Latest Research Activities of NHK Science and Technical Research Laboratories
-From Open House 2002-

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NHK Science and Technical Research Laboratories
History of NHK STRL(1)

- Established in 1930
  - 5 years later since radio broadcasting started
  - Started with 16 researchers

- Major Research Themes
  - Television (1937-1953)
  - Color Television (1948-1964)
    - Color Video of Tokyo Olympic Game was broadcasted all over the world through relay satellite.
History of NHK STRL (2)

—HDTV (1964-2000)
  • Next generation television after color TV

—PDP (1971-1998)
  • From the beginning of HDTV research, 50’-size PDP was to be a standard display to enjoy full quality of HDTV.
  • STRL Pioneered toward the direct reception of TV signals from a satellite.
  • The key was to develop a low noise receiver and small parabola antenna as well as high power transponder on the satellite.

—Digital Broadcasting (1982-)
  • **ISDB**: Integrated Services Digital Broadcasting
  • Original ISDB scheme was proposed in 1982.
  • BS digital services (ISDB-S) was launched in Dec. 2000.
  • Digital terrestrial broadcasting (ISDB-T) be started in 2003.
  • Biggest problem in ISDB-T has been settled because Japanese government decided to invest ¥180 billion ($1.55 billion) for analog channel conversion in July 19.
Features of ISDB

• Varieties of services such as
  —Digital Hi-Vision (HDTV) as well as SDTV
  —Multi-media Data services including electronic program guide (EPG)
  —Audio specific channels

• Flexible configuration
  - ISDB-S:TMCC (Transmission and multiplexing configuration control) signal enables independence among services coexisting in one carrier.
  - ISDB-T: Independent parameter setting for each segment of BST-OFDM
Features of ISDB

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  - Digital Hi-Vision (HDTV) as well as SDTV
  - **Multi-media Data services** including electronic program guide (EPG)
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Data Services

Weather information

Anytime news

Statistics and Analysis of sports

Program related information
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### Electronic Program Guide (EPG)

| 10:00  | NHK総合  | 「参議院行財政改革・税制特別委員会 総括質疑」 |
| 10:00  | NHK総合  | 「参議院行財政改革・税制特別委員会 総括質疑」 |
| 10:00  | BS-1     | 「参議院行財政改革・税制特別委員会 総括質疑」 |
| 10:00  | BS-2     | 「参議院行財政改革・税制特別委員会 総括質疑」 |

#### ハイビジョン
- 00: ハイビジョンでここ
- 11: きょうの料理「コンビニックキング」
- 11: 美しき大河！四万
- 11: 第1章・春

#### BS-1
- 00: ワールドカップサッカー・アメリカ
- 25: 東京マーケット情報
- 30: BSニュース50
- 30: アメリカ・CNNニュース

#### BS-2
- 00: ニュース
- 20: 世界水中紀行「山のくらし・岩手県」
- 30: ジャズ・セレクション
- 45: 大ちゃん(4,3) 連続テレビ小説
Features of ISDB

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Digital Terrestrial Broadcasting (ISDB-T)

- Potable reception
- Mobile reception
- Fixed reception
Transmission example of ISDB-T

ISDB-T

Audio Program
HDTV Program

Multiplexing

Interleave

5.6 MHz

OFDM Segments

Audio Program
SDTV for Mobile Reception
SDTV for Stationary Reception

ISDB-T_{SB}

Audio Program
Audio Program
Data

Interleave

429 kHz

1.3 MHz

Wideband Receiver (Integrated Receiver)

Narrow band Receiver (Pocket-size)
3rd Generation Research Complex

• Opened in April 2002
  —14 stories high
    (office tower)
  —6 stories high
    (experiment building)

• Researches based on "Middle and long term research vision (MLRV) of STRL" are conducted.
Open House 2002

- First since the new STRL research complex was completed.
- 32 exhibits presented research results under the catch phrase "We want Happiness to Bloom. -Egg or chick? Next Generation Broadcast Technologies".
- These included technologies categorized into three groups of MLRV:
  1. Advanced ISDB
  2. Content Production Technology
  3. Next Generation broadcasting
- More than 20,000 attendance in three days (May 17, 18, 19)
Major exhibits

1. Advanced ISDB
   - Re-transmission Technologies for Digital Terrestrial Broadcasting
   - Human-friendly Receivers for People with Visual and Hearing Impairments
   - Program Request Service over Network

   Other main exhibits
   - Broadcasting Service Based in Home Servers, TV4U (The Personal, Fun Future of TV)

