OPEN HOUSE 2013
Expect, Explore, Experience
Public exhibition information
NHK (Japan Broadcasting Corporation)
Science & Technology Research Laboratories
Greetings

Thank you very much for your continued cooperation and support for Japan Broadcasting Corporation (NHK).

This year marks the 60th anniversary of the start of TV broadcasting in Japan. NHK Science and Technology Research Laboratories (STRL) was first set up here in Setagaya in 1930, 23 years before the start of TV broadcasting. At that time, one of its main research themes was television, where there were still many unknowns in terms of what was technologically feasible.

Since then, STRL has constantly tackled cutting-edge technologies, and has contributed to the development of broadcasting technology in fields such as satellite broadcasting, HDTV and digital broadcasting, both in Japan and overseas.

For the 83rd year since the establishment of STRL, this year's Open House introduces 37 latest research achievements under the theme of "Expect, Explore, Experience". This slogan expresses the expectations that people bring with them to the exhibitions, and their experiences as they explore and experience the research results presented here.

Here, you can gain a preview of the Hybridcast broadcast/broadband convergence service that is due to go live any day now. We are also demonstrating the core technologies of Super Hi-Vision, such as highly efficient coding and the use of satellite and terrestrial broadcasting, which we are researching with a view to starting test broadcasting in 2016. You can also see the "Universal Broadcasting Services" technology we are developing to make broadcasting accessible to everyone, including our computer graphics-based sign language translation system and our technology for integrating broadcasting with tactile feedback.

To deliver rich broadcasting to all our viewers, we will continue with a broad range of research and development from basic technologies to complete applications. We hope for your continued support and cooperation with our activities, now and in the future.

Shuichi Fujisawa
May 2013
Head of NHK Science & Technology Research Laboratories
1. Hybridcast
2. Advanced Hybridcast
3. Super Hi-Vision Production Devices for Mobile
4. 120fps Full-specification Super Hi-Vision Image Sensor
5. Compact Video Recorder for Super Hi-Vision Camera
6. Super Hi-Vision HEVC Real-time Encoder
7. 12-GHz-band Satellite Broadcasting System for Super Hi-Vision
8. Large-capacity Transmission Technologies for Next Generation Terrestrial Broadcasting
9. Long Haul Optical Transmission for Super Hi-Vision
10. 145 inch Super Hi-Vision Display Integrated with Loudspeaker Array
37. Data Broadcasting Service to Select Sub-channel Using Color Buttons on Remote Controller
J. Consultation Booth of Digital Broadcasting Reception
Fusion of Broadcast and Broadband

1

Hybridcast
Towards the launch of integrated broadcast-broadband services

Outline

We are working on implementation of Hybridcast technology toward the launch of attractive services by integration of broadcast and broadband technologies and services. Example applications that can be launched with broadcast signals are demonstrated on receivers compliant to the specifications.

Features

● Independent services
Available any time. Viewers can choose services they want from a menu on the TV including the latest news, useful tips, and on-demand programs.

● Program-related services
Tied with the content or progress of programs by using control information sent via broadcasting channels. Viewers can use a smartphone or tablet device as a secondary screen for detailed information at their fingertips. For instance, they can use this style of operation to participate in interactive program.

In the works

By cooperating with other broadcasters, telecommunication providers, and receiver manufacturers, we will continue our research and development aimed at the growth and enhancement of Hybridcast services.


Hybridcast service example
2

Advanced Hybridcast
Towards a more comprehensive service

Outline

We are conducting research and development into technology that will make Hybridcast services even more appealing. We demonstrate technology that is aimed at future expansion, such as advanced functions that will make programs even more enjoyable and convenient.

Features

- **Linking programs and viewers’ interests: teleda+**
  The new service model “teleda+” as an extension of the concept of social TV “teleda” provides extended services between viewers and programs based on user’s behavior, social data analysis and program-related information. “teleda+” will assist the user to discover suitable programs and enjoy broadcast program with their friends.

- **Non-broadcast-oriented managed application activated without the airwaves**
  Non-broadcast-oriented managed applications are activated without broadcast airwaves. These applications can provide services from third parties, and users can select various appealing services such as through smartphone’s one.

- **Services enabled by broadcast transmission synchronism technology**
  These services will make broadcast programs more interesting and easier to understand by displaying related content provided through broadband networks as a composite display on a TV screen or as a synchronized display on a tablet, in synchronisation with the progress of the programs.

- **Service development for ultra high-definition TV**
  We are reviewing services that are specifically for the next generation of ultra high-definition TV.

In the works

We are developing technology to provide even more appealing Hybridcast services, to enhance services that combine between broadcasting and broadband networks.

Future

- Provision of variety of services
  - Hi-Vision
  - Mobile terminals
  - PC
  - Super Hi-Vision

Network service technology

- Service provider of third party
- Non-broadcast-oriented managed apps
- teleda+
- Linking programs and viewers’ interests

Synchronization technology

- Musical instrument sessions (program-synchronizing applications)
- Sign language CG (highly accurate synchronization applications)
- Highly accurate synchronism between contents sources

Super Hi-Vision compatibility

- Services for ultra high-definition TV
Besides developing means of video production, we are working to improve image quality, functions, and operability of Super Hi-Vision devices and on standardization of the video interface.

### Outline

We are conducting research and development into practical Super Hi-Vision program production devices. We present a new single-chip compact Super Hi-Vision camera system and easy-to-use video interface. These devices enable a mobile program production style that is equivalent to current HDTV program productions.

### Features

**Single-chip Super Hi-Vision camera system**

We have developed a compact camera system using single-chip color imaging. The camera head incorporates a new compact signal processing device (camera control unit (CCU)) and a compact signal transmission device that can utilize existing broadcasting camera cables. These developments will enable Super Hi-Vision production like that of HDTV.

**Video interface for extremely high data-rate video signals**

We have developed a video transmission interface that enables simple 144 Gbps connections for sending full-specification Super Hi-Vision video signals between Super Hi-Vision devices. Not only does this make the equipment more compact and reduce power consumption, it greatly reduces the work needed to set up the equipment.

### In the works

Besides developing means of video production, we are working to improve image quality, functions, and operability of Super Hi-Vision devices and on standardization of the video interface.

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*1 Single-chip color imaging: An imaging technique for acquiring color images with a single image sensor.
*2 Full-specification Super Hi-Vision video signal: Video signal with a pixel count of 7680 x 4320, RGB 4:4:4 color sampling, and a bit depth of 12 bits. The data rate is so high (144 Gbps), it necessitates the use of a large number of signal lines if existing interfaces are used.
In the future, we will develop an image sensor with a sensitivity as high as that of HDTV broadcasting cameras.

**Outline**

We are developing a full-specification Super Hi-Vision (8K) image sensor with a frame rate of 120 fps, based on the international standard*1 for UHDTV systems. We present a prototype 3-CMOS color camera*2 and a display system that has 120 fps and 8K resolution.

**Features**

- **Smooth-motion Super Hi-Vision video**
  Full-specification Super Hi-Vision outputs 120 frames of 8K images per second. Its picture quality is improved even for fast-moving objects.

- **33-million-pixel 120-fps CMOS image sensor**
  We prototyped an image sensor that provides an ultra high-definition image with a pixel count of approximately 33 million pixels, a frame rate of 120 fps, and a 12-bit depth. Increasing the frame rate does increase the power consumption, but we limited the power consumption to 2.5 W (60% of the previous device) by developing a new A/D conversion circuitry.

- **120-fps camera and display system**
  The 3-CMOS color system has three image sensors in the camera head, and it outputs data at 144 Gbps. The display device uses multiple liquid-crystal panels to display Super Hi-Vision (8K) at 120 fps.

**In the works**

In the future, we will develop an image sensor with a sensitivity as high as that of HDTV broadcasting cameras.

*This research is being conducted in cooperation with Shizuoka University.

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*1 Recommendation ITU-R BT.2020: Progressive scan, wide-gamut RGB with an effective pixel count of 7680 x 4320, a maximum frame rate of 120 fps, and either 10-bit or 12-bit depth.

*2 3-CMOS color camera: A camera in which a prism is used to divide light into the three colors red, green, and blue, for filming with three image sensors.
We are working on reducing power consumption and making the system even more compact, with the goal being a practicable compact video recorder for Super Hi-Vision cameras. We are also developing a removable solid-state memory package.

Outline

We are conducting research into a compact video recorder for a Super Hi-Vision camera to enable highly mobile program production. We present a compact video recorder that compresses a Super Hi-Vision camera signal and records it in parallel to solid-state memory.

Features

- **Reduction in size of video recorder**
  We have developed a compact signal processing board that compresses the signal from the image sensor and have made the device more compact by reducing the memory chips that are necessary for recording.

- **High-speed parallel recording using solid-state memory**
  We have developed a parallel write algorithm that shortens the waiting time for writing to solid-state memory. This makes it possible to increase recording speed to twice that of conventional systems.

In the works

We are working on reducing power consumption and making the system even more compact, with the goal being a practicable compact video recorder for Super Hi-Vision cameras. We are also developing a removable solid-state memory package.

