1

NHK

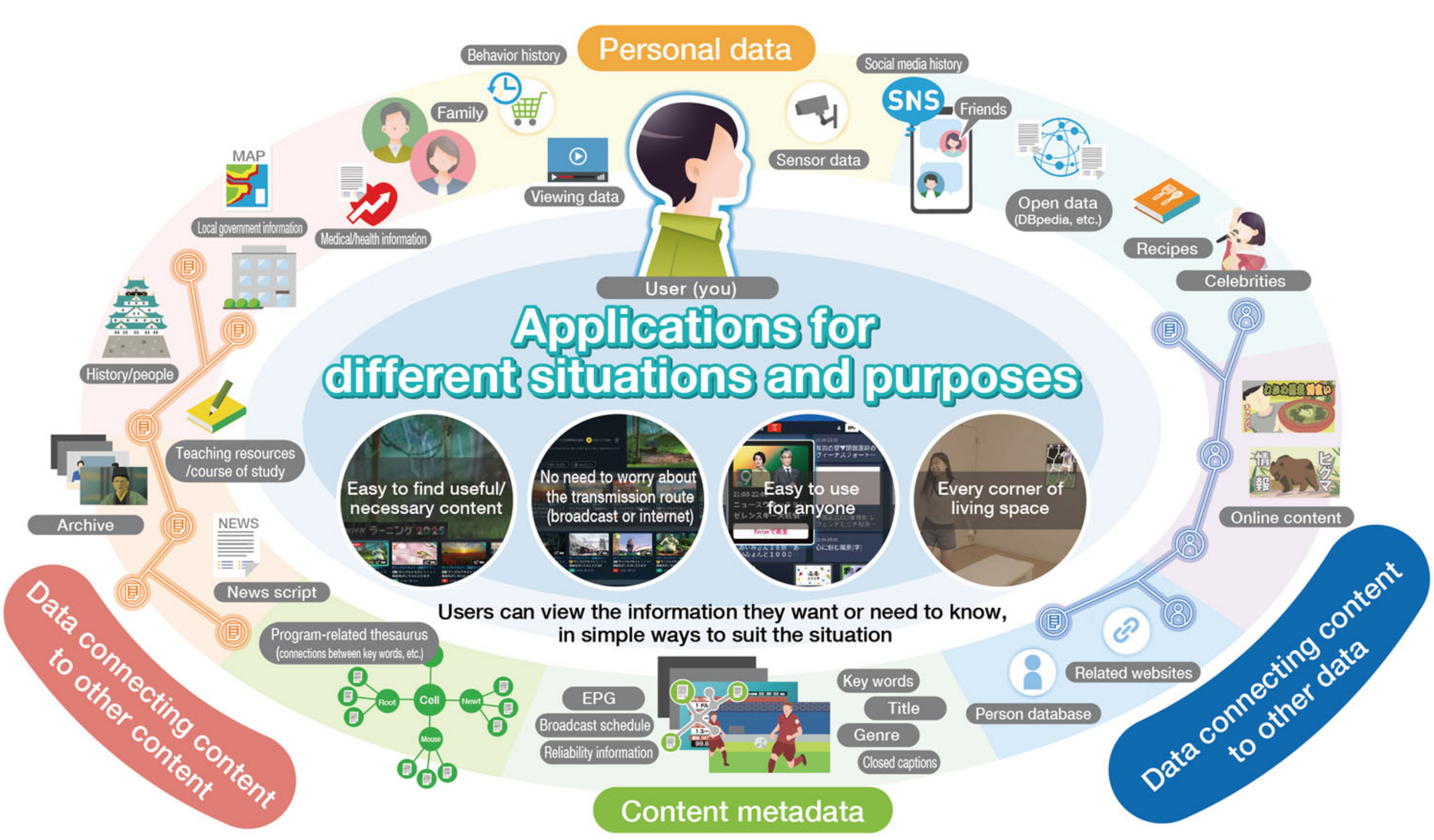
Universal Services

Short term

Web-Based Broadcast Media
① Content Viewing Application Technology

Technology to deliver content to all viewers

With web-based broadcast media, content is delivered via various forms of applications depending on the situation and purpose, regardless of the transmission route (broadcast or internet). STRL is researching ways for applications to use content-related data, personal data, and external data to enable users to receive the information they want or need to know in simple and easy ways to suit the situation.



● Delivering familiar broadcasts to more people, in more convenient ways

STRL has developed “content discovery technology” that uses content delivery status data to automatically determine the acquisition point of the desired content to suit the device and receiving environment. This will make it easy to view content provided by broadcast and internet transmission, no matter what viewing device is used.

● Expanding broadcast services to living spaces and virtual spaces

Combining personal data stores with various smart devices or IoT-enabled devices in the home will enable users to come into contact with broadcast services in more ways in daily life. This exhibit envisions a future where users can seamlessly enjoy real and virtual content by providing broadcast services with no gap between the real space and the metaverse.

【Future plans】

Web-based broadcast media is a technical concept spanning a wide perspective, from the present internet environment to a future with more advanced technologies like IoT and data processing. Assuming that it will be implemented step by step starting with the basic functions, STRL will first work with broadcasters and manufacturers on verification of the initial stage.

● This research is being conducted in cooperation with Nippon Television Network Corporation, TV Asahi Corporation, Tokyo Broadcasting System Television, Inc., TV Tokyo Corporation, Fuji Television Network, Inc., Tokyo Metropolitan Television Broadcasting Corporation, Mainichi Broadcasting System, Inc., Asahi Television Broadcasting Corporation, Kansai Television Co. Ltd., Yomiuri Telecasting Corporation, Television Osaka, Inc., TVS REGZA Corporation, LG Japan Lab Inc., IPG, Inc., M Data Co.,Ltd., ACCESS CO., LTD., and ALPS ALPINE CO., LTD.

