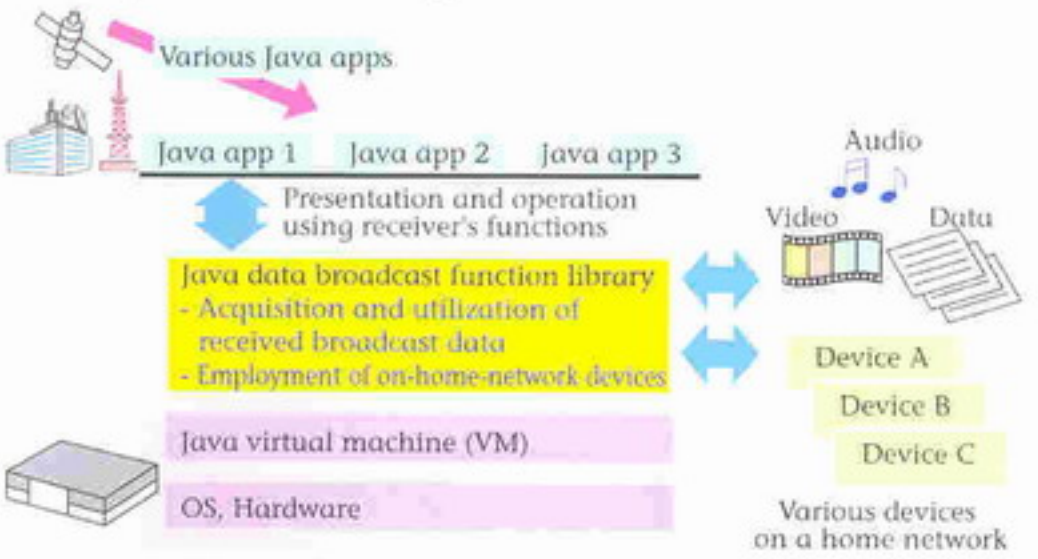



**Figure 1: Java data broadcasting receiver structure**

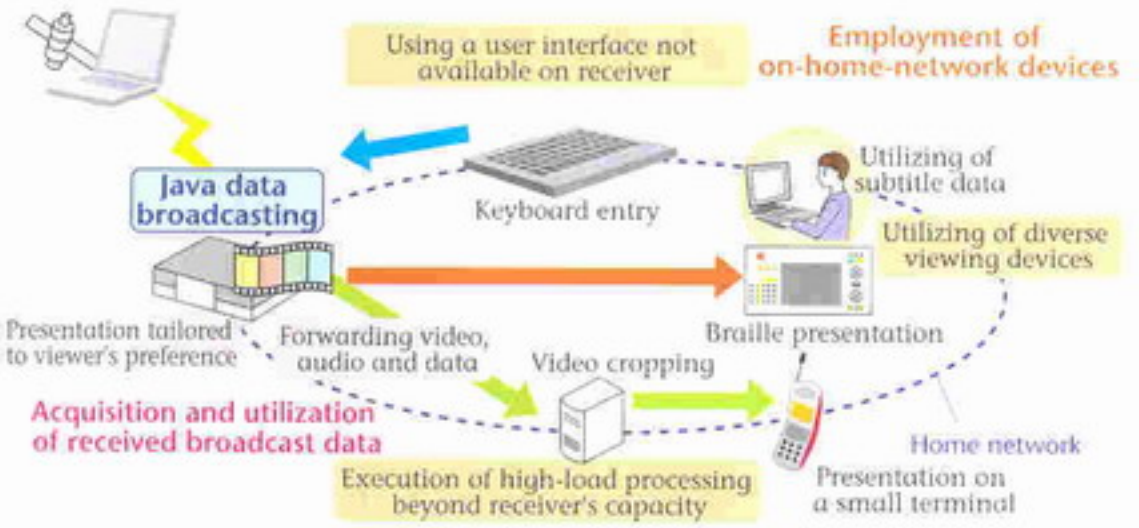



**Figure 2: Java data broadcasting conceptual service image**

1: A data broadcasting system using Java, based on the European DVB-MHP scheme, has been standardized in both Japan (ARIB STD-B23) and the United States (OCAP).

R&D

# Transmission Technology Based on IP Networks

The growth of optical fiber networks has made high-speed IP networks readily accessible. IP networks are categorized into two different groups, expensive ones that use a dedicated line to guarantee a specific transmission bandwidth, and inexpensive ones in which users share a line without a guaranteed transmission bandwidth. Our studies have the goal of attaining long, stable, uninterrupted, high-quality video transmissions even over the shared-line type of network.

## ●Issues related to video transmissions over IP networks

High-quality video transmission requires maintenance of a low video compression rate at the highest possible bit rate. However, this formula is prone to cause video interruptions when available transmission bandwidth on congested transmission paths shrinks. To avoid such video interruptions, the bit rate has to be selected carefully to stay within the congested transmission bandwidth; however, it is not feasible to select an appropriate compression rate prior to transmission because of the unpredictability of IP network congestion.