- This research is being conducted in cooperation with Tokyo Electron Device Limited.
Super Hi-Vision

Super Hi-Vision HEVC Real-time Encoder
Towards Super Hi-Vision broadcasting

Outline

We are researching high-efficiency video coding tools for compressing and transmitting Super Hi-Vision video. We have developed the world’s first Super Hi-Vision real-time encoder with the new video coding scheme MPEG-H HEVC/H.265\(^1\).

Features

- **New video coding scheme: HEVC**
  HEVC is a new video coding scheme which is being standardized in 2013. This scheme achieves approximately twice the compression performance of MPEG-4 AVC/H.264 and supports resolutions and frame rates up to those of Super Hi-Vision video.

- **Real-time encoding Super Hi-Vision video**
  Super Hi-Vision video signals are spatially divided into 17 parts, and each part is encoded in parallel with the equipment.

- **High-efficiency and high-quality encoding**
  High-efficiency and high-quality encoding is achieved by selecting the best of various encoding modes and by performing flexible block partitioning prescribed by the HEVC scheme depending on the input video characteristics and encoding settings.

In the works

We are working on adding signal multiplexing and transmission processing parts to this equipment and are developing a Super Hi-Vision codec incorporating the HEVC scheme.

- This research is being conducted in cooperation with Mitsubishi Electric Corporation.

\(^1\) MPEG-H HEVC (High Efficiency Video Coding) /H.265: A video coding scheme standardized by collaboration between ISO/IEC and ITU.


Real-time encoder specifications

<table>
<thead>
<tr>
<th>Video coding scheme</th>
<th>HEVC (WD4(^2)-compliant) Equivalent to Main 10 profile at level 6.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input/output resolution and frame rate</td>
<td>7680×4320/60P</td>
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<tr>
<td>Chroma format</td>
<td>4:2:0</td>
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<tr>
<td>Input/output and encoding bit depth</td>
<td>10 bit</td>
</tr>
<tr>
<td>Input/output interface</td>
<td>3G-SDI×17</td>
</tr>
<tr>
<td>Video output</td>
<td>Local decoded video</td>
</tr>
<tr>
<td>Maximum bit rate</td>
<td>340 Mbps</td>
</tr>
</tbody>
</table>
We are evaluating the transmission performance for Super Hi-Vision transmission using the transmitter and receiver that comply with the advanced wideband digital satellite broadcasting, and are working towards putting Super Hi-Vision satellite broadcasting to practical use in the 12-GHz-band.

In the works

We are working on the research and development of satellite transmission technology aimed at the start of test broadcasting of Super Hi-Vision in 2016. We introduce large-capacity transmission technology on the assumption that the 12-GHz-band currently used for satellite broadcasting will be utilized.

Features

Transmission of Super Hi-Vision by a single satellite transponder
We demonstrate transmitting Super Hi-Vision by using a transmitter and receiver that comply with the “transmission system for advanced wideband digital satellite broadcasting” (ARIB STD-B44). Transmission of Super Hi-Vision on a single satellite transponder is enabled by the use of 16APSK(3/4) as a modulation scheme.

Transmission system for advanced wideband digital satellite broadcasting
In addition to the BPSK, QPSK, and 8PSK modulation schemes, this transmission system for advanced wideband digital satellite broadcasting can use 16APSK, which enables even more information to be transmitted. This makes it possible to transmit approximately 1.8 times the information of existing satellite digital broadcasting.

Outline

We are working on the research and development of satellite transmission technology aimed at the start of test broadcasting of Super Hi-Vision in 2016. We introduce large-capacity transmission technology on the assumption that the 12-GHz-band currently used for satellite broadcasting will be utilized.

※1 BPSK, QPSK, and 8PSK (Phase Shift Keying): Modulation schemes that can simultaneously transmit 1 bit, 2 bits, and 3 bits of information, respectively, by applying 2, 4, or 8 phase shifts to the carrier wave for transmission.

※2 16APSK (Amplitude and Phase Shift Keying): A modulation system that can simultaneously transmit 4 bits of information by applying 16 amplitude and phase shifts to the carrier wave for transmission.
We are conducting research into terrestrial broadcasting of Super Hi-Vision. This exhibit introduces large-capacity transmission technology for transmitting a Super Hi-Vision program over a single channel (6 MHz bandwidth), and technology that improve the transmission characteristics in a single frequency network (SFN) by applying space time coding (STC) between the transmission signals of adjacent transmitter sites.

Super Hi-Vision transmission using a single channel
To transmit a Super Hi-Vision program over a single terrestrial TV channel (6 MHz), we use LDPC code as the error-correcting code and experimental dual-polarized MIMO, “ultra multi-level” OFDM transmission equipment with a 32k-point Fast Fourier Transform (FFT).

Improved transmission characteristics due to the use of STC in SFN
In the conventional terrestrial digital broadcasting system, the SFN covers the service area with multiple transmitting sites operating at the same frequency, so as to make efficient use of the frequency resource. To improve the transmission characteristics in comparison with the conventional SFN scheme, we are conducting transmission tests using a new SFN scheme to applying in which STC is applied to the transmission signals of adjacent transmitters.

In the works
We are continuing our research and development into transmission technologies based on dual-polarized MIMO and ultra multi-level OFDM technology, with the goal of using them for Super Hi-Vision terrestrial broadcasting.

Features

1. SFN (Single Frequency Network): A transmitting network covering a wide area, in which some transmitters use the same frequency.
2. STC (Space Time Coding): A method of encoding information temporally and spatially, then distributing the encoded signals to multiple transmission antennas.
3. LDPC (Low Density Parity Check): A linear error correcting code that makes it possible to obtain characteristics close to the Shannon limit. It uses a sparse parity check matrix.
4. MIMO (Multiple-Input Multiple-Output): A wireless transmission system using multiple antennas for transmission and for reception.
5. OFDM (Orthogonal Frequency Division Multiplexing): A digital modulation method that is used by conventional terrestrial digital broadcasting.
We are continuing development with the aim of making practical program material transmission systems for uncompressed Super Hi-Vision signals.

In the works

We are developing a long haul transmission system using an optical fiber for transmitting Super Hi-Vision program material from a relay site to a broadcast station. We present a system that can transmit a 72-Gbps uncompressed Super Hi-Vision signal 300 km through a single optical fiber.

Outline

We convert a 72-Gbps, full-resolution Super Hi-Vision signal, equivalent to 64 HD-SDI signals, into two 43-Gbps signals. Reed-Solomon (255, 239) error correction code is applied to each signal. They are converted into RZ-DQPSK optical signals of different wavelengths and transmitted over a single optical fiber by means of wavelength division multiplexing. This ensures that the signal is less likely to be affected by distortion on the transmission path, any errors caused by noise can be corrected at the reception side, and the signal can be transmitted stably.

Features

Stable optical transmission, even over long distances
We convert a 72-Gbps, full-resolution Super Hi-Vision signal, equivalent to 64 HD-SDI signals, into two 43-Gbps signals. Reed-Solomon (255, 239) error correction code is applied to each signal. They are converted into RZ-DQPSK optical signals of different wavelengths and transmitted over a single optical fiber by means of wavelength division multiplexing. This ensures that the signal is less likely to be affected by distortion on the transmission path, any errors caused by noise can be corrected at the reception side, and the signal can be transmitted stably.

No need for optical amplifiers along the optical fiber
With existing systems, it is necessary to install optical amplifiers along the transmission path to compensate for attenuation of the optical signal power due to long-distance transmission. Pump light sources for Raman amplification are now provided at both the relay site and the broadcast station, and the optical signal is amplified within the optical fiber by feeding the pump lights from both sites into the optical fiber. This means the transmission system does not require any optical amplifier on the transmission path, and it thereby simplifies set-up and operation of the transmission system.

In the works

We are continuing development with the aim of making practical program material transmission systems for uncompressed Super Hi-Vision signals.

Part of this research was carried out under a project titled “The Development of Next-generation High-efficiency Network Device Technology” (from 2007 to 2011) commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

Image of transmission of uncompressed Super Hi-Vision material

- HD-SDI (High-Definition television Serial Digital Interface): Interface for uncompressed HDTV use.
- Pump light source for Raman amplification: Device for generating a pump light to amplify an optical signal within a wavelength about 100 nm longer than that of the pump light.
We will continue our research and development on Super Hi-Vision displays for the home by studying sheet-like organic light-emitting diode displays. We will also study various means of improving image quality, such as wider gamuts and higher frame rates.

We are conducting research and development on Super Hi-Vision displays for the home. We present a Super Hi-Vision display with integrated audio that enables highly realistic sensations in a more compact package, including a flat-panel display and loudspeaker array with a small video conversion device.

**Outcomes**

- Small video conversion device for practical applications
  We simplified the connection interface and circuitry that converts a Super Hi-Vision video signal for use in a plasma display. This enabled us to reduce the size of the peripheral equipment to less than 30% of the previous equipment. This advance has brought us closer to implementing a flat-panel display with peripheral equipment built into the display.

- 22.2 multichannel sound reproduction using new loudspeaker array
  We are investigating technology that will enable reproduction of audio equivalent to that of 22.2 multichannel sound, without having to install 24 loudspeakers. We have developed a device that converts 22.2 multichannel signals in real-time into signals for a loudspeaker array built into the display. We have also designed a loudspeaker array that enables reproduction of a wide frequency range through smaller loudspeakers.

**In the works**

We will continue our research and development on Super Hi-Vision displays for the home by studying sheet-like organic light-emitting diode displays. We will also study various means of improving image quality, such as wider gamuts and higher frame rates.

