Lecture 1 (Summary)

Television, a Window to the Future
-Aiming to attain an enriched sensation of reality

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I'd like to talk about the perception of reality and presence and two closely related systems for attaining such a presentation, Super Hi-Vision (SHV) and integral three-dimensional television.

Certain feelings come over us when we look at some pictures, such as sensation of depth or openness. These are considered to be general impressions and sensations. On the other hand, as an individual, I am reminded of many personal experiences. I believe that the perception of reality and presence are related to how these "general feelings" and "personal experiences and impressions" work together to move our hearts and stir our emotions. While it is our task as engineers to identify the techniques needed to produce an opportunity to attain "general feelings," I think that such a sensation of reality, immersion, or existence are enhanced when personal actions, such as viewing TV, are linked to these.

There are two video technologies that can add to this sensation of reality. One relates to the quality of the presentation, involving many parameters such as resolution, dynamic-range, color, brightness, and movement. Researchers at STRL now consider these factors, in addition to the main aspect of resolution. Another technology broadens information spatially, that is, in the depth direction. We are studying image-reconstructive three-dimensional television to take full advantage of three-dimensional information.

The relationship between the field angle and the perceived sensation of reality was determined at the beginning of Hi-Vision system research. The current HDTV system is based on the finding that the sensation of reality increases at a field angle of approximately 30 degrees or more. At the dawn of HDTV research, we did subjective evaluations on the large-screen effect, and technological progress enabled us to fabricate a camera with 2,000 scanning lines in 1995. This marked the starting point of our SHV studies. In 2002, we completed a camera, display, and recording system and gave the first the SHV video presentation with 4,000 scanning lines. 2005 saw the very successful public exhibitions at the World Expo 2005 in Aichi and at the Kyushu National Museum. Starting in 2006, we also began overseas exhibitions, including those at NAB and IBC. Now, this year's STRL open house presents a 33-million pixel camera and a moving picture display. The full-resolution system benefits from advances on a wide range of related equipment.

I believe international collaboration is quite important, such as our exhibition together with the BBC of the UK and RAI of Italy at the IBC 2008. It not only raises the level of our technology but also is a stepping stone for international standardization.

SHV has been adopted as an international standard at ITU, and our primary goal now is to develop a set of orderly standards within the international framework. It will be exciting for us as researchers if we can hold a big event using SHV in 2025, which is the 100th anniversary of TV broadcasting. I believe that it will serve as a driving force for imaging technology.

Let me now address the other topic, three-dimensional television. STRL is working on image-reconstructive 3D imaging schemes. Priority is on the integral 3D TV due to its ability to use natural lighting. Our goal is strain-free three-dimensional television whereby a viewer can watch a program while lying down without special glasses. Although the integral 3D TV satisfies these requirements, there are still great technological hurdles to broadening the viewing field to get good three-dimensional images and capturing images of distant objects. The integral scheme employs a lens array consisting of many small lenses to capture a large number of small images. The display system reproduces a three dimensional image by directing a light beam from the opposite direction. Since an ordinary lens array will reverse the depth direction during display, a special optical system is used to correct the depth presentation. Its resolution limit is determined by the number of small lenses used in the array. The viewing field range and resolution of distant objects are also affected by the number of pixels within the individual lens element images. Increasing the number of pixels will require ultrahigh-definition imaging and display technologies.

We are advancing research on ultrahigh-definition and three-dimensional systems simultaneously so that we can use SHV technologies to make progress in integral three-dimensional television research.

Lecture 2 (Summary)

Super Hi-Vision Transmission Technologies and the Significance of WINDS Satellite Transmission Experiments

Kazuyoshi Shogen, Director, Broadcasting Systems

I will discuss the transmission technologies that will be used to deliver SHV programs to homes in the future and the significance of the satellite transmission experiments using the WINDS (Wideband InterNetworking engineering test and Demonstration Satellite) that are being conducted at this year's STRL open house. I will also touch on satellite broadcasting in the 21-GHz band.

There are several media options for SHV transmission. First is 12-GHz-band satellite broadcasting. Last year's report on the advanced satellite digital broadcasting transmission system by the Information and Communications Council indicated that

8PSK data can be transmitted at 70 Mbps with the use of a 34.5-MHz bandwidth satellite transponder, LDPC coding, and a roll-off of 0.1 instead of the current 0.35. Multi-level modulation schemes, such as 16APSK and 32APSK, will expand transmission capacity even more. I believe that either the use of APSK, or 8PSK with two transponders, will make SHV transmissions feasible. Another method is 21-GHz-band satellite broadcasting, which has a 600-MHz bandwidth from 21.4 GHz to 22.0 GHz and an approximate transmission capacity of 1 Gbps. Its wide-band transmission capability can be used to deliver multiple SHV channels to homes. One major issue is the significant rain attenuation in the 21 GHz band, and we are working to resolve it. The wide-band capacity will enable to deliver 8 to 12 SHV channels using a 45 cm receiving antenna with service ratio equivalent to that of current satellite broadcasting. The third method is terrestrial broadcasting. We are looking at 60 Mbps or more at a 6 MHz-bandwidth. The use of 6 MHz for two channels will enable SHV transmissions. As for cable TV, optical fiber, and coaxial cables, we will need to develop a re-transmission scheme for advanced satellite digital broadcasting and 21-GHz-band satellite broadcasting. Communications networks also have potential in relation to NGN and ordinary Internet.

I will now talk about the significance of the SHV satellite transmission experiment using WINDS. It was the world's first live relay broadcast of an SHV program using satellite. At this year's open house, visitors saw a live broadcast from Sapporo. It was the first time to transmit three channels of SHV programs together over satellite and the first time to use an 18-GHz-band satellite. The parameters are 8PSK modulation, a symbol rate of 250 Mbaud, a 500 Mbps transmission rate, and a 0.2 roll-off. The results of the experiment will be used to develop the 21-GHz-band satellite broadcasting service. NHK has contributed to ITU-R, and an agenda was set at WRC in 2007 for WRC2011 dealing with the 21-GHz-band broadcasting satellite frequencies, for which research is currently underway at ITU-R.

Research topics for 21-GHz-band satellite broadcasting include multiplexing, error-correction, and modulation. We will incorporate rain attenuation countermeasures in the satellite, which will use a phased array antenna to boost transmission power in areas experiencing heavy rainfall. This system is capable of providing boosted beams to areas with severe rainfall in addition to nationwide beam coverage, on the same frequency. Using boosted beams only in areas of rainfall reduces total satellite transmission power in comparison with the power consumed covering the entire country with the same beam strength. According to a simulation based on the 2000 to 2003 AMeDAS precipitation data converted into rain attenuation data, in the case of Tokyo, we found that the boosted beam gave a service ratio of 99.9%, which is equivalent to the current 12-GHz-band satellite broadcasting, and approximately 1,040 minutes of yearly recovery, compared with a 99.7% service ratio without the boosted beam. Since the feasibility of a 21-GHz-band broadcasting satellite has not yet been adequately explored, we need to conduct verification experiments using an experimental satellite.

Our test broadcasting target is sometime after 2020, and my colleagues and I are seeking your cooperation and support.