# Technical Presentations

## 2002 STRL Open House

### Advanced Data Broadcasting Service

Koichi Ishikawa (Multimedia Services)

Digital terrestrial broadcasting is scheduled to commence in the three major Japanese metropolitan areas in 2003. The broadcast system is the ISDB-T (Integrated Services Digital Broadcasting-Terrestrial) system, which is effective in fading and multi-path environments. The ISDB-T system will make possible new reception styles, such as mobile reception and reception via a small portable receiver, in addition to conventional home reception.

We devised new data services that make use of the characteristics of digital terrestrial broadcasting. The first type is location-linked data services. Here, a GPS receiving function would be built into receivers (portable or car mounted type) for mobile reception of digital terrestrial broadcasts. The characteristic of this service is that the receiver selects only the information relevant to the current position from all broadcasted information.

The second type is data services compatible with various types of receiver. It is expected that digital terrestrial broadcast receivers will come in a variety of screen sizes and support a variety of broadcast formats, such as HDTV, SDTV and LDTV. This service adapts to the specific screen layout of the receiver and enables efficient data transmission.

### Broadcast Wave Relay Technology for Digital Terrestrial Television

Syunji Nakahara (Digital Broadcasting Networks)

With the aim of enabling digital terrestrial broadcasting signal distribution over a broadcast-wave relay system, we studied the signal degradation caused by multipath and fading. To alleviate the problem, we developed a technique that applies diversity reception to either a temporal-axis equalization scheme or a frequency-axis equalization scheme, and tested experimental relay systems incorporating these schemes. The results were promising for multipath and fading environments.

This reception system has several widely separated receiving antennas and reproduces high-quality signals for retransmission by combining the received signals so as to maximize the C/N of the signal of each OFDM carrier. It can simultaneously alleviate the C/N degradation due to the lower reception level and compensate for the frequency characteristic fluctuation caused by multipath fading.

### Phased Array Antenna Technique for Advanced Broadcasting Satellite

Shoji Tanaka (Digital Satellite Broadcasting Systems)

The 21-GHz band is under consideration for use in an advanced satellite broadcasting system capable of large-capacity/multi-channel broadcasting. Transmissions in the 21-GHz band experience heavy signal attenuation caused by rainfall, resulting in low service availability. Studies were conducted on a variable beam forming technology using an onboard large phased array antenna, which can intensify radio signals exclusively in areas experiencing rainfall, to compensate for the rain attenuation. The phased array antenna radiates a nearly uniform level of power across the entire country (service area), called the "whole-area beam", while radiating a "boosted beam" of greater power to offset rain attenuation only to areas with heavy rainfall. The boosted beam can move with the heavy rainfall. We are also working on a next-generation broadcasting satellite system equipped with a large-scale phased array antenna.

We calculated the radiation pattern of a phased array-fed single reflector antenna to investigate the feasibility of the radiation pattern that can compensate for the rain attenuation.

## Development of Sound Image Control Technique Using Loud-speaker Array for 3-D Audio System

Yasushige Nakayama (Advanced Audio and Video Coding)

As a possible future broadcasting system, research is progressing on an ultra-realistic 3-D audio system, through which a viewer can enjoy at home a natural, realistic audio presentation similar to one in a concert hall. This audio system is intended to be part of a broadcasting system conveying an enhanced sense of reality to viewers, i.e., one providing the sensation of being at the location being shown in the broadcast. The 3-D audio system links a loudspeaker array system, which is capable of reproducing the perceived distance of a sound image, with a virtual reality audio system (VRAS), which can reconstruct a sound field space.

The near sound image is made by the loudspeaker array system, and the far sound image is made by VRAS with reverb. The perceived distance of sound images from the listener can be controlled, and images can be power-controlled and localized depthwise with respect to the listener. An audio signal is fed to the loudspeaker array system with appropriate time delays so that the sound waves from the loudspeakers focus at one point between the listener and the loudspeaker array. The sound pressure is very great near the focal point, and spherical equal-phase contours are synthesized from this focal point. Therefore, the sound image is perceived as being just in front of the listener.

## Ultrahigh-resolution, Wide-screen System

Masaru Kanazawa (Three-dimensional Audio-visual Systems)

4000 scanning line camera and display systems were experimentally manufactured for basic studies on broadcasting media that can convey the feeling of a three-dimensional space and of being immersed in the presentation. Both the camera and display employed four 8-million-pixel devices (CCD for camera and LCD for display), one each for red and blue, and two green devices with diagonal pixel offset. The video signals are transmitted from the camera to the display via 16 HDTV Serial Digital Interfaces (SDI). Their peripheral systems, such as frame memory, have also been studied. The huge 320 inch screen (4320×7680 pixel resolution) of the experimental systems has a viewing angle of 110 degrees, and the addition of a 3-D audio system consisting of 21 speakers (including 2 bass speakers) enhances the sensation of reality by combining ultra-realistic auditory stimuli with the visual presentation. Studies to determine the optimum number of scanning lines and other parameters of this media are planned.