- Research on this video conversion device is being conducted with the cooperation of NHK Engineering System, Inc.
- Research into this loudspeaker array is being conducted in collaboration with Foster Electric Co., Ltd.
We will continue our research and development of imaging and display technology in order to create three-dimensional images with even higher image quality.

**Outline**

We are conducting research into integral three-dimensional television\(^1\) as a future form of broadcasting. We present imaging technology for creating natural, easy-to-view three-dimensional images and some applications envisioned for the technology.

**Features**

1. **Imaging equipment with integrated imaging elements and lens array**
   
   Until now, images created by a lens array (a group of elemental images) have been projected onto an imaging device by using a camera lens. We have developed a micro-lens array of the same dimensions as the imaging device and have built a camera that is 1/10th the size of previous units by integrating the two components. Since there is no need for the camera lens between the imaging device and the lens array, there is no deterioration in resolution and the quality of the three-dimensional images improves as a result.

2. **Imaging equipment with increased pixel count by using a number of cameras**
   
   To capture a high-quality three-dimensional image, it is necessary to acquire elemental images with a larger number of pixels. We have developed imaging equipment that incorporates a number of cameras to obtain a higher pixel count. Having more pixels makes it possible to enlarge the viewing zone within which a three-dimensional image can be seen.

3. **Applications of technology for integral three-dimensional television**
   
   New technology that would be useful in digital museums\(^2\) lets integral three-dimensional images to be displayed interactively. We have also developed technology that makes it possible to view a three-dimensional image over a wide angular range. This will enable us to make a display resembling an exhibit case.

**In the works**

We will continue our research and development of imaging and display technology in order to create three-dimensional images with even higher image quality.

- Part of this research is being conducted under the project titled “R&D on spatial information acquisition system using multiple image sensors” sponsored by the Ministry of Internal Affairs and Communications, and in collaboration with NHK Engineering Systems, Inc.
- Part of this research was conducted under the project titled “R&D on proving test systems aimed at expansion to digital museums” (from 2010 to 2012) sponsored by the Ministry of Education, Culture, Sports, Science and Technology, and in collaboration with NHK Engineering Services.

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\(^1\) Integral three-dimensional television: Television that reproduces three-dimensional images by using a lens array formed of a group of micro-lenses for both capture and display.

\(^2\) Digital museum: A new kind of museum that will exploit advanced digital technology such as virtual reality. Three-dimensional displays are one example of this leading technology.
Super Hi-Vision

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Real-time Video Coding with Super-resolution Techniques

Outline

We are developing a reconstructive video coding system that makes use of super-resolution techniques as an ultra high efficient coding of Super Hi-Vision video. We demonstrate a real-time 4K video coding system with a super-resolution processor implemented on a PC card.

Features

- **Ultra high compression using image reduction, coding, and super-resolution reconstruction**
  By reducing the image resolution from 4K to 2K before encoding, the compression ratio can be alleviated in order to improve the decoded image quality with fewer blocking artifacts than direct encoding of 4K video. The decoded video is “super-resolved” to the original resolution without degrading the sharpness by supplementing the details lost in the reduction process.

- **Real-time hardware processing**
  The hardware processors for the image reduction and super-resolution reconstruction enable real-time 4K video processing.

- **The reconstruction parameters are optimized through transmission-side local super-resolution**
  The optimized reconstruction parameters are transmitted as side information to control the super-resolution reconstruction on the reception side.

In the works

We will continue to study quality establishing methods to improve the reconstructed image by transmitting side information and controlling the way of super-resolving various images. We also plan to develop real-time video processors for Super Hi-Vision with the goal of making a practical reconstructive video coding system.

*Super-resolution techniques: Techniques for obtaining higher resolution images by synthesizing/restoring image details.*
Fusion of Broadcast and Broadband

Hybridcast Application Production and Distribution System
Towards full-scale popularization of services that combine broadcasting and communications

Outline
We are conducting research and development on technology that produces applications and manages their distribution towards full-scale popularization of Hybridcast. We are demonstrating a system for producing applications efficiently and a system for distributing them safely and securely to users.

Features

● Application production support tool
This production support tool enables producing a Hybridcast application and preview in cooperation with a TV program. This production support tool is compatible with the domestic standard specifications for services that combine broadcasting and communications, and facilitates the development of applications.

● Application distribution management system
We have developed a system for comprehensively managing a large number of applications produced by broadcasters and service providers, from their registration to distribution to receivers towards full-scale popularization of Hybridcast. By affixing an ID to each application for distribution, this system makes services highly reliable on receivers.

● Technology for utilizing content safely and securely
This can ensure that only reliable applications are run on receivers by using application authentication technology for non-broadcast-oriented managed applications. We give the highest priority to the delivery of safe and secure information to viewers by providing a function that will halt the operation of an application in an emergency.

In the works
With the cooperation of broadcasting operators, telecommunications operators, and receiver manufacturers, we will works on research and development towards the popularization of Hybridcast, with the aim of further progress in services that combine broadcasting and communications.

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1 Standard specifications for services that combine broadcasting and communications: IPTV Forum Japan “Hybridcast Technology Specifications” (Integrated broadcast-broadband system specifications (IPTVFJ STD-0010) and HTML5 Browser Specification (IPTVFJ STD-0011)).
2 ID: A unique number affixed to each application to show details such as producer and attribute. This ID is used to manage the application reliably.
3 Non-broadcast-oriented managed application: An application provided by an operator other than a broadcaster.
We are improving the accuracy of detecting TV programs, and the appropriateness of the classifications.

The reactions from people who watched the trailer for “Giant Squid” are amazing!

Detection of programs which the tweets mention about
When TV programs are the topics of tweets, they contain explicit program names only about 20% to 30% of the time. We have therefore developed a program determination system based on three algorithms that can identify typical tweet patterns of program-related tweets. The system performs an overall assessment based on the candidates put out by those three algorithms, and is able to determine not only the program series, but also individual program names.

Tweet classifications
Tweets come in a variety of categories. We have specified tweet types in 20 categories relating to program viewing, such as positive or negative opinions, or behavioral types that express viewing or being ready for the program. The system classifies tweets automatically in terms of each item.

Tweet counting
Combining tweet classification with the function that detects the name of program the tweet mentions about, we have made it possible to count and mine tweets in more detail.

In the works
We are improving the accuracy of detecting TV programs, and the appropriateness of the classifications.

*1 Twitter: A networking site which enables an easy posting of remarks of up to 140 characters. These remarks are called “tweets”, and often have colloquial, chatty expressions. The constraint on the number of characters means that there are many abbreviations.

*2 We regularly use this analysis technique to extract and count tweets relating to NHK specials and provide them to program directors. Note that only publicly available tweets are used in the analysis.
Human-friendly Broadcasting Service

Sign Animation Synthesis System for Japanese Weather News
Towards the expansion of sign language services

Outline
We are conducting research into signing animation synthesis technology that translates Japanese text into sign-language computer graphics (CG) animations, to expand our sign language services. The exhibited system automatically translates as a way weather news into signing animations and shows the animations synchronized with the news video and captions.

Features

**Automatic sign synthesis for synchronizing CG animations with video and captions**
This system can synthesize signing CG animations that are synchronized with the video clips of weather news program by automatically translating the program captions into the CG animations and automatically matching the length of each animations to that of the video clips.

**Flexible screen design for synchronizing signing CG with video and captions by TVML**
Users can easily adjust the size and position of the CG animations, captions and video clips by writing simple TVML scripts.

In the works
We are improving the CG animation synthesis so that it can translate more expressions found in weather news and are developing Internet-coordinated services to provide signing CG animations.

*This research is partially being conducted in collaboration with Kogakuin University.*

*TVML (TV program Making Language): A program production language developed by NHK Science & Technology Research Laboratories. http://www.nhk.or.jp/strl/tvml*

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**Captioning**

19.56 21.78 This is the weather news.
21.78 26.19 Tomorrow, the rainy season front will head southwards.
26.19 30.16 Kyushu is likely to have continued heavy rain.
32.76 34.39 This is Okinawa.
34.39 38.30 It will be fine and extremely hot in all areas.

**Weather news with signing CG synchronized with their video and captioning**

**Sign animation synthesis system for weather news from video and captions**
In our ongoing research, we are evaluating the cognitive characteristics of information gathered by tactile and haptic means, and we aim to implement a television service that allows viewers to touch objects such as images delivered by data broadcasting and virtual works of art.

**Conveying tactile information that cannot be expressed in words**

- **Two-dimensional information**
  - Checking important information such as weather charts, maps, and graphs
  - Conveys information to people with visual impairments quickly and reliably

- **Three-dimensional information**
  - Culturally important artwork, rare animals and so on
  - Using various vibration modes
  - Providing everyone with virtual hands-on access to things that they cannot normally touch

**Outline**

We are studying technology that allows two-dimensional information (e.g., maps) and three-dimensional information (e.g., works of art) to be conveyed to visually impaired people by tactile and haptic means. This exhibit shows a tactile display that allows people to grasp the layout or salient features of a picture by touch alone, and a haptic presentation device that allows users to touch a virtual object that feels similar to a real object.

