R&D for Future Media and the Role of Displays

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ABSTRACT

NHK Science & Technology Research Laboratories is promoting research and development on future media services. In this paper, we present a vision for future media and the direction of research and development based on that vision and introduce display technologies that will support future media experiences.

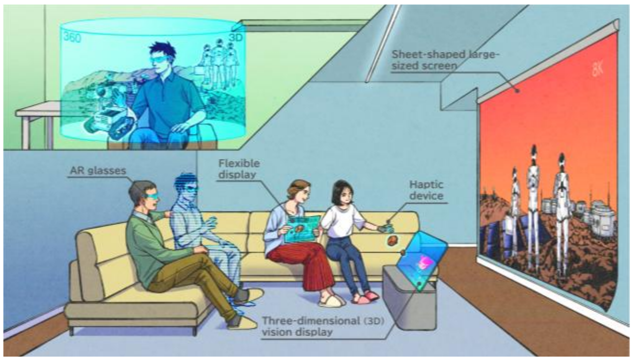
1 Introduction

Broadcasting in Japan began in March 1925, and this year, 2025, marks its 100th anniversary. Over the past century, broadcasting has continuously evolved alongside technological innovation—from radio to black-and-white television, color television, satellite broadcasting, digital broadcasting, and now 4K/8K ultra-high-definition video services.

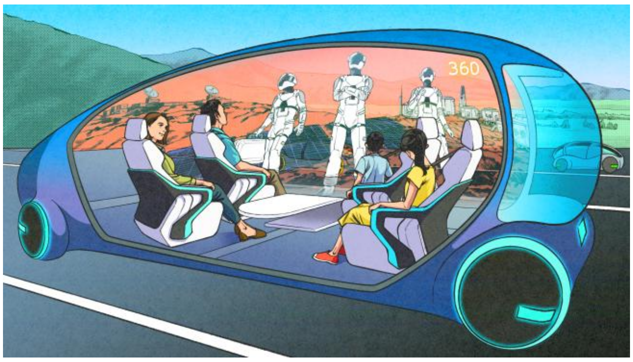
NHK Science & Technology Research Laboratories (STRL) was established in 1930, five years after the launch of broadcasting in Japan. As Japan's only research institute dedicated to broadcast media technologies, STRL has been leading the development of such technologies.

STRL conducts research across a wide range of fields—from foundational technologies that support the broadcast media, to video and audio technologies that revolutionize the viewing experience, and interactive technologies that expand the possibilities of new media.

In recent years, rapid advances in digital technology have led to the emergence of new viewing devices that utilize 3D video technologies, such as augmented reality (AR)/virtual reality (VR) glasses. The widespread adoption of social media and video streaming services has also significantly transformed the media landscape. With advancements in communication technologies, reliable information transmission using multiple channels has become possible even during disasters, raising expectations for new transmission methods. Furthermore, the emergence of generative AI is bringing

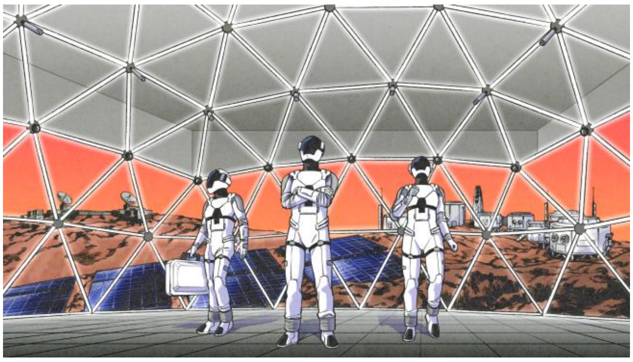


(a) Viewing in living room



(b) Inside autonomous vehicle

(c) Wearable display



(d) Next-generation content creation

Fig. 1 Images of the future media

major changes to content creation processes. At the same time, public interest in the reliability of information is growing, and the role of media is expected to become increasingly important.

