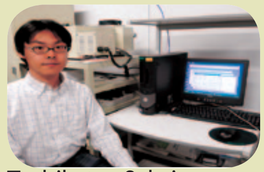
Technology to Attain High - Resolution Organic Image Sensors



Toshikatsu Sakai,
Imaging & Storage Devices Research Division

The current camera systems generate color video by using either a prism or color filters to separate incident light into blue, green, and red (light's three primary colors). Both separation methods, however, have problems. Prisms make it difficult to reduce the camera size, whereas the color filter method degrades picture quality such as the sensivity and the resolution. This tradeoff has made it difficult to make a small camera with high picture quality. The Science & Technology Research Laboratories has been developing a new organic image sensor consisting of three types of organic photoconversion films; each absorbs only one of the three primary colors and converts it into a charge while the other two are transmitted. These organic films are layered alternately with transparent circuits that read out the charges generated in the individual organic films. This sensor will eliminate the need for a prism and for color filters, and hence, it will lead to the advent of small, high-quality color cameras.

Our R&D has fabricated three prototype sensors (blue, green, and red) consisting of organic films that are each sensitive to only one of the three primary colors, with three transparent circuits. We confirmed that color imaging is feasible using an organic image sensor in which these prototype sensors are stacked (Figure 1). In the prototype sensors, however, when the optical image is focused on one of the three layers, the images formed on other layers are blurred due to 0.7-mm-thick glass substrates inserted between the organic layers.

To deal with this problem, we started work on developing a continuously stacked organic image sensor (Figure 2), in which the three types of organic films and the transparent circuits are layered alternately with a thin inter-layer insulating film in between over a single glass substrate to reduce the gaps between the three organic films to less than 1/100 mm. In this case, the inter-layer insulating films and the transparent circuit fabrication processes at a temperature lower than 150°C must be applied because organic materials are easily affected by heat. In the process of developing this sensor, we reviewed the materials and fabrication technologies to reduce the process temperature of the transparent circuit and the inter-layer insulating films, and successfully lowered the current 300°C process temperature to 150°C or less.

In the future, we will address miniaturization and high integration of the transparent circuit. Our goal is early implementation of a high-resolution continuously stacked organic image sensor.

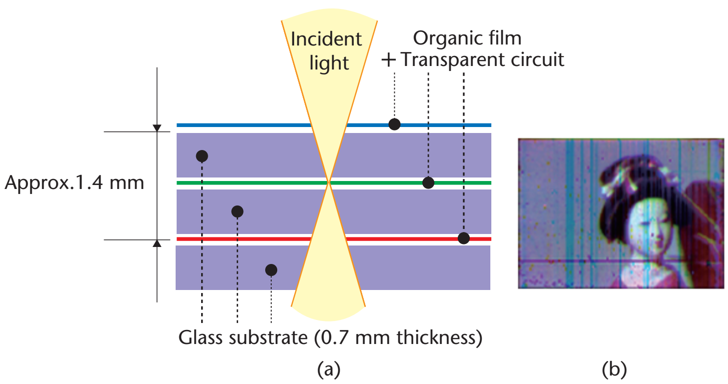


Figure 1: (a) Structure of organic image sensor for principle verification (b) Output image