**Features**

- **A tactile display that uses various vibration modes to represent an arbitrary area**
  
  By presenting the constituent elements of a picture with diverse vibration modes that combine different frequencies and vibration time intervals, it is possible to grasp by touch alone the categories of items in a menu, or positional information such as earthquake and tsunami information, or the important parts of a map or graph. This makes it possible to support the rapid transmission and understanding of information similar to that normally obtained visually.

- **Haptic presentation device with five stimulus points on a finger pad**
  
  Shape features are conveyed by five stimulus points where the finger touches the virtual object. Users can feel features such as vertices and contours that are difficult to feel with a single stimulus point. This makes it easier to recognize the shape of a virtual object.

**In the works**

In our ongoing research, we are evaluating the cognitive characteristics of information gathered by tactile and haptic means, and we aim to implement a television service that allows viewers to touch objects such as images delivered by data broadcasting and virtual works of art.

- Part of this research is being conducted in collaboration with the University of Tokyo.
We are researching a wireless transmission device (FPU\(^\text{\textregistered}\)) for transmitting materials used in the production of Super Hi-Vision programs (such as camera video signals) without having to install cables. This exhibit describes wireless transmission of uncompressed Super Hi-Vision signals in the 120-GHz band.

### Features

- **Wireless transmission of SHV signals by cross-polarized waves in the 120-GHz band**
  A dual-green\(^\text{\textsuperscript{2}}\) uncompressed SHV signal (approximately 24 Gbps) consisting of 16 HD-SDI (uncompressed HDTV) signals is transmitted by dual radio links using vertical and horizontal polarizations.

- **Aiming for highly reliable wireless transmission using 10-Gbps-class signal processing technology**
  Each wireless system multiplexes eight HD-SDI signals that are transmitted with forward error correction (FEC). They enable SHV signals to be transmitted stably by wireless.

### In the works

We will evaluate this system in outdoor transmission experiments and in other trials and put it to use in the production of SHV programs.

\(^1\) FPU (Field Pickup Unit): A portable wireless device for transmitting materials used in program production. Often used in outside broadcasts and other such scenarios.

\(^2\) Dual green: A Super Hi-Vision system that uses four image capture/display elements, each with a resolution of approximately eight megapixels. Two of the elements are assigned to green signals, and the other two are assigned to red and blue.
We are involved in the international standardization\(^1\) activities surrounding a new media transport technology called MMT\(^2\), which allows various services to be deployed by using broadcasting and broadband networks together. This exhibit shows how experimental equipment based on MMT can be applied to Super Hi-Vision broadcasting.

**Features**

- **Various services made possible by MMT**
  Harmonizing the media transport schemes on broadcasting systems with broadband networks makes it easier to synchronize presentations of various content from broadcasting and broadband networks on an extremely high definition large-screen display. It also makes it easier to present video and audio signals suited to the type of terminal (televisions, tablets, smartphones, etc.).

- **Improving the service availability by receiving media components on another delivery channel**
  When reception conditions deteriorate, it is possible to continue viewing by receiving alternative media components on another delivery channel.

**In the works**

We will use this test equipment to evaluate the functions and performance of our systems, and we will continue development of MMT-based Super Hi-Vision multiplexing equipment.

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\(^1\) International Standardization Organization: MPEG (Moving Picture Experts Group) of the ISO/IEC is developing standards for multimedia signal processing technologies.

\(^2\) MMT (MPEG Media Transport): A new media transport scheme that supports delivery of multimedia content over heterogeneous networks.
Human-friendly Broadcasting Service

19
Adjustment System of Sound Levels in TV Programs for Elderly Listeners
Making broadcasting sound services more user-friendly

Outline
As people get older, they tend to become distracted by background sounds in TV programs and find that the voices of announcers and actors become harder to make out. This exhibit demonstrates a technique that reduces background sounds and makes voices clearer and easier to listen to, simply by attaching an adapter to the receiver.

Features

● Speech enhancement technology that takes the hearing characteristics of elderly listeners into account
Elderly listeners often find it difficult to separate speech from background sounds. Our technology makes speech clearer by altering the acoustical characteristics of vowels and consonants and suppressing background sounds.

● Suppressing background sounds by using the characteristics of program sound
This technology subjects speech and non-speech segments to different signal processings. A general tendency in program production is for voices to appear as if they are coming from the middle of the screen. The speech signal components are processed by taking this tendency into account, and the background sounds are reduced by suppressing the volume of other sounds. We have also devised a method that estimates the frequency components of the background sounds and subtracts them from the speech signals. Deterioration of the sound quality in the overall program is suppressed by performing volume control only on the non-speech segments.

● Integrated signal processing control method
By enhancing speech and suppressing background sounds, sound levels of broadcasts can be adjusted to suit a greater number of people.

In the works
We are researching various ways of combining speech enhancement techniques and background sound suppression techniques so as to adapt to the characteristics of the sound in programs, and we are researching automatic control methods for this purpose.

Concept of a television receiver suited to elderly listeners
We will develop the Super Hi-Vision system that satisfies all of the ultra high definition, wide color gamut, and high frame rate specifications based on the ITU-R Recommendation.

To represent higher levels of visual realness and the sense of “being there”, Super Hi-Vision uses wide-gamut system colorimetry, which can reproduce vivid colors accurately. We present a Super Hi-Vision camera and a Super Hi-Vision projector that are compliant with this wide-gamut system colorimetry.

Features

Wide-gamut colorimetry for Super Hi-Vision
The wide-gamut system can cover the color gamut of existing video standards and reproduce most of the real object colors with the Rec. ITU-R BT.2020 RGB primaries on the spectrum locus.

Wide-gamut Super Hi-Vision camera
We have fabricated a prism that corresponds to the wide-gamut colorimetry and installed it in a Super Hi-Vision camera.

Wide-gamut Super Hi-Vision projector
We use red, green, and blue lasers corresponding to the wide-gamut colorimetry as the light sources for the Super Hi-Vision projector.

In the works

We will develop the Super Hi-Vision system that satisfies all of the ultra high definition, wide color gamut, and high frame rate specifications based on the ITU-R Recommendation.

1 System colorimetry: A system for expressing colors quantitatively.
2 Spectrum locus: A curve on a chromaticity diagram that represents all colors of visible monochromatic light.
We will continue to improve the directional control precision and operability of the robotic cameras. We will also verify the effectiveness of this technology as an integral 3D image capture system.

**Outline**

We are researching multi-viewpoint video\(^1\) techniques for video production and three-dimensional video. We recently developed a multi-viewpoint robotic camera system that uses cooperative control to point nine robotic cameras at the same subject. The system can capture multiple viewpoints of a moving subject or of multiple shots of subjects within a wide area.

**Features**

- **Displaying time slice views\(^2\) of a moving subject**
  This technology can display a time slice view of a dynamically moving subject such as a player dribbling a soccer ball.

- **Multiple cameras controlled by a single camera operator**
  It is possible for a single camera operator to train all the robotic cameras on a single subject by cooperative control.

- **Application to integral 3D television systems**
  By generating integral 3D video\(^3\) from the captured video images of a moving subject, it is possible to display moving sports players on an integral 3D television.

**In the works**

We will continue to improve the directional control precision and operability of the robotic cameras. We will also verify the effectiveness of this technology as an integral 3D image capture system.

\(^{1}\) Multi-viewpoint video: Video of a subject captured from numerous different viewpoints.

\(^{2}\) Time slice: A three-dimensional video expression technique where the subject is frozen in time while the viewpoint rotates around it.

\(^{3}\) Integral 3D video: A natural 3D video technique that creates parallax effects in the vertical and horizontal directions without the need for special glasses.
Enhancing Production

22

Low Delay and High Quality Digital Wireless Microphone System
For wireless high sound quality microphone

Outline
Japan’s frequency restructuring action plan includes a review of the frequencies used for specified radio microphones. We have developed a transmission system for a low-delay digital radio microphone that can be utilized in the new frequency bands. Here, we introduce a radio microphone and in-ear monitor that we have prototyped.

Features

1. Transmission of audio signals with little delay
In TV programs such as music shows, it is necessary to reduce the adverse effects of tonal changes sensed by the performers and effects on the performance due to delay in the return signal to in-ear monitors. We have devised a means of high-quality, low-delay audio transmission that sends uncompressed linear PCM signals.

2. Stable transmission using OFDM system and diversity combination
The use of orthogonal frequency-division multiplexing (OFDM) system, with its superior anti-multipath characteristics, reduces the adverse effects of reflections from walls and ceilings of halls and studios. We have developed a diversity function that has superior capabilities and enables stable transmission when it is installed in receivers.

3. Two-channel stereo transmission mode
We are also providing a compression mode that halves the volume of information by using an “instantaneous compressing and expressing” system and can transmit two-channel stereo. This can be used as a low-delay type of digital transmission system for in-ear monitors.

In the works
We are conducting tests on the assumption that operations will be in studios, concert halls, and outdoors and with the aim of early commercialization.

The Information and Communications Council of the Ministry of Internal Affairs and Communications is reviewing the technical aspects of this transmission system.