2

NHK

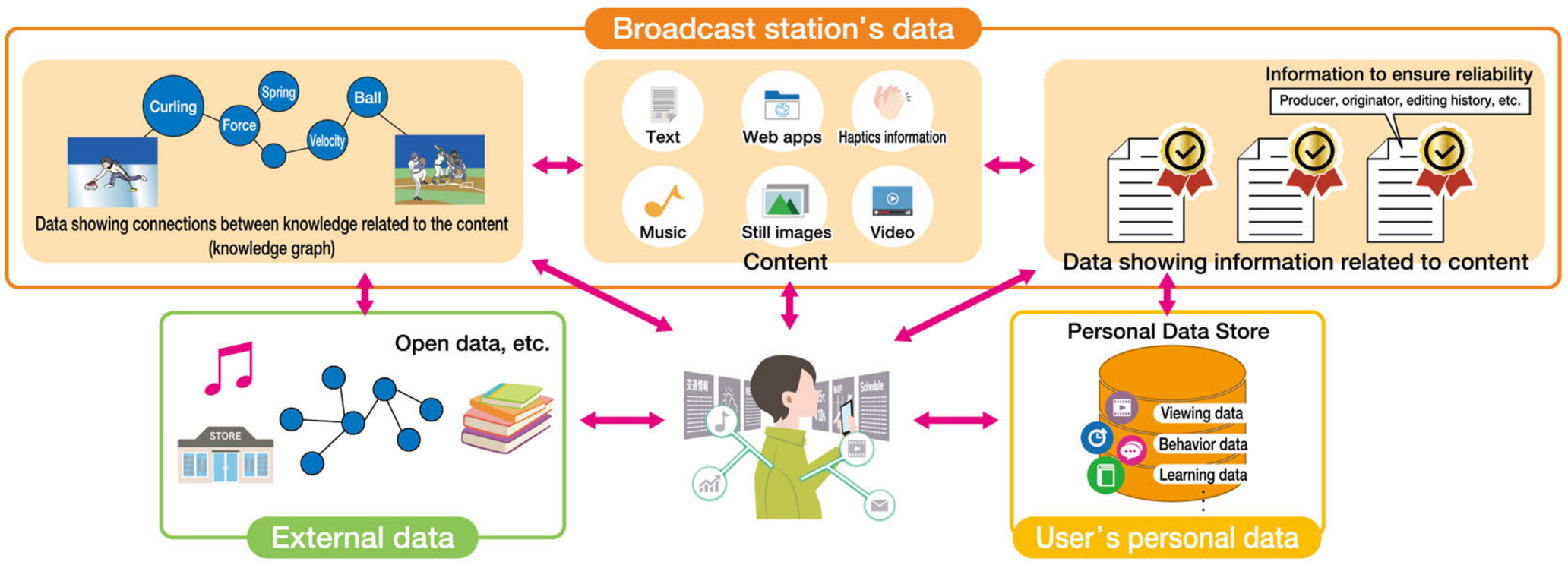
Universal Services

Short term

Web-Based Broadcast Media
② Cooperation and Processing Technology of Content and Data

Towards providing reliable and useful content

In this exhibition, we show technologies to facilitate the collaboration of data from inside and outside broadcast station and to provide users with reliable and useful content, by data description of content-related information and associated reliability information, knowledge related to content, and users' personal data in a form that can be interpreted by software.



Data collaboration for enriched services

● Knowledge graph to provide enriched learning

Lifelong learning is an important topic these days. Focusing on the idea of "learning," STRL is researching ways to generate knowledge graph to systematically structure the semantic relationships between words included in educational content. By using knowledge graph, users will be able to find related content and expand their interests.

● PDS※1 to allow users to manage and utilize their personal data

By storing various personal data, such as viewing data, in a PDS managed by the user themselves, it will be possible to provide personalized services tailored to each user's individual history while also ensuring transparency of data management and utilization.

● Content provenance presenting technology to ensure the reliability of content

There is a lot of unreliable content, such as fake news, on the internet. Attaching provenance information to content will help users determine whether the content is provided by a reliable source.

【Future plans】

STRL is formulating the specifications and verifying how the system will link to external data so that it can be applied to various services by broadcast station or others from around 2025.

※1 PDS: Personal Data Store. A system allowing users to store, manage, and utilize their personal data from various services.

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NHK

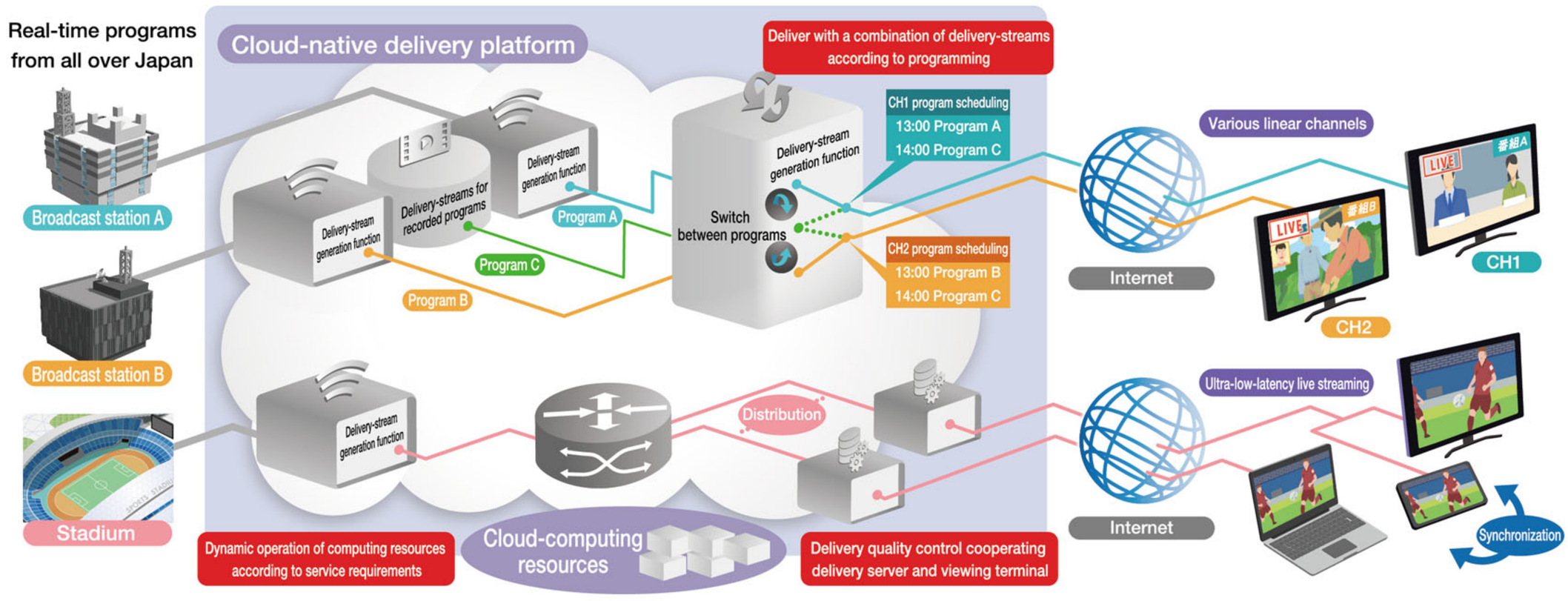
Universal Services

Short term

Web-Based Broadcast Media
③ Cloud Native Delivery Platform Technology

Aiming to achieve reliable and low-latency content delivery

STRL is researching cloud-native delivery platform technology to reliably and efficiently provide online video-delivery services to meet diverse needs. Providing various linear channels※1 and low-latency delivery technology will help achieve a better content-viewing experience.



Cloud-native delivery platform to provide a better viewing experience for various content

- **Efficient stream-generation/delivery technology to provide diverse linear channel**
  Based on real-time programs from various stations and recorded programs, a delivery stream is generated for each program. By combining programs as necessary to suit the viewer's preferences and viewing location, diverse linear channels will be efficiently provided.
- **Low-latency delivery technology to quickly and reliably deliver the information the user needs**
  Delivery-quality control cooperating the viewing terminal and delivery server, plus the latest web technology (such as WebTransport※2), will enable low-latency live streaming services with stability similar to broadcasting.
- **Cloud-native event-driven architecture**
  Services will be provided efficiently by only using the required computing resources for the required amount of time, according to the requirement of each service.

【Future plans】

STRL is working on technical verification and practical application of some functions, aiming to achieve a cloud-native delivery platform by around 2025.

※1 Linear channel: A service for online delivery of live programs and recorded programs in real time according to a program schedule, just like broadcast media.

※2 WebTransport: A Web API enabling low-latency bidirectional communication between a web client and server. Specifications are currently under development by the web standardization organization W3C (the World Wide Web Consortium).