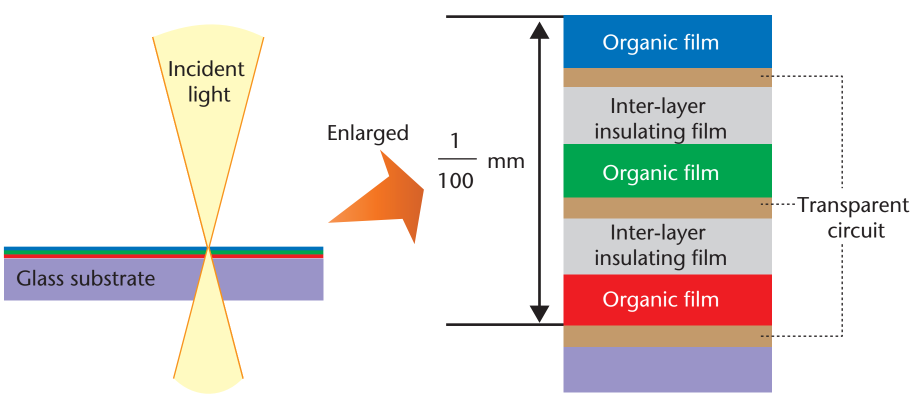


Figure 2: Structure of continuously-stacked organic image sensor

Cable Television Transmission Technology for Super Hi-Vision (SHV)

Yoshitaka Hakamada, Broadcasting Networks Research Division

We at the Science & Technology Research Laboratories are developing systems of delivering Super Hi-Vision programs to homes via cable television networks. SHV having large data quantity, with sixteen times the pixels of ordinary HD content, is unfeasible to transmit over a single cable television channel. To resolve this issue, we are researching a technology that splits an SHV signal between multiple channels so that they can be transmitted over an existing cable television systems.

Currently, cable television networks distribute HD programs on digital broadcasting by multiplexing the data into fixed-length multiplex frames*1 for a single 64QAM*2 carrier-wave transmission. The future adoption of 256QAM, which has a larger transmission capacity than 64QAM, will expand the transmission capacity of a channel. Our new transmission technology can make use of these multiple 256QAM carrier-waves in order to transmit a large-capacity SHV signal after dividing them up at the transmitter of the cable television network operator. Because 256QAM is more sensitive to noise and distortion than 64QAM, a channel in some cases may require the use of 64QAM scheme for proper transmission. To attain SHV signal transmission through efficient channel usage, we also developed a new technology that is capable of transmission in combinations of multiple 64QAM and 256QAM carrier-waves (Figure 1). This technology achieves synchronized combination of signals sent at the different transmission rates of 64QAM and 256QAM by exploying the super frame (Figure 2), with a unit consisting of multiple multiplex frames. The length of a super frame was determined on the basis of the integer ratio of the 64QAM and 256QAM transmission rates (3:4). The transmitter sends out signals divided between multiple carrier-waves using super frames. A receiver then performs combination of the data carried over these multiple carrier-waves by super frame unit for accurate SHV signal restoration.

Extended multiplex frame functions also make it possible to use variable-length packets to distribute storable content, together with SHV and multiple HD programs. We developed a cable television distribution technology that splits variable-length packets into 188-byte-length packets to efficiently multiplex them into frames with the other packets used in digital broadcasting.

Our future work will involve experiments of SHV signal transmission with these newly developed schemes at actual cable television operators' facilities.

*1 Multiplex frame: a frame used to multiplex multiple programs for transmission. A frame holds 53 slots, with each slot consisting of 188 bytes.

*2 Quadrature Amplitude Modulation (QAM): a digital modulation scheme to add information about the amplitude and phase of a carrier wave.