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※1 Specified radio microphone: Of the various professional wireless microphones, this is one that requires a license for use. It provides high-quality transmissions in productions of broadcast programs and in theaters, concert halls, etc.
※2 In-ear monitor: A system of transmitting custom-mixed audio to performers, etc.
※3 Instantaneous compressing and expressing: A method of bit compression with little delay in a range where aural sensation is not affected.
Enhancing Production

Mobile Video Transmission Technologies on Wireless LAN IP
Supporting quick news-gathering in emergencies and disasters

Outline

We are conducting research on mobile relay technologies that use wireless IP Links. This exhibit demonstrates a new mobile video transmission technique that improves robustness by adjusting the video rate to the available bandwidth of a wireless link and a compact wireless IP video transmitter that implements this technique.

Features

Mobile video transmission technique using link information
By controlling the video rate using wireless link information, we can make the video rate more responsive to fluctuations in the bandwidth of the wireless link, thereby making interruptions in the video less likely.

A compact wireless IP video transmitter
We have developed a compact wireless IP video transmitter that can be attached to a camcorder. This allows on-site video to be transmitted back to the broadcasting station easily, even in an emergency situation when a satellite or microwave link is unavailable.

In the works

Our plan is to develop video transmitting devices with high mobility that make use of a variety of wireless links.

Part of this research was conducted in collaboration with NHK ITEC, Inc.

Wireless link information: Information on the quality of a wireless link, such as the received signal strength and wireless transmission speed.

Broadcast Engineering Department cooperated with us in this demonstration of the compact wireless IP video transmitter.

Features

- Mobile video transmission technique using link information
- A compact wireless IP video transmitter

In the works

- Our plan is to develop video transmitting devices with high mobility that make use of a variety of wireless links.
- Part of this research was conducted in collaboration with NHK ITEC, Inc.

Wireless link information: Information on the quality of a wireless link, such as the received signal strength and wireless transmission speed.

Broadcast Engineering Department cooperated with us in this demonstration of the compact wireless IP video transmitter.
We are using prototype devices to conduct laboratory and field experiments, and are reviewing rugged transmission technologies with even larger capacities (high efficiency).

Outline

We are conducting research into rugged large-capacity transmission technologies, with the aim of enabling stable reception of higher-definition video in next generation digital terrestrial broadcasting for mobile reception. This exhibit demonstrates technology for transmitting three Hi-Vision programs on one TV channel.

Features

Capacity increment by space division multiplexing MIMO

We use 2x2 MIMO-OFDM transmission technology that transmits a broadcasting signal from two transmission antennas and receives it by two reception antennas. Since different data is transmitted from each transmission antenna using the same frequency band (channel), we can double the transmission capacity.

Reception improvement by phase rotation on transmission side

With space division multiplexing MIMO, if the amplitude and phase of the channel from two transmission antennas to a certain reception antenna are the same, it is not possible to reconstruct the transmitted signal. Therefore, we use a technique that enables reception in which the signal transmitted from just one transmission antenna is subjected to phase rotation beforehand, so that the transmission channel characteristics appear to be different.

In the works

We are using prototype devices to conduct laboratory and field experiments, and are reviewing rugged transmission technologies with even larger capacities (high efficiency).

1 MIMO (Multiple-Input Multiple-Output): A wireless system in which a number of antennas are used for transmission and for reception.

2 OFDM (Orthogonal Frequency Division Multiplexing): A kind of digital modulation method that is used in the current terrestrial digital broadcasting.
We will continue to research and develop live streaming technology that can operate even more reliably and on even larger scales in order to provide a wide range of services through a combination of broadcasting and communications.

Outline

We have developed live streaming technology based on a P2P model as a low-cost means of large-scale live content delivery, and we have verified the practicality of this technology in tests including live streaming at the Olympic games. We are demonstrating a delivery technique that adapts to viewing under different connection conditions (e.g., wired or wireless) and on different terminals (e.g., smartphones or tablet devices).

Features

- **Using layered delivery streams to minimize viewer disruption**
  The delivery stream is split into two layers — a base layer containing the audio and low-quality basic video, and an enhancement layer containing the difference between the original video and the basic video. When the terminal has a good reception channel, it receives both layers and plays back the high-quality video. If the channel becomes temporarily congested, the base layer can still be received and displayed stably without interruption.

- **Improving the adaptability of P2P live streaming to heterogeneous mobile devices**
  For devices such as smartphones and tablets that have hitherto been unable to receive P2P live streaming, we can implement P2P live streaming adapted to heterogeneous user environments by relaying the stream after transforming it into a form that can be played back on a computer.

In the works

We will continue to research and develop live streaming technology that can operate even more reliably and on even larger scales in order to provide a wide range of services through a combination of broadcasting and communications.

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1. P2P (Peer-to-Peer): A communication system where the computers on a network transmit and receive data among themselves via direct connections.
2. During the London Olympics, NHK performed high-quality video (1.5 Mbps) delivery tests at "Live Streaming" events in selected venues. Many people were impressed with the stable high-quality video of Olympic events.
Enhancing Production

Integrated Downloadable CAS for Broadcasting and Communications

Ensuring the security of services provided through broadcasting and communications

Outline

We are researching an advanced conditional access system (CAS)\(^1\) that can protect content rights and make broadcasting services more secure and more convenient for users. We are demonstrating a CAS for integrated management of broadcasting and communication services. The system can securely provide a wide range of easy-to-use services.

Features

- **Enhancement of broadcasting services by collaborating with communications**
  Broadcast viewing licenses can be securely distributed by communications as well as by broadcasting. This means we can quickly and reliably control how broadcast services are provided. Furthermore, the ability to deliver licenses in different ways means we can adapt to diverse business conditions.

- **Secure integration of broadcast and communication services**
  Integrated management of access control to broadcasting and communications means that content can be delivered more conveniently to users.

In the works

We will continue to investigate methods of applying this technology to today’s digital broadcasting and Super Hi-Vision.

\(^1\) CAS (Conditional Access System): Technology for ensuring that broadcast content can only be viewed by subscribers.
\(^2\) DRM (Digital Rights Management): Copyright management technology for digital content.

With a single license, viewers can play back content in various media.

Technology for ensuring services are used more securely and more conveniently
Enhancing Production

SNS Style CG Content Creation System with Content Re-creation

A communication style that lets everyone create content

Outline

We are developing a system with which any user to have fun creating and sharing their own CG (computer graphics) content. This exhibit shows how users can create their own content from content submitted by someone else and have fun sharing their creations.

Features

- **Easily created chains of CG video content**
  Besides the completed CG video content, this system provides users with an interface and information about the video content produced with TVML\(^1\). Users can easily create their own content from content that has already been produced.

- **Content can easily be created and shared with a web browser**
  By putting the CG video content creation functions and sharing/delivery functions on the server side, it is possible for users to create and share CG video content simply by operating their web browsers.

- **Communicating via video content**
  SNS\(^2\) users can communicate by watching video content with friends and creating content. This system also stimulates the distribution of user-created content.

In the works

We will enhance the video generation functionalities and continue with research on new broadcast services in which users can enjoy producing and sharing video content.

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\(^1\) TVML (TV program Making Language): A markup language for TV program production that was developed at the NHK Science and Technology Research Laboratories; http://www.nhk.or.jp/strl/tvml/

\(^2\) SNS (Social Networking Service): An Internet service that promotes and supports connections between people.
Enhancing Production

Multi Device Link Service with Mobile Camera
Allowing video content services to extend beyond the TV screen

Outline

We are researching a service that provides a new viewing experience by using a mobile camera to capture images of a TV screen. This exhibit introduces our technique for displaying synchronized high-resolution computer graphics (CG) content that is linked with the program appearing on a TV screen captured by a mobile camera.

Features

A synchronization method that does not depend on the mobile terminal’s performance
We have developed a system that synchronizes the display of animated CG content on top of a related TV program by using the camera of a mobile terminal to capture the TV video and extracts convoluted time information from the captured picture. This system can ensure accurate synchronization even on terminals with low computational performance.

Frame-accurate synchronization
By splitting the signal that represents the playback time into rough time information expressed in units of seconds and detailed time information indicating fractions of seconds, we have achieved accurate synchronization to within one frame (0.03 seconds or less).

In the works
To develop practical services, we are continuing to research systems that use this technology while taking the viewing environment and program production into consideration.

Note: This technique is called "Augmented TV" to distinguish it from existing augmented reality (AR) techniques.
We will conduct transmission tests with the prototype modulator, demodulator, and hardware simulator of a satellite transponder. We are also developing rainfall attenuation compensation technology and wideband transmission technology for 21-GHz-band satellite broadcasting.

In the works

We are researching and developing wideband satellite transmission technology for future large-capacity broadcasting of Super Hi-Vision on multiple channels. We developed a 12-GHz-band wideband modulator and demodulator that can handle up to twice the bandwidth of existing equipment and the 21-GHz-band wideband modulator and demodulator with a 300-MHz-bandwidth.

Occupied bandwidth: 69 MHz

Modulator with a 300-MHz-bandwidth for transmissions in the 21-GHz-band

Demodulator with a 300-MHz-bandwidth in the 21-GHz-band

Concept of broadcasting in the 12-GHz and 21-GHz-bands

Features

- **Wideband transmitter and receiver with 69-MHz-bandwidth in the 12-GHz-band**
  We have developed a transmitter and receiver with up to a 69-MHz-bandwidth, i.e., twice that of existing 12-GHz-band broadcast satellites. The transmission system complies with the ARIB standard for advanced wideband digital satellite broadcasting (ARIB STD-B44). Doubling the bandwidth per channel and the satellite radiated power makes it possible to transmit at approximately 139 Mbps with 8PSK (3/4) or approximately 186 Mbps with 16APSK (3/4).