In response to these technological and societal developments, STRL has formulated the “Future Vision 2030–2040,” which anticipates the media environment for the years 2030 to 2040 [1]. In this paper, we present the direction of research and development based on this vision and introduce current initiatives and future prospects for display technologies that will play a central role in future media experiences.

2 Future media environment

In the media environment envisioned for around 2030 to 2040, viewing devices will seamlessly integrate into living spaces, enabling personalized viewing experiences tailored to individual preferences and residential environments. These devices will enrich everyday life across various settings—from living rooms to personal spaces, and even while on the move.

With the widespread adoption of technologies such as sheet-type large-sized screens, flexible displays, 3D vision displays, and haptic devices, viewers will be able to enjoy content in styles that suit their preferences (Fig. 1(a)). AR/VR glasses will offer immersive viewing experiences, creating a sense of presence as if the content were right in front of the viewer. They will also enable shared experiences with distant family and friends, as if watching together in the same space.

Moreover, the diversification of transmission paths and viewing devices will allow flexible access to a wide variety of content, regardless of time or location. Inside autonomous vehicles, curved displays will provide highly immersive visual experiences, and such technologies may become widespread in vehicles before they do in homes (Fig. 1(b)). Advances in wearable displays will enable more personal and free viewing experiences through body-mounted devices. These devices will offer access to information anytime, anywhere, and contribute to the delivery of accurate and essential information during disasters (Fig. 1(c)).

To support such diverse viewing styles, advancements in content production technologies are also essential. Beyond the currently emerging virtual production using LED walls, volumetric studios capable of capturing 3D information are expected to become more common. By surrounding subjects with numerous cameras, microphones, and sensors, it will be possible to capture movements, facial expressions, and spatial information with high precision, enabling the creation of realistic virtual worlds (Fig. 1(d)).

In this way, the evolution of both viewing environments and production technologies is expected to lead to richer and more diverse media experiences. Display technologies, in particular, are anticipated to go beyond simply presenting visual information, evolving into media that offer realistic experiences and enable the sharing of emotions and atmospheres.

3 Display technologies for future media

This section introduces STRL’s initiatives for developing display technologies for future media. To