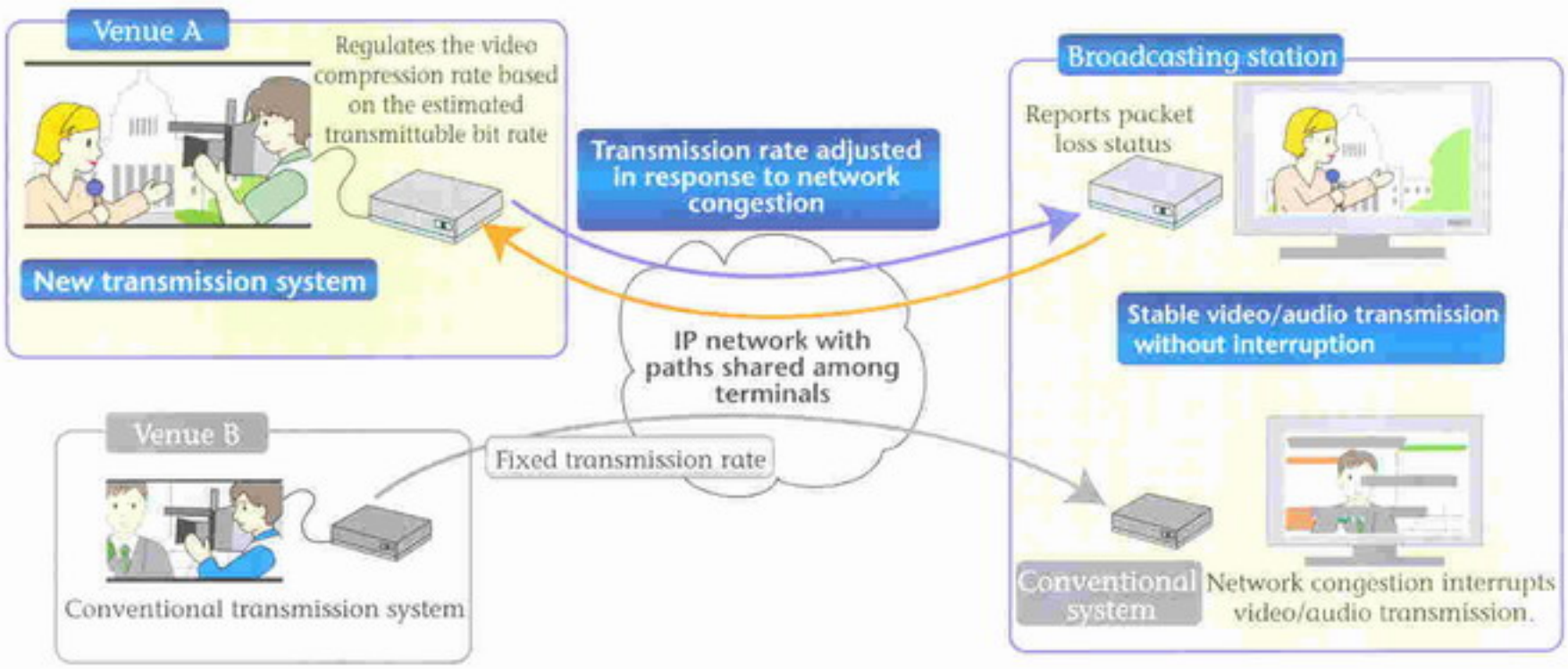
## ●New transmission system

With these circumstances in mind, we constructed a video transmission system for an IP network that regulates the video signal compression rate to adapt the network's transmittable bit rate, which fluctuates according to the amount of network traffic. In this system, this transmittable bit rate is estimated from received IP packets. It transmits video at a low compression rate for good picture quality when there is light network traffic. However, it enforces packet loss countermeasures together with a higher compression rate when the network is congested. This operation might cause slight picture quality degradation, but interruptions, such as blackouts and noise in the video, can be prevented.

Shuhei Oda,
Advanced Broadcasting Platforms Research Division

## ●Future work

This transmission system has been used for live transmissions connecting news-reporting sites and a broadcasting station since January 2008; stable year-round operation has been confirmed. We will enhance the system to improve rate control response and develop coordinated rate control way for multiple devices to deal with greater variety of application environments.s




**A video transmission system which adjusts the amount of transmitting data to available network bandwidth**

# Treatise

## A 252-Mb/s Recording Experiment Using Flexible Optical Disks for Broadcast Use

IEEE TRANSACTIONS ON MAGNETICS, VOL. 45, NO. 5, MAY 2009
Daiichi Koide, Yoshimichi Takano, Haruki Tokumaru, Nobuaki Onagi*, Yasutomo Aman*, Shozo Murata*, Yasunori Sugimoto*, and Kiyoshi Ohishi**
* Ricoh Company Ltd., **Nagaoka University of Technology

We are working on the development of new recording media applicable for rapidly growing video archives. Flexible optical disks (FOD) have a feasibility of their high data-transfer rate and large capacity for archival storage. We have been developing the FOD in order to replace the current professional video cassette recorder (VCR) of HD-D5 format which has a data-transfer rate of more than 250 Mb/s. In this study, we developed a new FOD with high recording sensitivity for high-speed recording, and succeeded to record the 252 Mb/s data with a high-speed tracking control method and optimized write strategy. We also employed the partial response maximum likelihood (PRML) read channel to play back the data. We achieved the low byte-error rate (BER) below $2 \times 10^{-4}$ at the recording speed of 252 Mb/s, enough to record the video signals of HD-D5 VTR for professional broadcast use.