- **Wideband modulator and demodulator for transmissions in the 21-GHz-band**
  We are developing a wideband modulator and demodulator with a 300-MHz-bandwidth, on the assumption that the 600-MHz-bandwidth that has been allocated to 21-GHz-band satellite broadcasting will be divided into two channels. The advantages of a wideband spectrum will make it possible to transmit at approximately 370 Mbps with QPSK (3/4).

In the works

We will conduct transmission tests with the prototype modulator, demodulator, and hardware simulator of a satellite transponder. We are also developing rainfall attenuation compensation technology and wideband transmission technology for 21-GHz-band satellite broadcasting.

The development of the 21-GHz-band wideband modulator and demodulator is supported by the Ministry of Internal Affairs and Communications of the Government of Japan through its project, “Research and development of technology encouraging effective utilization of frequency for next generation satellite broadcast systems,” which is part of a program called “Research and development to enhance utilization of radio spectrum resources.”

1  8PSK (8-Ary Phase Shift Keying): A modulation scheme that simultaneously transmits 3 bits of information by using carrier waves with eight different phases with 45-degree spacing.

2  16APSK (16-Ary Amplitude and Phase Shift Keying): A modulation scheme that simultaneously transmits 4 bits of information by using 16 waves with different combinations of amplitude and phase.

3  QPSK (Quaternary Amplitude and Phase Shift Keying): A modulation scheme that simultaneously transmits 2 bits of information by using carrier waves with four different phases with 90-degree spacing.
We will continue to develop a wide range of metadata acquisition and analysis methods suited to the needs of video production in order to expand the range of useful functions and build a practical system. In the works

Automatically analyzing stored video footage
- Automatic keyword tagging
- Feature extraction based on elements in a scene
- Face detection/tracking/recognition
- Camera calibration with greater precision
- Video segmentation

It creates metadata automatically!

Supporting video production
- Easy to search for a particular shot
- Composition based on camera parameters
- Extracting different video elements for composition

That’s useful!

Acquiring useful information at the time of shooting
- Automatic acquisition of camera parameters by sensors
- Acquiring information about the shooting environment and subject
- Easy to add descriptions (captions) to the footage

Adding all this information later would be much harder!

Video Bank’s benefits and constituent technologies
Television broadcasting started on February 1, 1953 in Japan (Showa 28 in Japanese reckoning). That was 60 years ago.

“Television” research at Japan Broadcasting Corporation (NHK) started in June 1930 (Showa 5) with the establishment of the Science and Technical Research Laboratories (The present NHK STRL). Research and development aimed at the Tokyo Olympics of 1940 (Showa 15) continued, but the Olympics were cancelled because of World War II and television research was also suspended.

Television research restarted after the war and trial runs went public throughout Japan. To enable large numbers of people to view, NHK is conducted research and development into projection television in which video footage is expanded by a lens and is projected onto a large-scale screen, which drew the attention of the public. Subsequently, television prices fell and broadcasting stations produced a wide variety of programs, such as news, leisure programs, culture programs, dramas, and documentaries. Television spread rapidly and became one of the “three sacred treasures” of the home, together with the refrigerator and the washing machine.

The world of “Television” has continued to advance since then. Color broadcasting started in September 1960 (Showa 35), satellite broadcasting started in June 1989 (Heisei 1), and terrestrial digital Hi-Vision broadcasting started in 2003 (Heisei 15), and the possibilities for tomorrow’s television are expanding even now.

We are working towards television development at the NHK Science and Technology Research Laboratories and we look back on the time when television broadcasting began, from footage recorded back at the start of television broadcasting and reference materials.
Utilization and Development of NHK's Technology

How NHK's technologies that contribute to society

Outline

NHK Engineering System, Inc. is promoting the PR of patents and technology knowhow that are the results of NHK’s R&D activities; and is further developing the broadcast technology aimed at contributing back to society. We exhibit some of the technologies that will have a wide range of application in the future, and the systems derived from patented NHK technology currently being developed for practical application.

Video-related technology
- Hybrid sensor that enables CG to composite with video shot by handy camera, easily
- Ultra high-sensitivity CMOS camera for space applications that can capture crisp images even in the darkness of space.
- “Diorama 3D binoculars” using Super Hi-Vision video technology

Audio-related technology
- 22.2 multichannel portable player for playing 3D audio anytime and anywhere
- Speech rate conversion technology* that facilitates user-friendly, convenient audio playback

Technology that will be used in various fields
- High-performance “splash-proof” 1/4-inch silicon microphone that resists rain
- Set-top box that can cope with long-delay multipath waves for multiband ISDB-T and that adapts to different reception environments

Technological transfer of patents and know-how
- Introduction to NHK licensing and technical partnerships to pass on NHK’s patents and know-how to society

Contact us on how you can use NHK's patent and technological know-how

NHK Engineering System, Inc.,
1-10-11 Kinuta, Setagaya-ku, Tokyo 157-8540, Japan
TEL: (03) 5494-2400  FAX: (03) 5494-2152
URL: http://www.nes.or.jp/

* Parts of this research and development were funded by the “2011 research and development assistance for enrichment of communication and broadcast services for the elderly and challenged” of the National Institute of Information and Communications Technology and the “2012 research and development of Technology ProjectforBridgingtheDigitalDivide” (subsidies for promoting the use of information and telecommunications) of the Ministry of Internal Affairs and Communications. The iPhone app “Gogaku Player” is being developed in collaboration with NHK Publishing Co., Ltd.
At NHK, we are conducting technological improvements and novel developments to ensure that users will enjoy broadcasting that is enriched, more convenient, easier to understand, safer, and more secure. This exhibit introduce various technologies that are being developed or have recently been developed at our broadcasting stations.

Features

● **Landmark display system “Sky Map”**
When covering news on location from a helicopter, it can be very difficult to rapidly identify the subject being filmed within airborne video footage. We have developed a “Sky Map” system that displays map information in real time on the video footage, for application in situations such as earthquake disaster coverage and other emergency reporting.

● **Far-infrared ultra-telephoto camera**
A far-infrared camera that can film a subject clearly even at night detects heat emitted from objects, so it can film without being greatly affected by conditions such as dust, smoke, or thick fog. An ultra-telephoto lens for this far-infrared camera enables clear filming of even distant subjects.

● **Robot camera system using natural energy**
We have developed a robot camera system that is provided with solar or wind power generators and large capacity storage batteries, enabling continuous operation even during long power outages such as during a major disaster. This is currently located in Watarichou, Miyagi Prefecture, where it is undergoing proving experiments.

● **Coordination of TV and mobile terminal with the application of digital watermarking technology**
This exhibit shows how to coordinate between TV and a mobile terminal using digital watermarking technology, which enables the automatic display of related sites on a mobile terminal by using the camera of the terminal to photograph the TV screen.

● The development of this far-infrared ultra-telephoto camera is being conducted in collaboration with Showa Industry Co., Ltd.
● The development of a windmill device for this natural energy utilization robot camera system is being conducted in collaboration with Meidensha Corporation and Kyushu University.
● The development of coordination between TVs and mobile terminals, applying this digital watermarking technology, is being conducted in collaboration with Mitsubishi Electric Corporation and Mitsubishi Electric Information Systems Corporation.

Exhibited by Broadcast Engineering Department and Engineering Administration Department.
Flexible Organic Light-emitting Diode Display
Towards the realization of ultra-thin large-screen televisions

Outline
We are conducting research on thin, light flexible displays. We are demonstrating an 8-inch flexible display that uses highly efficient and long-lifetime organic light-emitting diodes (OLEDs). We are also showing some of the key technologies that will be part of ultra-thin televisions in the future.

Features

● Materials for high-efficiency OLEDs
We have developed a highly efficient light-emitting layer material based on a benzoquinoline derivative, and we have fabricated a red organic light-emitting diode device with low power consumption and a long lifetime.

● Oxide TFTs suitable for large displays
We have built an oxide TFT that uses soluble polymer films for the passivation layer, and other such parts. The TFT is very flexible and suitable for large-screen displays.

● Key technologies for large-screen ultra-thin displays
We are using a new device structure to increase the lifetime of flexible organic light-emitting diode devices and electrode formation techniques that make use of printing methods.

In the works
We will continue to improve the performance of TFTs and OLEDs in order to make larger displays with higher resolution, and we will continue to develop our fabrication techniques and materials so that we can make larger screens.

1 OLED (Organic Light-emitting Diode): A device that emits light when a current flows through it.
2 Benzoquinoline derivatives: Organic materials with a molecular skeleton made of benzoquinoline.
3 TFT: Thin film transistor.
Next Generation Broadcasting Devices

High-speed Data Readout in Holographic Memory
Intended for ultra-high-capacity, high-speed read/write systems

Outline
We are conducting research into ultra-high capacity holographic memory that will enable extremely high-speed recording and readout of video signals, with the goal of providing archive storage for Super Hi-Vision programs. The exhibit shows experimental equipment that can reproduce two-dimensional data pages at 500 Mbps, which is four times faster than what we achieved last year.

Features

- **High-speed processing of playback signal by parallel processing**
  We have developed an algorithm that rapidly acquires a two-dimensional data page that is reproduced from a hologram. We implemented this algorithm in a parallel processing unit and improved the transfer rate during reproduction.