4

NHK

Universal Services

In practical use

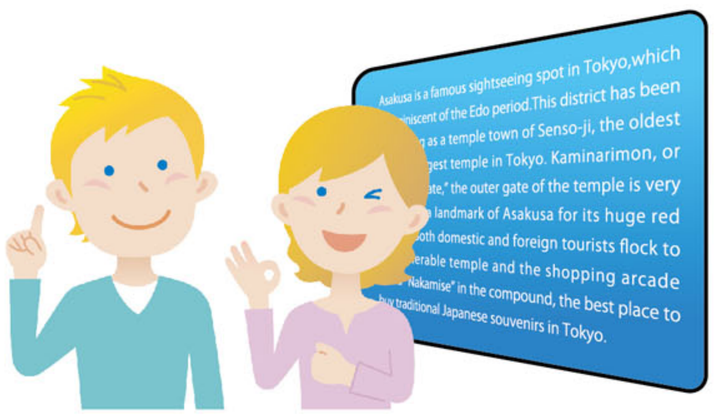
Supporting Technology for Accessibility Services

Making broadcasting accessible to everyone

STRL is researching information transmission technologies to make broadcasting widely accessible to everyone, including visually impaired, hearing-impaired, elderly, and non-Japanese people. Take a look at some of the technologies that help people to understand content: from sign-language CG to audio description, closed captioning, and translation.

Communicating information to different people in different ways

Audio description for visually impaired people



English closed captions for non-Japanese people

Closed captions and sign-language CG for hearing-impaired people

● Sign-language CG translation and generation technology

STRL is researching technologies to translate Japanese text into sign language and generate CG animations. Based on Japanese sentences including named entities, information is translated into sign language, which is easy for hearing-impared people to understand, and then a CG animation is created.

● Japanese-to-English machine-translation technology

In emergency situations such as natural disasters, special TV news reports are live streamed on the internet with English closed captions as a service for non-Japanese residents and visitors to Japan. The English closed captions are automatically generated from the Japanese closed captions by a Japanese-to-English machine-translation system that has been trained using NHK news reports.

● Audio-description production and delivery technology

STRL is developing a system to produce and deliver audio descriptions for live sport broadcasts to help more people, including those with visual impairments, to view TV programs. Explanatory text is generated by image recognition or manual input, converted to audio description by speech synthesis, and delivered to the user's smartphone. The app also allows users to adjust the speed or amount of information.

【Future plans】

Sign-language CG : CG animations to be generated for some news bulletins by 2025.

Japanese-to-English translation : Translation system to be used by broadcast stationsnationwide by 2025.

Audio description : System to be operated by a single operator by 2025.

5

NHK

Immersive Media

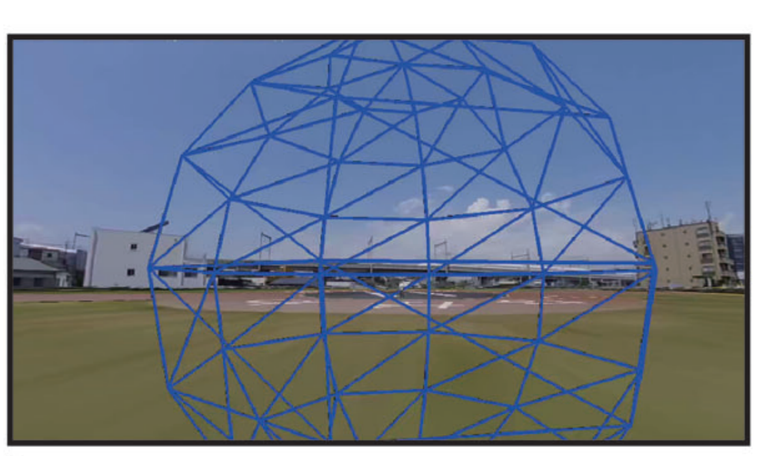
Medium to long term

Authoring Tool for 3D Space

Designing time-series 3D space for immersive content

STRL is researching ways to create immersive media, allowing users to enjoy moving freely within a three-dimensional (3D) image space. STRL has developed a 3D space authoring tool that makes it easy to create immersive content and a system to deliver this content to various types of display devices.

Place volumetric-video and 360-degree-video objects in 3D space



Set the range in which the user can move in 3D space (blue lines)

Output a scene description configuring the 3D space

Outline of authoring tool

● Simplifying the creation of immersive content

STRL has developed an authoring tool that enables video objects (including volumetric video and 360-degree video) to be easily placed in a 3D space using a mouse or game controller.

● An easy way to enjoy immersive content

Users can use various types of devices, such as a head-mounted display or tablet, to present immersive content and enjoy moving freely within the 3D space.

● Making use of the latest international standards

The system makes use of the latest MPEG※1 standards, including the method of encoding volumetric video and the scene-description format to show how video objects are configured in time-series space.

【Future plans】

STRL will develop technology to expand the range of space in which users can move, and improve the tool based on verification in a practical environment by around 2026.

※1 MPEG (Moving Picture Experts Group): Subcommittee of ISO/IEC (International Organization for Standardization/International Electro technical Commission) for standardization of information technology on multimedia.

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NHK

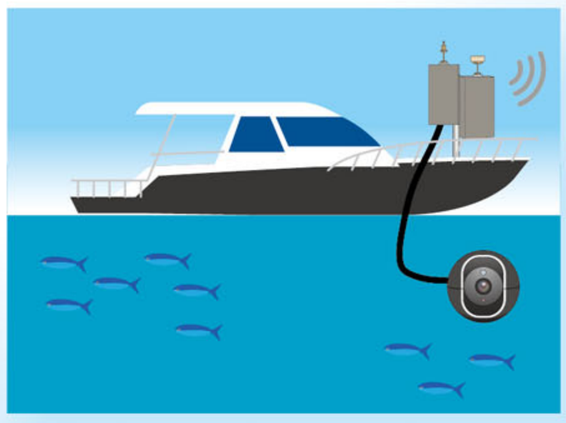
Immersive Media

Short term

400Mbps Class Millimeter-Wave Wireless Transmission Technology for Contents Production

Wireless relay of ultra-high-definition 360-degree video

STRL is conducting research into large-capacity transmission technology used for 360-degree contents production, to help provide realistic immersive-media services. This demonstration shows real-time transmission of ultra-high-definition 360-degree video using a wireless transmission system with a 400-Mbps-class transmission capacity using millimeter waves※1.



Filming underwater images

Filming action close up at a festival

Outside broadcasting van

Filming a race from inside the track

Home

Examples of real-time transmission of 360-degree video
by 400-Mbps-class millimeter-wave wireless transmission

● Wireless transmission using millimeter waves

By using millimeter waves in the 42-GHz band allocated for broadcast purposes, cameras can be made wireless, enabling live relay of ultra-high-definition 360-degree video in locations where it is difficult to lay cables.

● Expanding transmission capacity using spatial division multiplexing transmission technology

STRL has developed MIMO-SC-FDE※2 technology for spatial division multiplexing transmission of single carrier-modulation signals at the same frequency with smaller transmitters. By using the wide bandwidth of millimeter waves, this has achieved a 400-Mbps-class transmission capacity, around twice that of the conventional system.

【Future plans】

STRL will develop 700-Mbps wireless transmission technology to further improve the definition of 360-degree video by 2025.