## Integrated Digital Rights Management for Mobile IPTV Using Broadcasting and Communications

IEEE TRANSACTIONS ON BROADCASTING, VOL. 55, NO. 2, JUNE 2009
Yusei Nishimoto, Hiroyuki Imaizumi, and Nagahisa Mita*
* Kumamoto University

We are developing a digital rights management (DRM) scheme for mobile broadcasting that integrates management via broadcasting and communications. The scheme provides access control and rights protection for subscription of Mobile IPTV (Internet Protocol TV), enabling transmission of contract information to control broadcasting reception via both broadcasting and communications. It has transmission functions that reduce the amount of contract information that has to be transmitted through broadcasting as well as a function for transmitting contract information via communications. A PC simulation indicates that the DRM scheme is effective in terms of the transmission rate required to send contract information via broadcasting wave. We also demonstrated the feasibility of the DRM scheme by using a prototype system implemented on an SIM card. The DRM scheme enables advanced mobile receiver functions such as pay-per-view with an interactivity channel using communications and a subscription TV such as pay-per-month on mobile receivers without an interactivity channel by transmitting contract information via broadcasting wave.



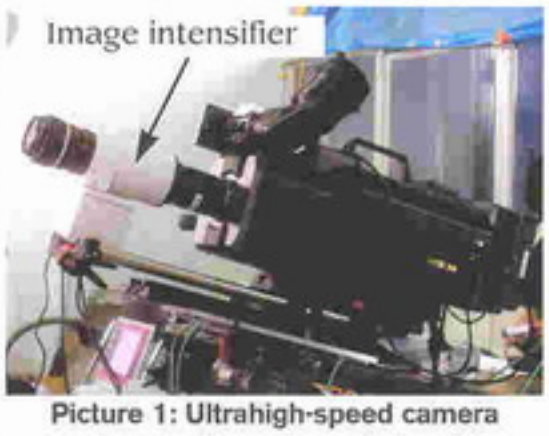
*We are distributing various types of information through the Internet. Shown here are just some examples. Please feel free to access them and send us your opinions.*

*www.nhk.or.jp/strl*

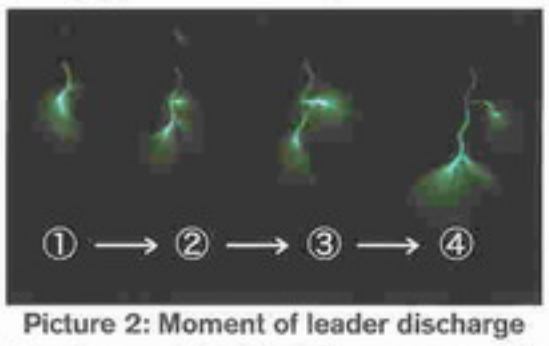
# NHK Technology

## First Successful Capture of the Moment Lightening Strikes

The human eye ordinarily sees lightening strikes as a bolt of light. However, scientists have stated that in actuality, a small discharge from a thundercloud advances toward the ground along discharge channels or leaders, branching out as it goes with repeated propagation and intermission until finally a massive amount of charge flows through one of the discharge paths, resulting in a lightning bolt. The speed of this leader propagation is extremely fast, on average approximately 150 km/s, and no clear fast time resolution image of a lightning strike has ever been captured before.




**Picture 1: Ultrahigh-speed camera equipped with an image intensifier**




**Picture 2: Moment of leader discharge**
(shooting speed of 1,000,000 frames per second)

As part of a program production collaboration with the Nippon Institute of Technology Ultra High Voltage Laboratory and the Central Research Institute of Electric Power Industry, we took on the challenge of capturing an image of such a leader by using our ultrahigh-speed camera. This camera has a maximum shooting speed of one million frames per second. While its extraordinarily high speed enabled us to obtain ultra-slow motion images of a leader, the maximum number of frames per ultrahigh-speed shoot was only just 144, and cameraÄfs sensitivity was inadequate for capturing the very small discharge of the leader.

To resolve these problems, a trigger sensing electromagnetic waves was fabricated. The trigger could control the shooting timing in microsecond units, and it enabled us to complete a shooting session within the 144 frames of the camera.

We improved the camera sensitivity by incorporating an image intensifier that amplifies very weak light (Picture 1). This led to first successful capture of clear images of a leader discharge (Picture 2).

# From the Editors

In this issue of Broadcast Technology, we featured "tactile" and "haptic" display technologies. You might think such technologies are too futuristic for the broadcasting field. However, we consider that they could be effective aids for visually challenged people. We are working on them because conveying information to visually challenged people is quite important for NHK as a public service broadcaster.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