- **Optical compensation for hologram distortion using highly accurate wavefront control**
  When hologram distortion occurs due to volumetric changes in the recording medium, data can be reproduced accurately by controlling the wavefront of the reference beam. The optical compensation enables accurate data reproduction even with data pages of higher resolution and thereby increases the amount of data that can be stored on a data page.

In the works
We will continue improving the data transfer rate of our prototype holographic memory even further, and developing systems that can record and reproduce Super Hi-Vision programs.

- This research is being conducted in collaboration with Nippon Steel & Sumikin Chemical Co., Ltd.

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1 Two-dimensional data page: A two-dimensional array that represents the zeros and ones of a digital signal as black and white pixels, like a two-dimensional barcode.

2 Data transfer rate: The quantity of data that can be recorded or reproduced in one second. Units are bits per second (bps).
We are developing new imaging devices to improve the performance of cameras. We introduce the elemental technologies for an organic imaging device that implements a compact, high-image-quality single-chip camera and a 3D integrated imaging device that is intended to provide both an ultrahigh-definition and a high frame frequency.

Continuous lamination technology for organic imaging devices
The newly developed continuous lamination technology enables us to stack three different organic photoconductive films and charge readout TFT circuits on top of each other. Each layer is sensitive to red, green, or blue, and an optical image is focused on each one. By using this technology, we can keep the spacing of the three organic photoconductive films to within 10 μm.

Circuit formation technology for 3D integrated imaging device
The 3D integrated imaging device consists of stacked substrates that provided with functions such as photodetection and signal processing. Towards the implementation of this device, we have developed technology for fabricating a 3D integrated logic circuit, which serves as the basic element for the signal processing circuit, by direct bonding of substrates on which the transistors are formed.

In the works
We are working on increasing the definition of the organic imaging devices by making TFT circuitry more compact and integrated. We are also verifying the signal readout operations of the 3D integrated imaging device in the depthwise direction of the device.

- The research into TFT circuits for organic imaging devices is being conducted in collaboration with Kochi University of Technology.
- Part of the research into organic photoconductive films for organic imaging devices is being conducted in collaboration with Saitama University.
- The research into 3D integrated imaging devices is being conducted in collaboration with the University of Tokyo.

Features

- Continuous lamination technology for organic imaging devices
- Circuit formation technology for 3D integrated imaging device
- Improving the performance of cameras

Silicon substrates with photodetection, amplification, and signal-processing functions
3D integrated logic circuit
Organic photoconductive film
Interlayer insulating films
Charge readout TFT circuits
Photodetector
Amplifier circuit
Signal-processing circuit
Glass substrate

Part of the research into organic photoconductive films for organic imaging devices is being conducted in collaboration with Saitama University.

The research into 3D integrated imaging devices is being conducted in collaboration with the University of Tokyo.

TFT: Thin-Film Transistor.
At NHK, we are using the characteristics of digital broadcasting for the purpose of subchannel broadcasting. Sometimes, people find channel-switching methods used by remote controls difficult to understand. We have developed a service that allows the viewer to switch between subchannels simply by pressing the colored buttons on the remote control.

Features

- Using data broadcasting for channel switching between multiple subchannels
  Switching between subchannels is made possible through data broadcasting. When multiple subchannels are transmitted in terrestrial digital broadcasting, pressing the d button brings up a channel guide display that lets viewers switch channels by pressing colored buttons. In addition, channel switching can be performed in BS digital broadcasting by using the temporary channel guide display shown at the start of viewing or at the start of a multiple subchannel broadcast.

In the works

We plan to launch a color button service for terrestrial digital broadcasting of our regional services. This exhibit is presented by the Broadcast Engineering Department.

Exhibited by Programming Department, Engineering Administration Department and Broadcast Engineering Department.

To switch a terrestrial digital broadcast, press the d button and then the blue or red button

To switch a BS digital broadcast, press the blue or red button

Using the colored buttons on a remote control to switch channels
Service for Viewers

Consultation Booth of Digital Broadcasting Reception
Digital broadcasting reception and receiver systems for the era of broadcast/communication collaborative services

Outline
This booth introduces the service that is brought about because communication cooperates with a broadcasting program. And to explain operation method of the digital television and a convenient function. We will also answer various questions relating to the reception of digital broadcasting, including digital receiver systems and an overview of the TOKYO SKYTREE.

Features

● Introduction to NHK’s broadcast/communication collaborative services
We will present an introductory overview of NHK’s broadcast/communication collaborative services, and describe how to operate a digital TV.

● Digital broadcasting reception and receiver systems
We will describe digital broadcasting reception methods and receiver systems available for individual households and housing complexes. We will also describe the reception by Cable TV and the communication systems.

● Deployment of terrestrial digital broadcasting for stable reception
We will transfer our transmitter from the Tokyo Tower to the TOKYO SKYTREE so that digital broadcasting can be received more stably throughout the Tokyo metropolitan area. It is expected that households and facilities that have aerials pointing at Tokyo Tower will be able to continue receiving signals without having to change the antenna direction.
### P1 A Parallel Distributed Processing System for Broadcasting Contents

**Processing content quickly and stably**

We are developing a parallel distributed processing system that can process broadcast content quickly and stably. We recently developed a fast and stable method for processing content by identifying bottlenecks in parallel processing and controlling the number of parallel servers, data communication paths, and traffic.

### P2 Spherical Microphone for Super Hi-Vision 22.2 Multichannel Sound

**Simplifying the recording of 22.2 multichannel sound**

To make it easy to record 22.2 multichannel sound, we have developed a spherical microphone that uses acoustic baffles partitioning the sphere into solid angular segments. We present an overview of this microphone and the signal processing methods used to compensate for the deterioration in directivity that occurs when the device is made smaller.

### P3 Accommodation Responses in Viewing Integral 3DTV

**Aiming for natural three-dimensional image**

We have conducted experiments to subjectively evaluate depth perception and measure the accommodation responses of the eye when viewing integral 3D television. The resulting data, presented here, suggests that the depth perception and accommodation responses are correlated with the depth positions of three-dimensional objects.

### P4 Improvement on Speech Recognition for Live Captioning of Emergency Disaster Broadcasts

**Learning through the efficient collection of disaster-related information**

In the aftermath of the Great East Japan Earthquake, some news programs featured experimental live captioning created by automatic speech recognition. This exhibit introduces our efforts to tackle the speech recognition and captioning issues that were identified during these broadcasts and subsequent improvements to speech recognition system to convey accurate information to those in need.
| **P5** | **TV Program Recommendation Based on a Personal Preference Model**  
Automatically discovering tastes of TV viewers |
---|---|
We developed a statistical TV program recommendation method that attempts to identify programs that fit the tastes of individual users and gives reasons for its recommendations. Matching scores are evaluated by using a statistical model based on how each user has rated certain previously viewed programs and on details of the content of programs extracted from semantic information provided by electronic program guide (EPG) services.

| **P6** | **Carrier Multiplication at Low Voltage in Photoconductor**  
Producing stackable high-sensitivity photoelectric conversion films for solid-state imaging devices |
---|---|
To increase the sensitivity of cameras capable of capturing pictures with smooth motion at high resolution, we are researching high-sensitivity photoelectric conversion films that can be stacked together on a solid-state imaging device. To achieve this, the signal charges generated by the incident light must be multiplied at a low applied voltage. A technique for achieving this is introduced here.

| **P7** | **Low Current Driving of Multiple Magnetic Domains in Magnetic Nanowires**  
Aiming for compact storage devices that can operate at ultra-high speed |
---|---|
With the aim of producing compact storage devices that can operate at extremely high data transfer rates, we are developing a new magnetic recording device with no moving parts that works by moving magnetic domains along magnetic nanowires. Here, we introduce a technique for moving magnetic domains with lower electric currents and a reliable technique for stopping the movement of magnetic domains.

| **P8** | **High-density Recording Technologies on Thin Optical Disk**  
Aiming for compact Super Hi-Vision recording equipment capable of long-term storage |
---|---|
We are researching fast high-capacity recording techniques with a view to producing compact Super Hi-Vision recording equipment that uses thin optical disks. Here, we introduce a low bit error rate recording technique that has four times the recording density of conventional technology for recording and playing back video data.
<table>
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<th>P9</th>
<th>Spin Spatial Light Modulator Using Tunnel Magnetoresistive Effect</th>
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<td>Electro-holography for the 3D television of the future</td>
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<td></td>
<td>We are researching an ultra-fine spin spatial light modulator with the aim of developing a new kind of three-dimensional television based on holography. Perpendicular magnetic tunnel junction devices with potential to reduce drive current of spin spatial light modulator were developed.</td>
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<th>P10</th>
<th>Flexible Sound Generator Based on Thermoacoustic Effect</th>
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<td>Aiming for vibration-free flexible loudspeakers</td>
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<td></td>
<td>We are researching a thin flexible acoustic device that can be integrated with ultra-thin televisions of the future. We recently studied the possibility of using the thermoacoustic effect, which can generate sounds without mechanical vibration. We fabricated a prototype flexible sound generator using organic materials with high flexibility, and we evaluated its acoustic characteristics.</td>
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<th>P11</th>
<th>Display Driving Technology Using Optical Wavelength Multiplexing</th>
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<td>Towards future displays with very high resolution and high image quality</td>
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<td></td>
<td>We are conducting research into driving technology for high resolution and high image quality displays of the future that will have a huge number of pixels. This effort requires new driving technology. We have devised an optical driving method that uses wavelength multiplexing and have verified its basic operations.</td>
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<th>P12</th>
<th>Technologies for Fabrication of Self-aligned Oxide Semiconductor Thin-film Transistors</th>
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<td>Towards ultra-thin large-screen televisions</td>
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<td>We are improving the performance of oxide TFTs that will be used to produce ultra-thin large-screen televisions in the future. To produce displays with a larger screen size and higher resolution, we have developed self-aligned oxide TFT fabrication technology that makes smaller TFTs.</td>
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<th>P13</th>
<th>Far-field Pattern Control of Light-emitting Devices Through Sub-micron Dielectric Structures</th>
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<td></td>
<td>For future display applications</td>
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<td></td>
<td>We are looking into far-field pattern control of light-emitting devices with the aim of applying this technology to a direct view type display in the future. Here, we present a theoretical analysis of the directionality characteristics of light passing through sub-micron-sized structures.</td>
</tr>
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## Interactive Exhibit

| T1 | Experiencing News Service in “Easy Japanese”  
|    | Another news services for foreign residents and Japanese children |