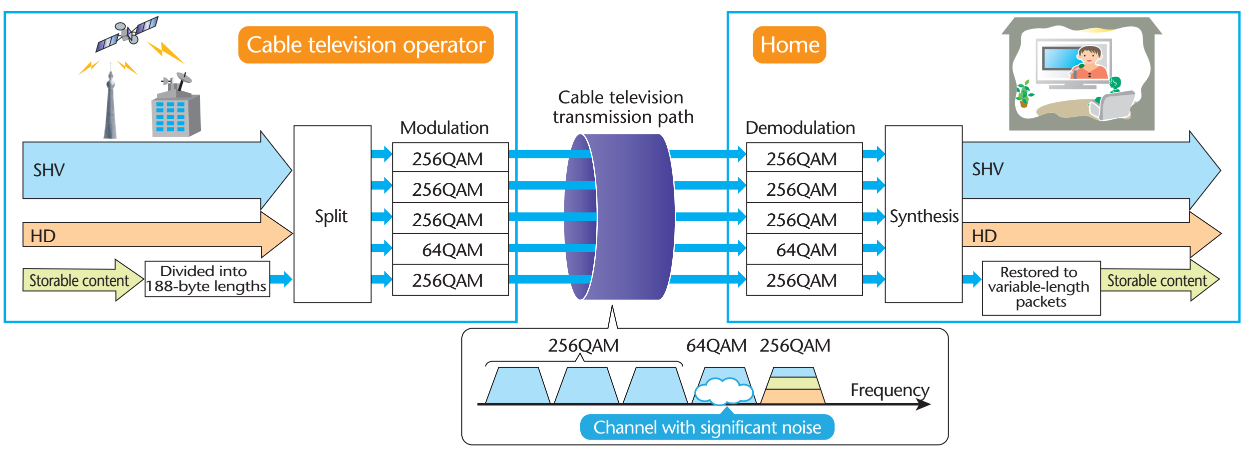


Figure 1: SHV cable television broadcasting using multiple carrier-waves

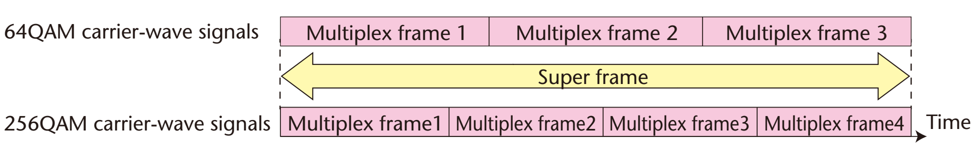
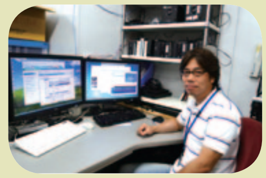


Figure 2: 64QAM and 256QAM signal synchronous combination

Great Earthquake Archives: Approach to Metadata Compensation



Hideki Sumiyoshi, Human & Information Science Research Division

The amount of video content documenting the Great Eastern Earthquake and its aftermath in March and April 2011 exceeds 20,000 hours. NHK has been commissioned to organize and archive this video for disaster prevention and damage reduction purposes and make it available for public viewing via broadcasting and the Internet. This is one of the four main goals in the current administrative plan. However, compiling a database of what each video clip contains and where it was captured from the massive amount of video footage would be an expensive and time consuming manual task. To reduce the manual labor as much as possible, STRL is developing a mechanism to efficiently generate metadata, i.e., descriptive information about video content that will be applied to STRL's video and audio analysis technology.

The use of video materials requires information describing the specific location, individual persons, incidents, and timelines included in the footage (metadata). Metadata indexing, which involves recording temporal data and video content while a video is being replayed, cannot be performed without watching all of the footage to determine the subjects in the video sequence. The actual data entry is normally done by someone who is not part of the program production crew referring to a "shooting memo" video, which includes pictures of notes on the location, time, and subject of each shoot written on paper by the production staff for clues to determine accurate details of the video content. To efficiently complete these processes, we divided the work as mechanical and manual as shown below:

- Mechanical processing: dividing video into segments and part of the subject recognition, including the "shooting memo."
- Manual processing: confirmation, correction, and semasiological indexing (i.e., indexing according to meanings and senses of words).

Our system automatically divides video into seamless recording units called shots. It then extracts a few images from each shot to find the "shooting memo," which is useful for data entry, and it determines some of the subjects such as aerial shots and facial images. It also determines human voices that can be used to recognize interview segments with facial images and voices and automatically extracts data that are likely to be used as effective metadata with the necessary extraction accuracy. After that, the automatically extracted results are manually confirmed and corrected in order to improve the accuracy of the metadata and efficiency of the semasiological data entry.