※1 Millimeter waves: Radio waves with frequencies of 30–300 GHz (wavelengths 1–10 mm)

※2 MIMO-SC-FDE: Multiple-Input Multiple-Output Single-Carrier Frequency Domain Equalization

7

NHK

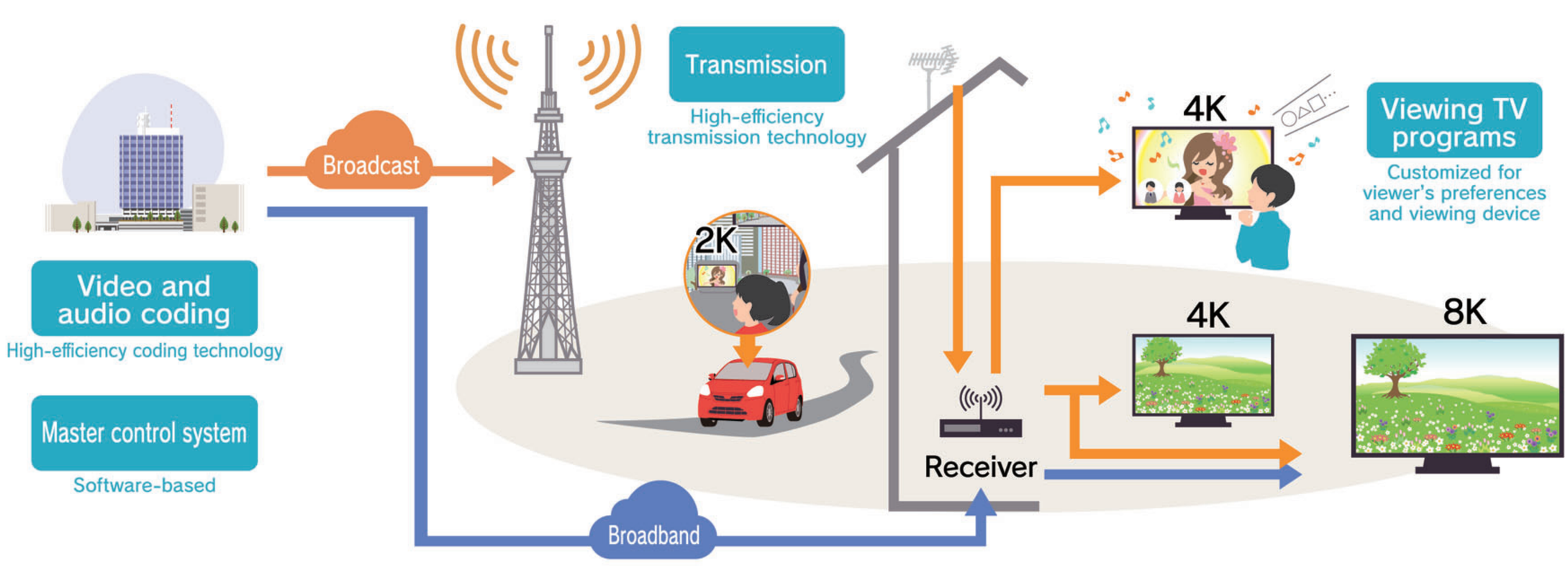
Immersive Media

Short term

Advanced Terrestrial Broadcasting

High-quality and multi-functional broadcast services using the latest video/audio coding, master control system and transmission technologies

STRL is pursuing research towards the next generation of Digital Terrestrial Broadcasting (DTB). The new terrestrial broadcasting system shown here uses the latest video/audio coding, master control system and transmission technologies, that the standardization is currently in progress in Japan.



New terrestrial broadcasting system using latest technologies

● Services can be customized for the viewer's preferences and viewing device

The latest video- and audio-coding technologies allow viewing services to be customized for individual preferences, including 8K services combining 4K broadcast and broadband, or services allowing sports fans to watch a game from the perspective of their favorite team by selecting sub-content video and audio objects.

● Software-based master control system

Program-control functions are built using software on a general-purpose server, which saves space and means specialized hardware is not required. The software-based system also improves scalability and will contribute to BCP[※1] by placing some or all functions on the cloud.

● High-efficiency transmission technology

The latest transmission technology can achieve 1.7 times the transmission capacity of existing DTB. It will also be possible to transmit two 4K programs (suitable for fixed reception) and two 2K programs (suitable for mobile reception) on a single channel, helping to improve broadcasting services and achieve efficient use of frequency.

【Future plans】

Focusing on the benefits to viewers as the top priority, STRL will investigate specific measures in order to successfully migrate to next-generation DTB, enabling efficient use of frequency as well as high quality and multi-functionality.

● Part of this research was conducted as part of the “Study on technical measures for effective utilization of broadcasting frequencies” for the Technical Examination Services Concerning Frequency Crowding of the Ministry of Internal Affairs and Communications.

※1 BCP: Business Continuity Planning

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NHK

Universal Services

Short term

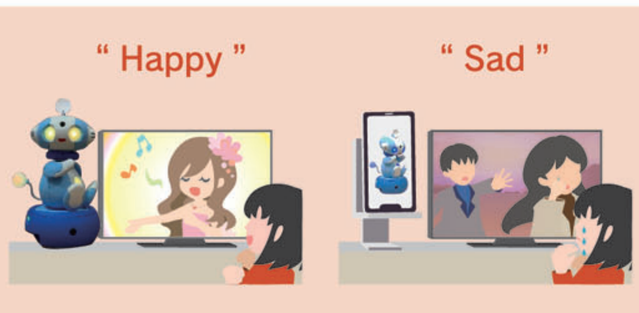
TV Companion Robot on Various Devices

An easy way to experience watching TV with a robot

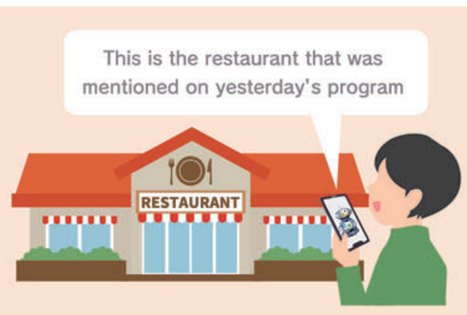
STRL is researching robots that chat with users and express emotions to make watching TV even more enjoyable. So that more people can easily experience watching TV with a robot, STRL has developed a robot application that can be executed on a smartphone or PC.

Utterances relating to content of TV programs

Sharing emotions



Useful in various situations



Hardware

Common functions used on various devices

Web application

Analysis of TV programs | Estimation of human's position | Control of behavior | Generation of utterances

Recognition of user's utterances | Estimation/generation of interest | Speech synthesis

TV companion robot supporting technology and viewing experience

● Execution on various devices

STRL has developed a new software robot as a web application, which behaves the same as the existing hardware robot.

● Natural utterances relating to content of TV programs

The robot chats with users while watching TV. The robot has been trained data set of sentences people often say while watching TV, so it can now produce more natural utterances.

● Expressing emotions

The robot expresses emotions to users such as "happy" or "sad" by moving its head and limbs. It has been improved to convey the robot's emotions even when it is watching TV with its back to the user, such as implementing tail movements.

【Future plans】

STRL will continue to improve the robot so that it behaves in consideration of user's interests and TV program situations, and will conduct experiments and evaluations in a home environment. Around 2025, STRL will establish the fundamental technology for a TV companion robot.

● Research into emotional body movements is being conducted jointly with Shibaura Institute of Technology.