Let's read future news stories in “Easy Japanese” and ordinary Japanese, then answer some quiz questions. You may find it easier to answer them with the easy Japanese news than with the ordinary Japanese news.

Jointly exhibited by News Department and Broadcasting Culture Research Institute.

| T2 | Hide and Seek Over a Lattice  
|    | Check out the wonders of human vision |

Human vision is full of wonders. You can play our “hide-and-seek” game to get some sense of these wonders. Can you find the hidden characters? The secrets of human vision will be unlocked to create the broadcasting of the future.

| T3 | Easier Visual Recognition of Moving Objects  
|    | Experience of smoothly moving images |

A moving picture on television is created from a large number of images displayed in sequence. If the number of images per second increases, high-speed moving objects will become recognizable. Try to answer the questions in the quiz by looking at such video images.
As society moves from the industrial age to the information age, broadcasting is changing from one-way content delivery to all at the same time towards personalised services. The spreading Internet Protocol (IP) networks provide broadcasters with the opportunity to implement IP from the camera to the home – IP End-to-End. This will allow the delivery of content much richer than now, in terms of quality, reach, additional data and interactive services. Taken together, these developments represent a ‘New Broadcasting System’ (NBS) to bring immersive, pervasive, data-rich services to the public.

The Olympics historically is a showcase for innovations and the BBC wanted London 2012 to be known as the ‘Digital Olympics’, showing new technologies and services; The BBC, NHK and OBS collaborated to use SHV to bring a new immersive experience to audiences in the UK and Japan.

The pervasive aspect of the NBS is that content should be available anywhere and on a wide range of devices. Our work includes investigation of technology from 4G mobile standards for delivering broadcast content to mobile devices.

The 2012 Olympics showed that the public appreciates the provision of data-rich services to accompany content. We are investigating ways of adding data overlays to a scene, such as sports statistics that could be turned on or off at will.

An IP End-to-End system is the means to implement the immersive, pervasive and data-rich aspects of the NBS. As IP network speed continues to increase, broadcasters can benefit from handling real-time production-quality video and audio over IP infrastructure.

This year marks the 60th anniversary of television broadcasting in Japan. Since TV broadcasts began in 1953, the technology has evolved from black-and-white television to color television, and then to satellite broadcasting and high-definition TV. Digital TV broadcasts began in 1996 via communication satellites. And in 2012, the switchover from analog terrestrial television broadcasting to digital terrestrial television broadcasting was finally completed. Accomplishing this major changeover was like a self-given gift to Japan’s TV broadcasting on its 60th birthday, but it also suggested that the time has come to move on to a new stage.

At this turning point, I would like to look back on the history of broadcasting technology and also rethink the unique agreements made within the broadcasting circles. Based on the above observations, I will examine the relations between UHDTV (Ultra High-Definition TV), Smart TV and 3DTV, which are recognized to provide new services in the future.

Both expectations and criticisms exist for UHDTV, also known as 4K or 8K TV. The development and adoption of the technologies will certainly broaden the range of services that may be provided by smart TV and accelerate the realization of 3DTV. Furthermore, applications of 4K and 8K technologies in other fields are expected and an early realization of the technologies is hoped for from the perspective of strengthening the international competitiveness of ultra high-definition video systems, Japan’s own forte, as a base technology in the global market.

In my lecture, I will also look into, as much as possible, the deployment scenario of 4K and 8K technologies and the schedule for examining their technical standards.
Next generation broadcasting systems will provide new services by using broadband networks in addition to broadcasting channels. STRL has been studying new multiplexing schemes and media transport technologies for hybrid delivery of content on multiple delivery channels such as broadcast and broadband networks. It has also been involved from the very beginning on international standardization of a new multiplexing scheme called MPEG Media Transport (MMT).

This presentation introduces the advantages of hybrid delivery, whereby video and audio signals delivered over broadcasting channels and broadband networks can be simultaneously presented. Hybrid delivery can maximize the benefits of their one-to-many delivery and one-to-one delivery characteristics. It also introduces the key technology of MMT for hybrid delivery and compares the functions of MMT and existing media transport technologies. The presentation also discusses how to implement MMT in broadcasting systems and shows that MMT can be efficiently transported on broadcasting channels with the IP packets that are widely used on broadband networks. Finally, we present an overview of MMT-based equipment being developed at STRL.

STRL has been researching video coding technology towards Super Hi-Vision (SHV) broadcasting that can efficiently compress huge capacity video data while retaining high image quality. We have also engaged in international standardization activities surrounding the new video coding scheme called HEVC (High Efficiency Video Coding)/H.265. HEVC achieves approximately twice the compression performance of the existing AVC/H.264, scheme and supports the SHV video format. We have developed the world’s first SHV real-time encoding equipment incorporated with HEVC.

This presentation introduces an overview of the HEVC video coding scheme, its standardization process, and the recently-developed SHV real-time encoding equipment. By adapting elemental technologies, such as partitioning the area by the quad-tree and extensions of the coding, prediction and transform block sizes, HEVC is able to encode the high-resolution SHV video with high compression performance. We compare HEVC with AVC/H.264, and introduce the SHV HEVC encoding equipment, which is capable of real-time processing with high image quality and high efficiency by spatially partitioning the SHV video signal and processing each partition in parallel.

To allow people to experience the sense of presence offered by Super Hi-Vision on large-screen televisions in their own homes, it is expected that displays will be developed that are ultra-thin, lightweight, and easy to carry. At STRL, we have been researching thin-film transistors (TFTs) as the driving devices and organic light-emitting diodes (OLEDs) as the light-emitting devices in flexible displays. We recently fabricated flexible displays using new highly efficient phosphorescent OLEDs and oxide TFTs that are suitable for fabricating displays with large numbers of pixels.

In this presentation, we will explain the oxide TFTs required for high-speed driving when increasing the number of pixels. We used soluble polymer materials as the insulating layers for large-screen displays and fabricated TFTs with good switching characteristics. We also developed a process for integrating TFTs on a plastic film at a fabrication temperature of about 200°C. After that, we will describe the phosphorescent OLEDs with high efficiency and a long lifetime. We recently improved the materials used in the light-emitting layer and developed a red light-emitting device with one-third the power consumption and seven times the lifetime of conventional devices. Using these technologies, we fabricated an 8-inch VGA (640×480) flexible OLED display.
Super Hi-Vision Theatre

May 30 (Thu.) – June 2 (Sun.) 10:00 am – 5:00 pm
NHK STRL Auditorium
(seating limited)
The final screening on each day is scheduled to end at 5:00 pm.

The Super Hi-Vision Theater will be closed for lectures and research presentations between 12:00 noon and 3:45 pm on Thursday May 30.

Screening program: “London Olympics Digest & Rio Carnival”

Last year’s London Olympics attracted a great deal of interest in Japan. At this year’s exhibition, highlights of the event, featuring the achievements of Japan’s team will be presented. Also pictures of the Rio Carnival will be presented. This is the biggest festival in the world, featuring four days of parades with ingenious float and dancing by 3,000-4,000 people dressed in glittering costumes. The dancers are accompanied by percussion sections (called “baterias”) who stir up the crowd with their intense ground-shaking samba rhythms.

Enjoy experiencing these events through the highly realistic combination of 33 megapixel high-resolution video and a 22.2 multichannel sound system.

Event dates

June 1 (Saturday) and June 2 (Sunday)

10:00 am – 3:20 pm; inquire at entrance

Guided tours

STRL researchers will give guided tours of the main exhibits to groups of about 7 people each. Participants are free to ask detailed questions about our research.

10:00 am – 4:30 pm; inquire at entrance

Stamp rally

Have fun collecting stamps from all over the exhibition venue. Collect them all and receive a free gift!

10:30 am – 4:00 pm

Workshop

We are holding a workshop for parents and children (of elementary school age and above). Make your own magic spring telephone.
Please use the train and the bus for coming. Please get off at the bus stop: NHK Gijutsu Kenkyujo

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http://www.nhk.or.jp/strl/