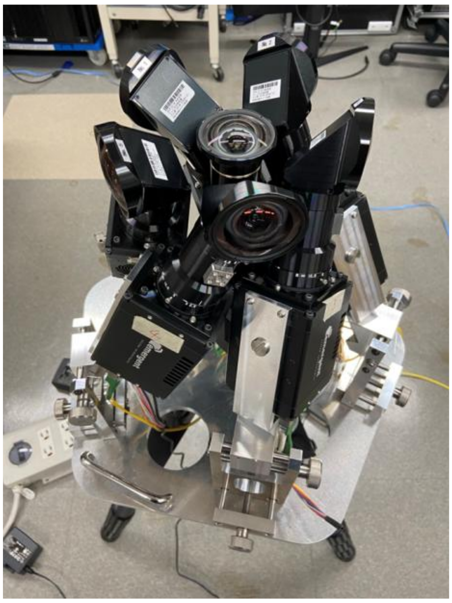


Fig. 2 30K 360-degree camera

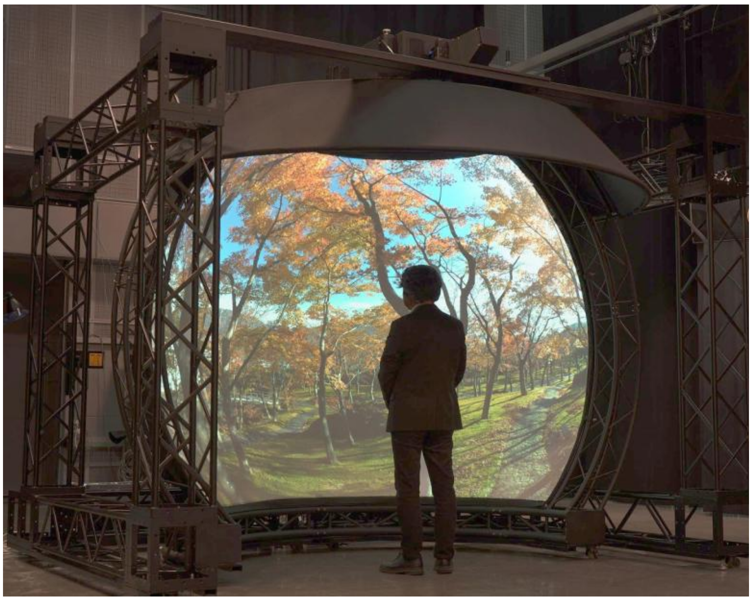


Fig. 3 Hemispherical display with 15K-equivalent projector

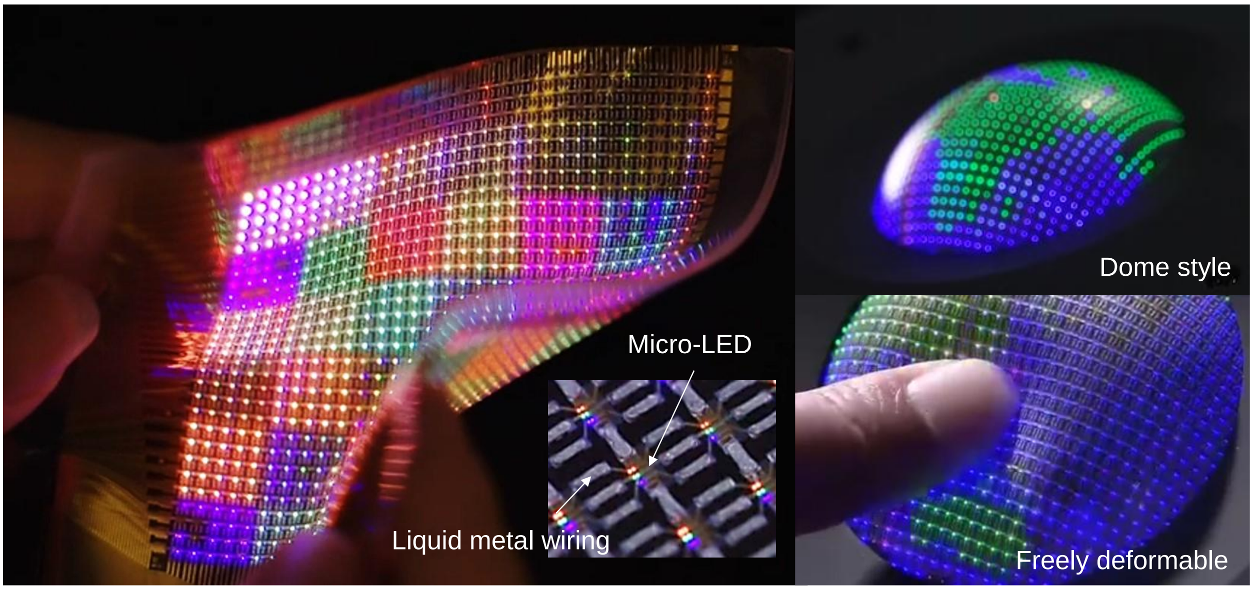
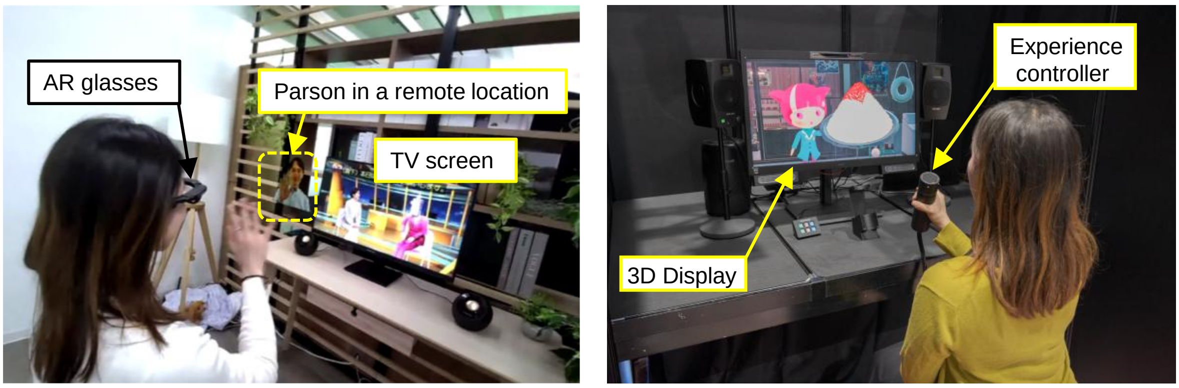