2. Content Production Technologies
   - Advanced Virtual Studio
   - Digital Content Copyright Protection
   - High-speed Recording on a High-density Optical Disk

   Other main exhibits
   - Video Editing Support using Image Recognition Technology, Free Viewpoint Video Reproduction System

3. Future Broadcasting Services and Fundamental Technologies
   - Ultra-high-definition, Wide-screen System with 4000 Scanning Lines
   - RGB Phosphorescent Polymer EL Materials
   - IC Microphone

   Other main exhibits
   - 3-D Audio System Conveying a High Sense of Reality, Next-generation Satellite Broadcasting System,
   - Field Emitter Array Image Sensor with HARP Target
Next Generation Data Service
Portable TV Receiver based on MPEG4

Prototype of ISDB-T Portable Receiver

Block diagram of ISDB-T Portable Receiver

Portable Antenna

OFDM Demod.

13 seg. TS (DVB-P)

PC I/F

1 seg. TS (USB)

MPEG4 AAC Decode

TS Dump

PC for MPEG4 Decode

Demodulated Audio/Video

(Radio LAN)

PDA
Mobile Reception in the future

• Recently MegaChips Corp. announced that they developed a new LSI which can decode OFDM signals based on ISDB-T spec.
• It plans to develop both full(13)-segment-type and partial(3)-segment-type LSI.
Next Generation Data Service
Location-linked Service

- By combining a ISDB-T receiver with GPS, you can get appropriate information at your receiving site.
- Example: In the area of disaster, the nearest evacuation site is shown with a map and out of the area the news of the disaster will be shown.
- Receiver filters broadcasted data using the location information from GPS.
Develop technologies for constructing stable and cost-effective relay networks so that digital terrestrial broadcasts can be delivered all over Japan.

- Coupling loop interference (CLI) cancellers can eliminate distortion when signals are relayed in a single-frequency network (SFN).
- A diversity reception system for relay stations can reproduce high-quality signals from those degraded through transmission.
Construction of SFN

Construction of Single Frequency Networks (SFN)

- Microwave Link
  - more frequency bands
- Optical Fiber
  - construction cost
- Broadcast Wave Relay System
  - low cost
  - problem: loop interference
Loop Interference

From Master Station $f_1$

Mountains etc.

Transmitting Antenna $f_1$

Receiving Antenna $f_1$

SFN Relay Station

NHK
Principle of Loop Canceller

Condition for cancelling: \( W(w) = G(w) C(w) \)
Effect of Loop Canceller

Booster output without loop canceller

Booster output with loop canceller
• For visually impaired people, we develop a terminal using tactile presentation and synthesized voice to show the contents of data broadcasts.
  - Displays menus and graphics on the screen using a two-dimensional tactile display.
  - Reads out the text in a natural quality voice.
For hearing impaired people, we developed a closed captioning system which converts news announcers speech into a transcript.

- Recognition accuracy for announcer-read speech exceeds 95%.
- Now used in News7 and News9 (major news programs in the evening)
To verify the technical possibility of broadcast on demand, experimental system is being developed which allows viewers to request and view their favourite programs via network.

- A receiver is connected to a broadband network to view programs of HDTV format in 20Mbps for home use.
- A portable receiver is also developed which utilizes low bit rate video channels such as IMT2000.
Advanced Virtual Studio
- Virtual Studio Based on Real Studio Sets -

• An advanced virtual studio where you can freely combine real studio sets with a virtual space created using computer graphics.
  - Allows real and virtual sets to be combined seamlessly without using any special blue background.
  - An **Axi-Vision camera** makes for a natural interaction between a real performance and a CG character through consideration of their relative positions.
  - Intelligent robot cameras smoothly and accurately track invisible CG virtual objects.
HDTV Axi-Vision Camera

- HDTV Axi-Vision Camera is capable of detecting depth information of an object in real-time as well as color HDTV video images. This camera can present a new image synthesis using the depth information in advanced virtual studio without blue-back screen.
In HDTV Axi-Vision Camera, depth information is detected by illuminating infrared intensity-modulated light to the object and measuring the intensity of light reflected by the object. Depth image can be represented by the black and white gray scale.
HDTV optical disk camera

Outdoor

Optical disk camera

Optical disk

Satellite

Variable rate

Broadcasting station

Archiving, reuse

Transmitting

Nonlinear editing

Compact & long archiving
Repeated reproducibility without degradation

Endless recording
Field editing

Content Production
Technologies
• With two channels using dual optical heads, we developed a system which can provide 200 Mbps high-speed recording and playback required for HDTV video recording.
• The 12 cm disk size and 2.6 GB/cm² recording density allow recording of up to 20 minutes of HDTV video.
Target Performance of HDTV Optical Disk Camera