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NHK

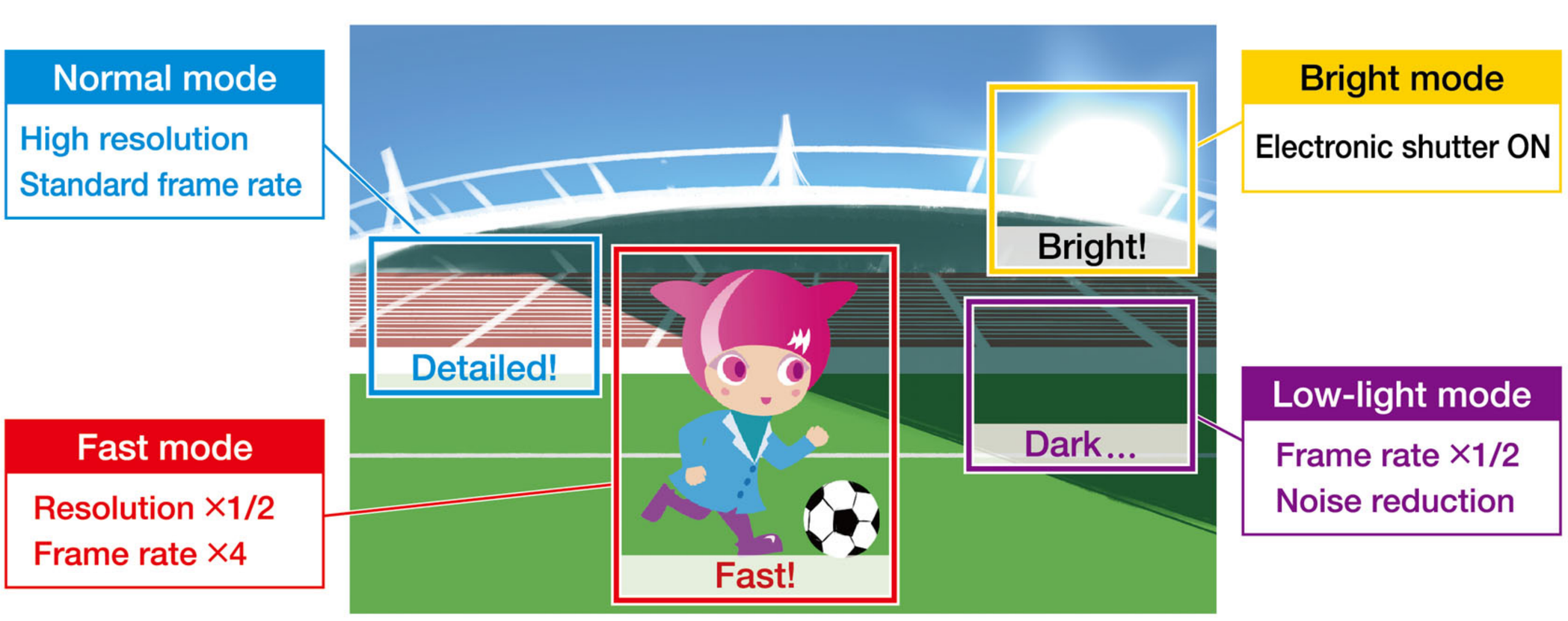
Immersive Media

Short term

Scene-Adaptive Imaging Technology

New image sensor allowing resolution and frame rate to be set for each area

STRL is researching imaging technology that will enable images to be captured with different imaging conditions depending on the scene, to produce 360-degree video involving objects with different motion or brightness on the same screen. This technology instantly analyzes images and changes the image sensor frame rate or resolution for each area.



Shooting with optimal conditions for each area

Outline of scene-adaptive imaging technology

● Area control image sensor

STRL has developed an image sensor that splits up the imaging area into 272 control blocks and allows different resolutions and frame rates to be set for each control block. Combined with scene information analysis technology, this will allow each scene to be shot under the optimum imaging conditions.

● Scene information analysis technology

By analyzing video images in real time, the system automatically determines the optimum conditions for each control block and immediately feeds back the results to the image sensor.

【Future plans】

STRL will increase the resolution of the image sensor and develop a scene-adaptive imaging system that can capture video images at a practical level of resolution by 2024.

● Part of this research is being jointly conducted with Shizuoka University.

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NHK

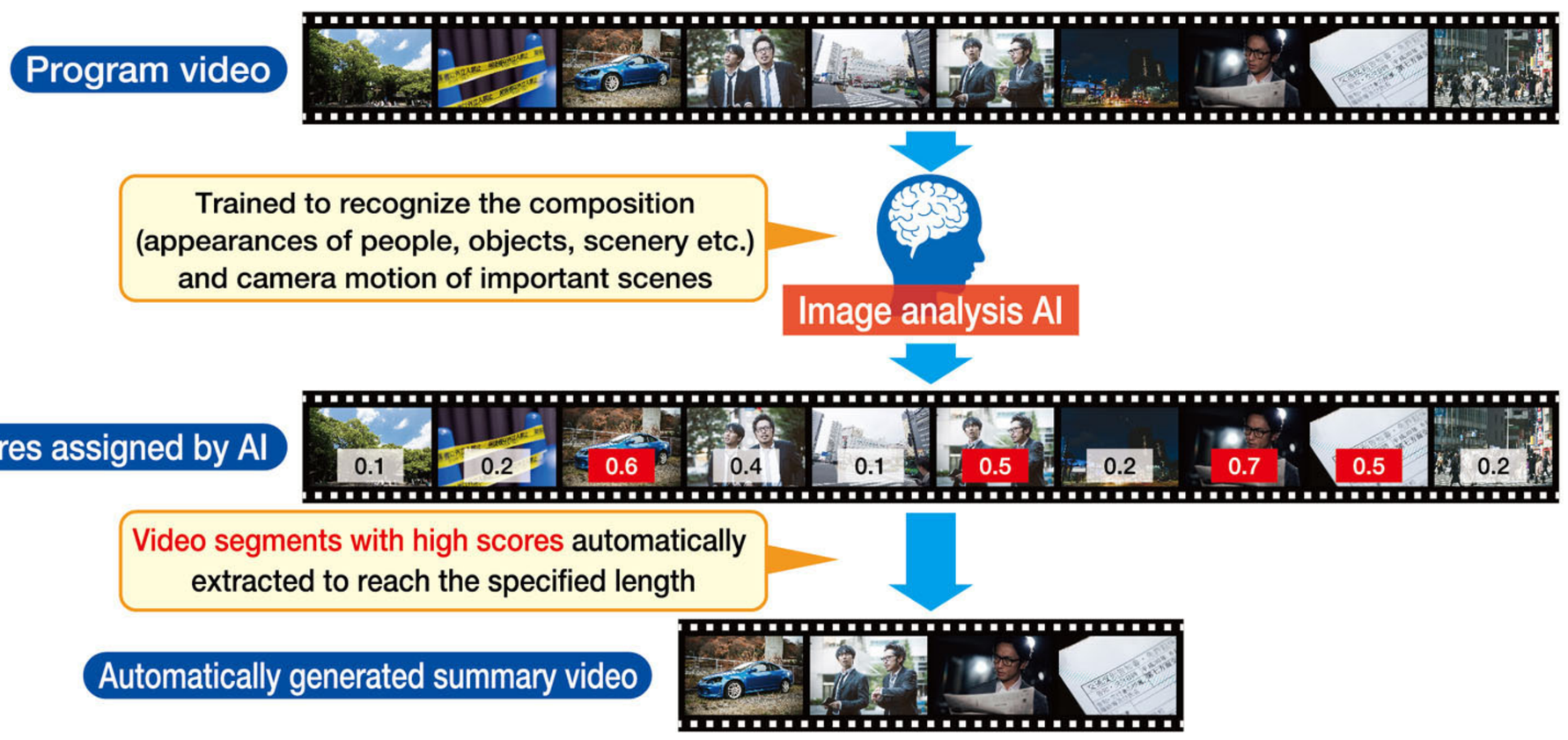
Frontier Science

In practical use

Automatic Program Video Summarization System Using Image Analysis AI

Creating short videos for quick and easy viewing

STRL is researching automatic video summarization technology to support the production of short videos for online distribution in order to showcase TV programs to viewers. This exhibit shows a system to automatically generate a summary video of a program using scenes selected by image analysis AI.



Outline of automatic program video summarization process using image analysis AI

● Using image analysis AI trained to recognize the composition and camera motion of important scenes

The image analysis AI used in this system has learned to recognize the characteristics of composition (appearances of people, objects, scenery, etc.) and camera motion of important scenes that should be included in the summary video. By selecting extracts using this AI, it is possible to generate summary videos with similar quality to those edited by an actual video producer.