Fig. 4 Deformable display

realize highly immersive visual experiences, STRL is conducting research on cameras and displays capable of capturing and presenting omnidirectional video. A newly developed pentagonal prism-style can capture 360-degree video at a resolution of 30K (30,720 × 15,360 pixels) (Fig. 2) [2]. The camera consists of six element cameras with 9K × 7K resolution—five arranged horizontally and one facing upward—allowing high-resolution capture in all directions. To create a 360-degree video, the footage captured by each element camera is stitched together. To minimize misalignment at the stitching boundaries, the horizontal element cameras are tilted and equipped with a folded lens, which reduces the distance between adjacent cameras. The 30K 360-degree camera complies with the standard of Recommendation ITU-R BT.2123, enabling ultra-high-definition omnidirectional video capture.

The captured footage is projected onto a 3-meter diameter hemispherical screen using a projector equivalent to 15K resolution, displaying 180 degrees of the video. The projector, based on an 8K display device, achieves a 15K-equivalent resolution by diagonally shifting the image by half a pixel for each frame (Fig. 3).

Flexible displays, which are thin, lightweight, and bendable, are becoming increasingly practical, especially in smartphones. A next-generation advancement in this field is the deformable display, which is stretchable and freely shapeable, offering significant functional enhancements. Potential applications include dome-shaped omnidirectional displays for direct viewing, wearable displays that adhere to clothing or skin, and foldable displays that can be compactly stored. STRL is researching rubber-based deformable LED displays using novel liquid metal wiring technology (Fig. 4) [3, 4]. By using liquid metals that



(a) AR communication

(b) 3D content with sense of haptics and scent

Fig. 5 Experiencing content expansion

remain in a liquid state at room temperature, the wiring maintains low resistance even when stretched, preventing breakage and enabling high stretchability. The developed deformable display can operate with a strain of up to 50%, allowing it to be reshaped into dome forms or folded multiple times like a handkerchief.

At the STRL Open House 2025 [5], two interactive exhibits were presented under the theme "Expanding content experiences." One exhibit showcased future AR communication, where viewers wearing AR glasses could see others watching the same program remotely appear beside the TV screen. This created an experience of shared viewing and conversation, as if the viewers were in the same space (Fig. 5(a)) [6]. This represents a near-future media experience made possible by advanced communication technologies.

The second exhibit featured 3D content enhanced with haptics and scent. When holding a cylindrical "experience controller" in front of a 3D display, viewers could see content such as shaved ice or tea appear in front of them in sync with the program (Fig. 5(b)) [7]. By tilting the experience controller, viewers can view the 3D content from any desired angle and enjoy haptic feedback (vibrations and hot/cold sensations) as well as scents, in accordance with the program content. This exhibit illustrated a richly sensory vision of future media experiences.

4 Conclusions

The evolution of display technology is essential for realizing the future media environment. In addition to delivering realistic and immersive visual experiences, displays that can flexibly transform their shape will enable a wide range of applications tailored to different spaces and purposes, creating new added value. Furthermore, the emergence of experiential displays that incorporate tactile and olfactory sensations will deepen the sense of immersion, transforming visual experiences from simply "seeing and hearing" to "feeling." Displays are expected to evolve beyond mere image presentation devices into interfaces for communication, emotional sharing, and spatial expression. As media experiences become increasingly multifaceted, display technologies will play a central role in shaping their future. Through continued innovation in this field, STRL aims to contribute to the advancement of future media.

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