- HDTV recording
  Bit rate: > 150 Mbps
- Recording time (120mmΦ & one side)
  > 20 min.
  Capacity: > 23 GB / side
- High reliability (shock resistant)
- Low noise
- Low power consumption
• The process of editing large volumes of video material can be made more efficient if target scenes in the video can be selected and retrieved promptly.
• With the aim of realizing such prompt retrieval of desired video scenes, we are pursuing research on a variety of technologies for data retrieval and the automatic generation and attachment of index information to each frame or cut of video material.
This face recognition technology can recognize individuals despite variations in facial angle and size.
To retrieve scenes that might be difficult to describe in words, we developed a way of searching video material for scenes that are similar in structure, pattern, and color to an image.
Ultra-high-definition, Wide-screen System with 4000 Scanning Lines
- For Future Broadcast conveying a strong sensation of reality-

- Aiming at **the extreme audio-visual system** of post HDTV
  - To realize a space surrounded by audio and video
  - To pursue basic research on psychological phenomena related to wide and large screen image such as wide view effect, motion sickness, and audio-visual multiplier effect.

- We are now at the first step of development
  - An experimental system of camera, display, and recording device was developed.

**Future Broadcasting Services and Fundamental Technologies**
Viewing Distance and Visual Angle of 4000 Scanning Line Display

<4000 scanning lines>
Get sensation of immersion

Viewing distance: 0.75 H
Visual angle: 100 degree

<HDTV>
Get sensation of presence

Viewing distance: 3H
Visual angle: 30 degree

H: screen height
• 4000 scanning line image is **outstanding**
Implementation of 4000 Scanning Line Video system by four panels

- Both camera and display has double resolution in green which is most important for resolution sensation in human visual system.

About 8000 pixels

Red

Green 1

Green 2

Blue

About 4000 pixels

About 2000 lines

About 4000 lines

About 8000 pixels
Outline of Experimental System

- Four 8 million-pixel panels for both camera and display (2 for G, 1 for both R and B)
- The devices are connected with 16 parallel HD SDIs.

**<Camera>**
- Lens
- Digital HDTV 16 channels

**<Display>**
- Two projectors
- 4m × 7m (320inch) screen
- R, B
- G, G
- 21 channels surround stereo

**<Others>**
- Recording: about 34 seconds for video
- Storage capacity: 64 Gbytes
  (=14 DVDs = 28 hours NTSC video)
Projectors:
- Light output: 5000 lumen

Screen:
- Size: 4m × 7m
- Gain: 0.85
- Scattering: ±80° (gain:1/3)
- Luminance: 50 cd/m²

**Viewing angle of screen**
- Front: app. 110° horizontally
- Back: app. 60° horizontally
External View of the Room
Problems to be solved

• Break throughs in essential technologies are required.
  - Shooting device of higher sensitivity
  - Display of large, thin and light, and foldable
  - Wide band recording and transmission
  - Sound technology which can supply presence and immersion
RGB Phosphorescent Polymer EL Materials
- Progress Made on a Self-emitting Foldable, Flexible Display -

Promoting basic research into polymer-based organic electro-luminescent (EL) materials that will give higher light-emission efficiencies and allow the achievement of flexible displays that can be folded and bent in any direction.

• Development of high-efficiency RGB light-emitting materials using a new light emission mechanism (phosphorescence) that breaks through the 5% ceiling on conventional (fluorescent) light emission efficiency.
• Ideal for flexible displays since they are made from polymer-based organic electro-luminescent (EL) materials

Phosphorescent Polymer-based EL Display

<table>
<thead>
<tr>
<th>Light emission quantum efficiency (%)</th>
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<tbody>
<tr>
<td>Conventional highest value</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>NHK's prototype value</td>
<td>2.8%</td>
<td>6.8%</td>
<td>5.4%</td>
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<tr>
<td>Limits</td>
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Obtained RGB emission efficiency compared with highest value reported so far, and efficiency limit fluorescence

Future Broadcasting Services and Fundamental Technologies
Concluding Remarks

• Broadcasting is a culturally creative activity based on the latest technology. As technology continues to advance, broadcasting will keep evolving.

• In 21st century, it is our determination to confidently meet the challenge of realizing our viewers’ dreams.
  – Seamless Service: the broadcasting service of 5A; “anytime, anywhere, any program, through any media, and for anybody.”
  – Content Production Technologies: more creative, more adaptive, and more efficient.
  – Ultrahigh reality audio-visual system: ultrahigh-definition system, 3D TV system