● Users can easily modify the automatically generated summary video

Short-video producers have various aims or preferences, such as “avoid close-ups of faces,” “keep camera movement slow,” or “keep each cut short.” To respond to these precise requirements, the system includes functions enabling users to easily modify the automatically generated summary video.

● Practical use of news program automatic summarization system applying this technology

STRL has developed a “news program automatic summarization system” combining image analysis AI and speech recognition technologies that is now in practical use at news production sites. Summary videos of news programs can be generated and shared on social media immediately after broadcasting of the program has finished.

【Future plans】

As well as expanding the use of the news program automatic summarization system, STRL aims to put automatic summarization systems into practical use for other genres of TV programs.

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NHK

Frontier Science

In practical use

Approach to ELSI Toward Realization of People-Friendly Society

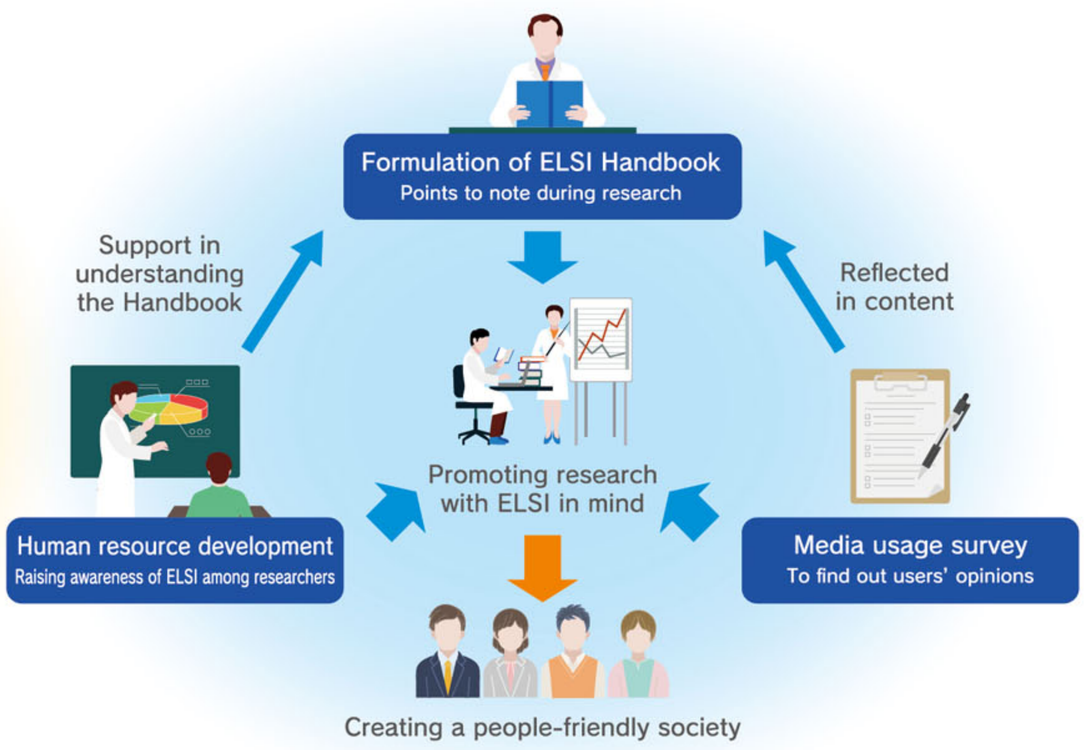
Promoting research with ELSI in mind

In order to channel research results back to society in a desirable form, as well as investigating technical issues, ELSI *1 (Ethical, Legal and Social Issues) must also be taken into consideration. This exhibit shows STRL's approach to these issues in research, development and practical application of new technologies.

ELSI

- **Ethical Issues**
  Human dignity, fairness, etc.
- **Legal Issues**
  Laws, regulations, etc.
- **Social Issues**
  Effects of technology on people and society, etc.

Examples of issues:
・Digital divide caused by ability/disability
・Obtaining and using personal information
・Response to fake videos created by Artificial Intelligence (AI)



Promoting research with ELSI in mind

● Formulating a handbook to promote research with ELSI in mind

New technologies help to make our lives more convenient, but sometimes they may have unexpected effects on people or society. STRL is formulating an ELSI Handbook to give guidance about how research work should be conducted, based on the idea of "ELSI by design" (being aware of ELSI from the research planning stage).

● Survey of diverse users about media usage and awareness

To ensure the contents of the ELSI Handbook are in line with users' media usage and awareness, STRL conducted a survey of a diverse range of users, including people with disabilities and LGBTQ+ people. The survey asked users what they feel concerned or uncomfortable about in their everyday use of media, and how they want content to be. The results of this survey will be reflected in the contents of the Handbook.

● Raising awareness of ELSI and human resource development

STRL holds in-house seminars on topics such as gender, law, risk, ethics, and public interest, in order to raise awareness of ELSI among researchers. Attendees discussed the significance of addressing ELSI, found out about the latest trends, and learned the necessary specialized knowledge.

【Future plans】

As well as continuing work on the ELSI Handbook, STRL will promote research and development towards creating a people-friendly society through dialogue with users and collaboration with external organizations.

● This research is being jointly conducted with the NHK Broadcasting Culture Research Institute, Osaka University, and Tsukuba University of Technology.