## Face Recognition Technology for Video Scene Retrieval

Simon Clippingdale (Human Science)

If video data can be indexed by content, scenes that match search criteria can be rapidly retrieved from current or archived video material. Research is underway on image recognition technology for the automatic indexing of video, focusing on the faces of individuals, which carry significant meaning in many program contexts.

Variations in shooting parameters such as camera angle and lighting lead to wide variations among the images of even the same person's face between scenes and between frames from the same scene. Face recognition technology for broadcast video must therefore be able to handle substantial variation in, for example, the size, position, and angle of facial images. A prototype system has been developed that detects, tracks and recognizes faces in a flexible and integrated manner.

The system is based on deformable template matching. Images of target faces are registered in a database, and templates that capture certain features of each face image are constructed. During operation, these templates are applied to successive frames of the input video and deformed in order to achieve the best possible match. The system accumulates information about the matches achieved over multiple frames, tracking and identifying face regions as they move in the video.

The presentation described the system architecture and experimental results, with various possibilities for improving performance.

## RMP (Rights Management & Protection) System for Digital Broadcasting Based on Home Servers

Yusei Nishimoto (Recording Technology & Mechanical Engineering)

Digital broadcasting based on home servers provides various new capabilities to viewers, such as instant retrieval of their favorite programs and summaries with highlights. To promote this new type of broadcasting, studies are underway on a content protection system called RMP (Rights Management Protection), which prevents illegal copying and secondary use of digital contents. We clarified the requirements for content protection in broadcasting services based on home servers, and developed an RMP system satisfying such requirements.

The RMP that we propose is an extension of the conditional access (CA) concept. By adding a content key and RMPI (RMP Information) to every program, a broadcaster can manage and protect a stored content. The RMPI component includes the validity term of the stored contents and segment information that controls the playback method.

This RMP system is suitable for a one-to-many type of content transmission, which is a characteristic of broadcasting, enabling access control of a stored program, yet maintaining the conventional real-time viewing capability of live broadcasts.

## Development of Ultra-small, High-performance Silicon Microphone

Toshifumi Tajima (Advanced Imaging Devices)

We have fabricated the world's first condenser-type silicon microphone (IC microphone), as part of our effort to develop an ultra-small, high-performance microphone system.

This prototype microphone system was constructed with a new fabrication technique that uses single-crystal silicon, which has an extremely high tensile strength. It also required the development of a unique semiconductor process technology. The system has the following characteristics:

- Extremely small (diaphragm area : $2 \times 2$ mm$^2$)
- Excellent acoustic characteristics (wide dynamic range, high sensitivity, good frequency characteristics)
- Reliable (durability, thermal resistance / moisture resistance)
- Mass producible (lower price)
- It can be arrayed or integrated with peripheral electronic circuits

We will improve the functionality of the microphone in terms of its directivity control and noise characteristics by integrating arrayed microphones and electronic circuits. Examinations will also be made on ways to apply the system to areas other than broadcasting, such as consumer electronics.

This research is carried out in cooperation with Tohoku University.

## HDTV Three-dimensional Camera: Axi-Vision Camera

Masahiro Kawakita (Display & Optical Devices)

We have developed three-dimensional HDTV camera (Axi-vision camera) that can simultaneously acquire both an HDTV color image and a high-resolution depth image of a scene. The depth detection system consists of intensity-modulated light illuminators and a high-resolution CCD camera with an ultra-fast shutter utilizing an image intensifier (I.I). A high signal-to-noise ratio (SNR) of the depth images has been achieved by developing a new highly sensitive I.I. tube, by optimizing the optics, and by using high-power LED array illuminators. The camera can detect the depth information on more than 920,000 pixels at a frame rate of 29.97 Hz or on 410,000 pixels at a frame rate of 59.94 Hz and can output the depth image as an HDTV video signal. The HDTV Axi-vision camera is capable of selectively extracting the images of an object at a specific depth, and synthesizing them with other pictures in real time. Comparison of the depth information also enables the three-dimensional blending of camera images and computer-generated images. The basic principle and characteristics of the HDTV Axi-vision camera, as well as applications of image synthesis using depth information, were presented.