※1 ELSI: Ethical, Legal and Social Issues

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NHK

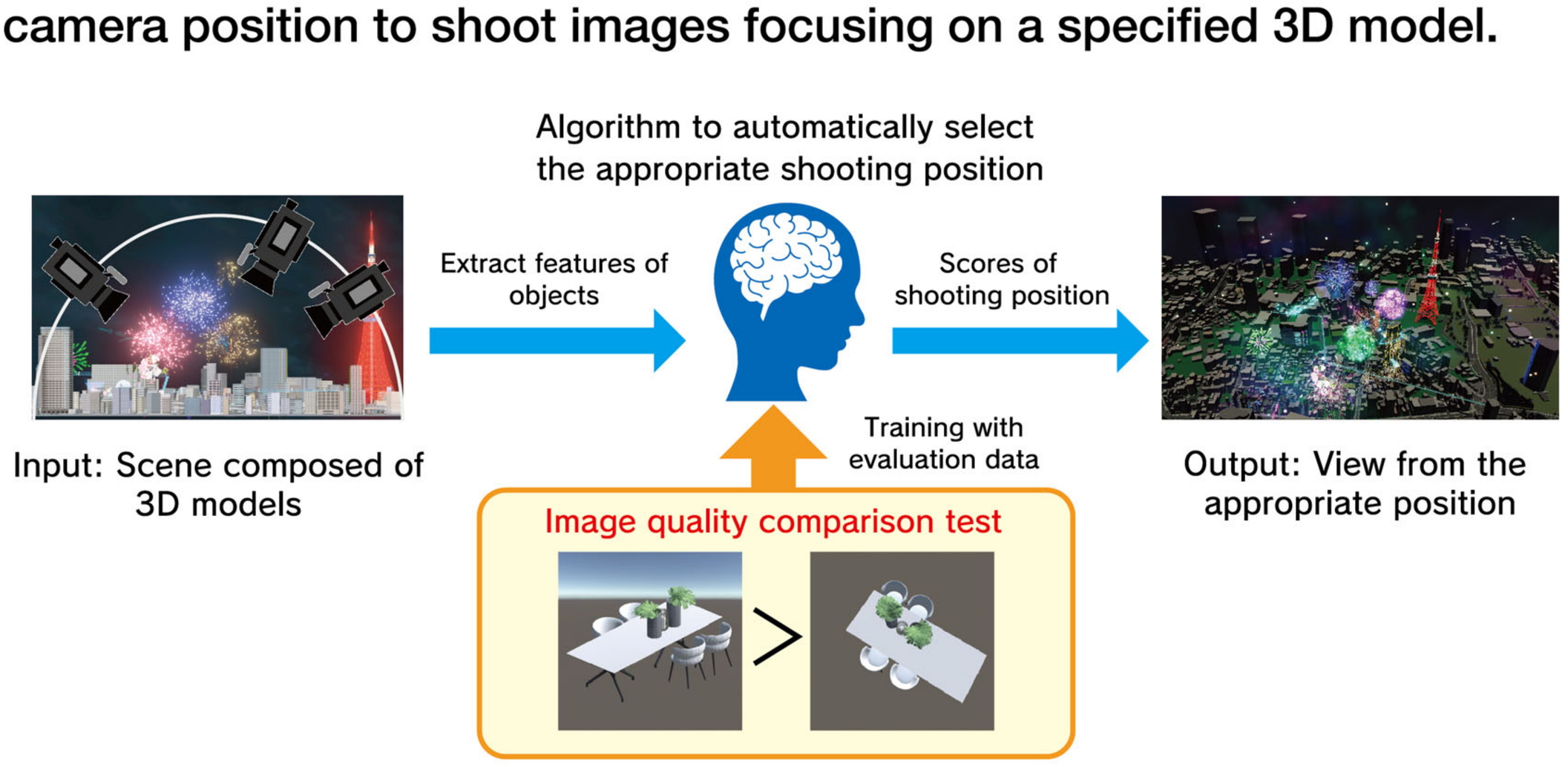
Frontier Science

Medium to long term

Technology for Automatic Viewpoint Selection in 3D Space

Towards a technique to shoot 3D models in a user friendly way

STRL is developing an algorithm to estimate the appropriate shooting position for a scene composed of multiple 3D models, to make video production more efficient. This technology automatically finds the best camera position to shoot images focusing on a specified 3D model.



Automatic selection of appropriate shooting position based on findings from experiments

● Estimating the appropriate camera position to shoot images with best subjective qualities

STRL conducted experiments to collect a large amount of subjective evaluation data about the perceived quality of images shot from different positions. Based on the relationship between this evaluation data and the features of each object, STRL developed an algorithm to estimate the appropriate camera position to shoot the best images.

● Applicable for scenes containing multiple 3D models

Given multiple 3D models in a scene, the 3D model in the foreground sometimes occludes the other 3D models in the background, making it difficult to predict the appropriate shooting position with the existing technique. The proposed technique takes into account the effect of each 3D model on the goodness of views for the whole scene, making it possible to predict the appropriate shooting position for a scene composed of multiple 3D models.

【Future plans】

STRL will work on improving the processing speed to support animated scenes by around 2025. We will also apply this technique to adaptively select proper expressions depending on different viewing styles by around 2030.

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NHK

Frontier Science

Medium to long term

Display Technologies for Immersive Content Experiences

Aiming for stretchable and deformable displays

STRL is conducting research into stretchable displays that can be deformed into different shapes, allowing users to enjoy realistic and immersive content anytime and anywhere. This exhibit shows stretchable display and quantum-dot※1 LEDs※2 to produce vibrantly colored displays.

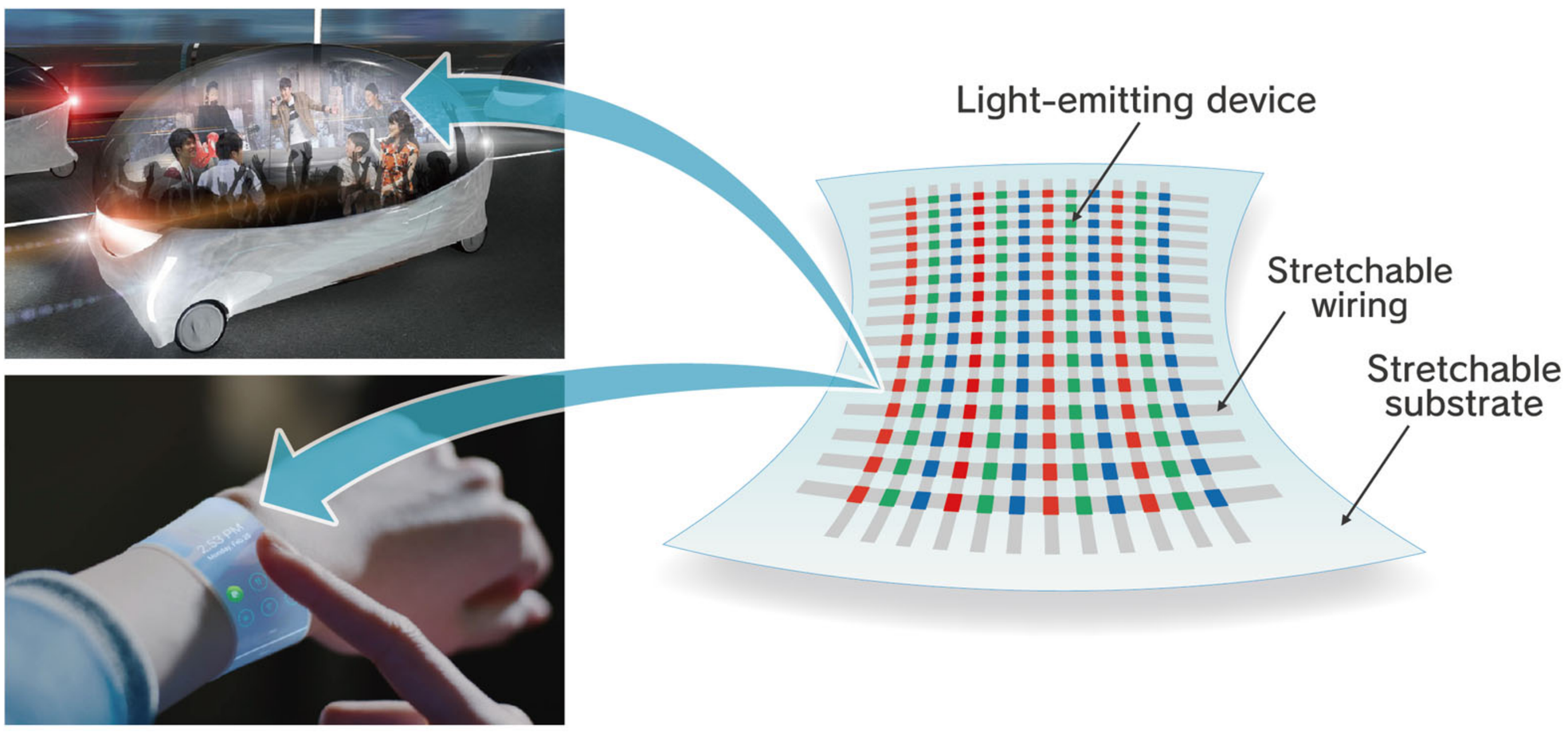

Image of a deformable display

● Stretchable-display

STRL has developed a stretchable LED※2 display using a flexible rubber-based substrate. Pixels are connected with stretchable wiring that can expand and contract freely, so it can be formed into different shapes, such as a dome, or wearable displays to show images on the skin.

● Quantum-Dot Light-Emitting Diodes (QD-LEDs) with vibrant colors

Quantum dots are semiconductor crystals in particle form. They can be applied like ink and have potential as a light-emitting material with high color purity. By improving the material composition and device structure using a new quantum-dot material that does not contain toxic cadmium, STRL has developed vivid red, green, and blue QD-LEDs that will be effective in producing displays with a wide color gamut.

【Future plans】

STRL will produce a prototype with ultra-high definition and high image quality by around 2025, to be put into practical use by 2030.

● Part of the research into stretchable-display is being jointly conducted with Shin-Etsu Chemical Co., Ltd. and System & Application laboratories. Inc.

● Part of the research into QD-LEDs is being jointly conducted with Osaka University and Nagoya University.

※1 Quantum dot: Semiconductor materials on a nano scale. Light is emitted by irradiation or charge injection. The color of light emitted depends on the particle diameter.

※2 LED: Light Emitting Diode. A semiconductor device that emits light when electric current flows.

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NHK

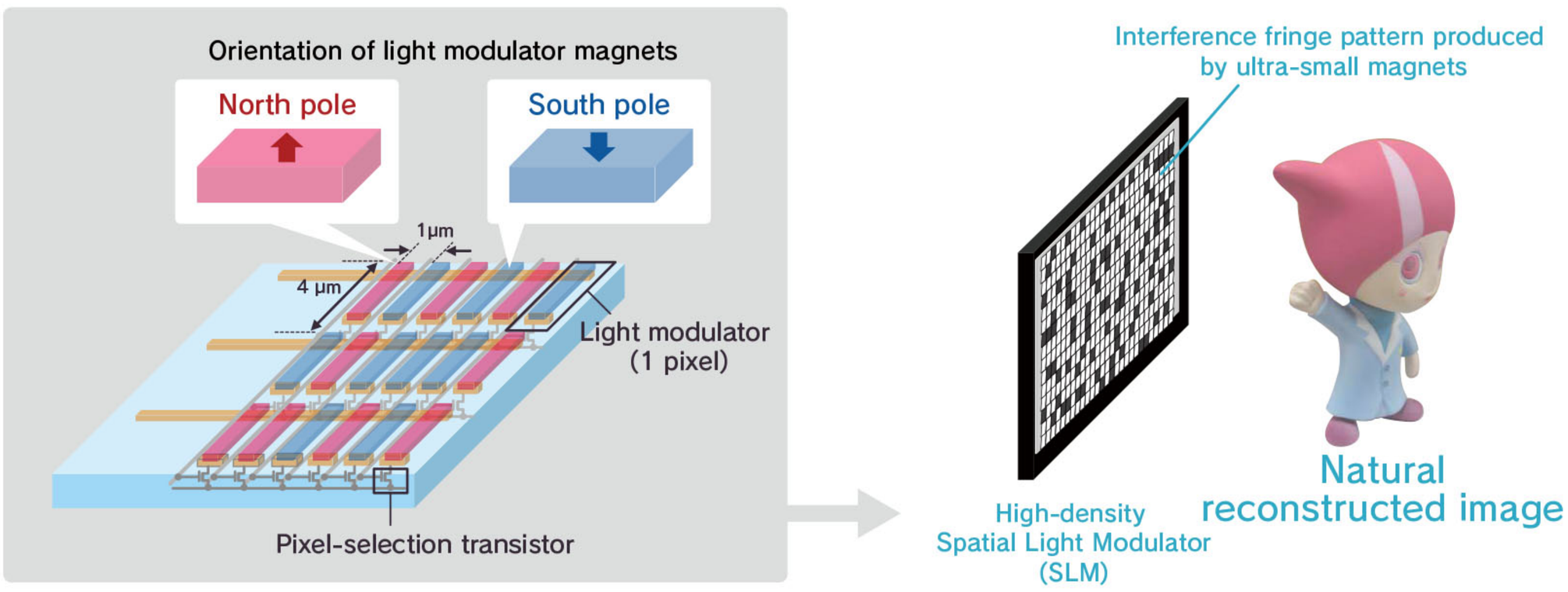
Frontier Science

Medium to long term

Lifelike 3D Motion Images with Holographic Display

Development of high-density spatial light modulator (SLM) for wide viewing zone angle

Holographic displays ※1 reproduce lifelike three-dimensional (3D) images without wearing special glasses. To widen the viewing zone angle ※2 of holographic displays, STRL has been developing a high-density Magneto-Optical Spatial Light Modulators (MOSLM) ※3 with submicron scale small-pixels. We have successfully demonstrated 3D holographic images with wide viewing zone angle using the MOSLM.



High-density SLM developed by STRL

● High-density MOSLM with pixel pitch of 1 μm

The viewing zone angle of a holographic display depends on the pixel pitch. With a conventional low-density SLM, images could only be viewed within a narrow range. To widen the viewing zone angle of holographic displays, STRL has developed a MOSLM (10K×5K pixels) using Current Induced Domain Wall Motion (CIDWM) ※4 with the world's smallest pixel size (1 μm×4 μm).

● Display of 3D images with wide viewing zone angle

The MOSLM developed by STRL can successfully display 3D images with a horizontal viewing zone angle of 30 degrees. A rewritable wide viewing zone angle holographic display has been demonstrated. As the structure of this MOSLM is suitable for higher density, it should be possible to widen the viewing angle further by reducing the pixel pitch.

【Future plans】

STRL will work on developing elemental technologies for a high-density SLM that can achieve high diffraction efficiency and display high-speed moving images by around 2025. The quality of reconstructed images will be improved and moving images will be displayed in color by around 2030.

※1 Holographic display: A display that can reproduce lifelike 3D images using an interference fringe pattern to reproduce the light in a space.
※2 Viewing zone angle: The range in which a 3D image can be seen.
※3 Magneto-Optical Spatial Light Modulator (MOSLM): A device containing a two-dimensional array of tiny light modulators (equivalent to pixels) that can control the state (intensity, phase, etc.) of light. A MOSLM can reproduce 3D images by rotating the polarization of light using the Magneto-optical Kerr Effect (MOKE) to produce an interference fringe pattern.
※4 Current Induced Domain Wall Motion (CIDWM): A technology to reverse the direction of the micro-magnets that make up a pixel (move the domain wall) by applying a pulse current instead of a magnetic field. There is no crosstalk to adjacent pixels, making it suitable for high density of 1 μm or less.

T1

NHK

Immersive Media

The Future of Content as Envisioned by Immersive Media

Experience the next generation of live entertainment!

This exhibit presents an experience-based concept of immersive media, showing how the world of content will expand with large-screen displays, AR（Augmented Reality） glasses, and VR（Virtual Reality） goggles. Visitors can experience immersive, interactive content with family and friends.

● Immersive content surrounds you with powerful images and sounds

As a concept of the next generation of live entertainment, take part in an immersive experience with friends and family that is so realistic that it feels like stepping right into the content by watching an immersive display or from inside a self-driving car, showcasing what content might be like in the future.

● A choice of ways to enjoy interactive content

Get up close to an artist or relax and look down at the scene from above. This exhibit shows the possibilities of interactive content with a choice of different ways to enjoy it. Experience the difference in sound depending on which viewing style is chosen.

● Media that connects people via content

Immersive media can connect people via content, deepening communication by providing new experiences. Imagine that many other people not only at this venue but elsewhere are also enjoying the same live entertainment with their family and friends.

T2

NHK

Undersea Photography VR

Capture a moment of 360-degree video!

STRL is developing VR content linked to TV programs and events. Enjoy an interactive VR experience, taking photos of fish in the sea with an underwater cameraman.

● Capture a moment of 360-degree video

STRL is investigating ways to make our Future Vision a reality. This interactive system lets viewers watch 360-degree video and press a button when they see something exciting to capture the moment in a photograph.

● Available on multiple devices

As well as a head-mounted display, a tablet version is also available for young children. The UI※1 has been specially designed to allow people of all ages to enjoy this interactive VR experience.

※1 UI (User Interface): The way the device controls information presented to the user depending on how the user touches the panel or the angular velocity detected by the built-in gyro sensor inside the tablet.