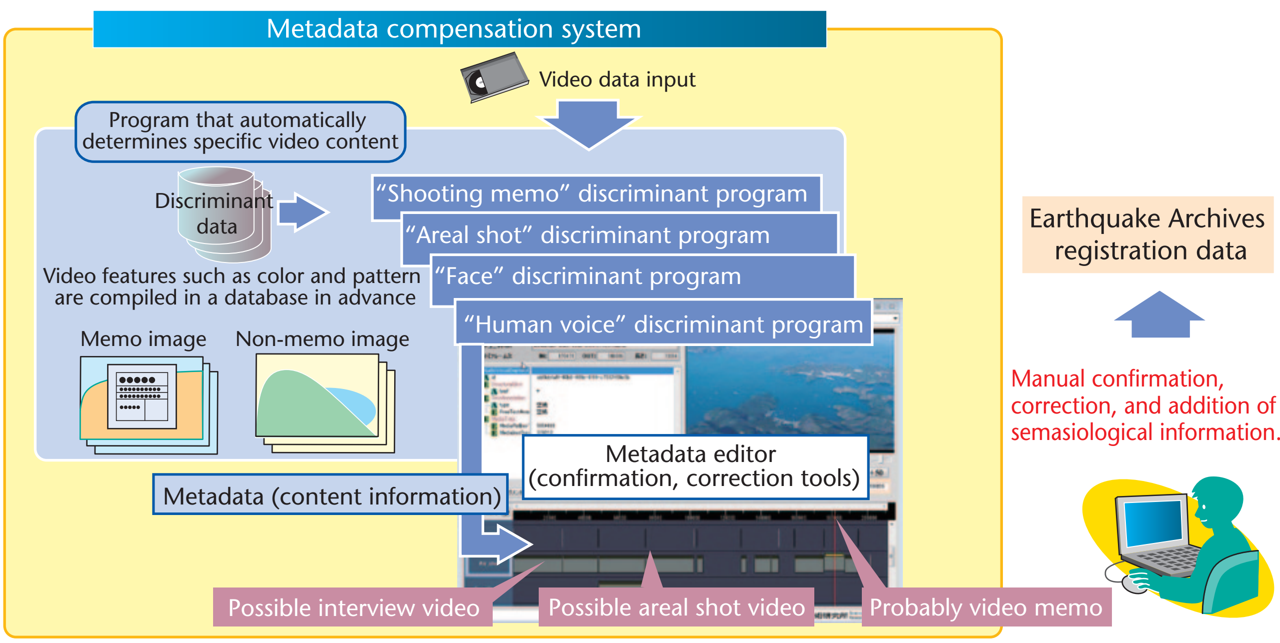
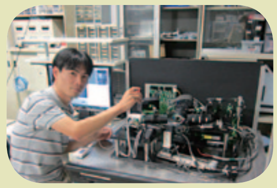


Figure: Metadata compensation system overview

Parallel Signal Processing in Holo-Memory
– For High-speed/high-capacity Recording Devices



Nobuhiro Kinoshita, Display & Functional Devices Research Division

Super Hi-Vision (SHV) contains a massive amount of video signal information, requiring a high data transfer rate and ultrahigh-capacity recording device.

Holographic memory principle and characteristics

Holographic memory exploits the phenomenon of optical interference for recording and reproduction. It records the input digital video data as a two-dimensional array of data (data page) that can be displayed on a spatial light modulator such as a small LCD panel. The crossing of a spatially modulated laser beam (signal beam) and a reference beam generates an optical interference fringe (dark-and-light distribution), which is then recorded as a refractive index distribution, or hologram (Figure 1).

To reproduce the original input data, a reference beam is irradiated onto the hologram in order to obtain diffracted light that corresponds to the interference fringe. The obtained diffracted light contains the same image as the recorded data page, and shooting it with a camera and processing its signal restores the original data.

Holographic memory collectively records and reproduces 1 Mbit of data page in a single optical irradiation, and this means it has a high data transfer rate. Its ability to overwrite several hundred holograms at the same recording medium location gives it the potential for use in a high-capacity device.

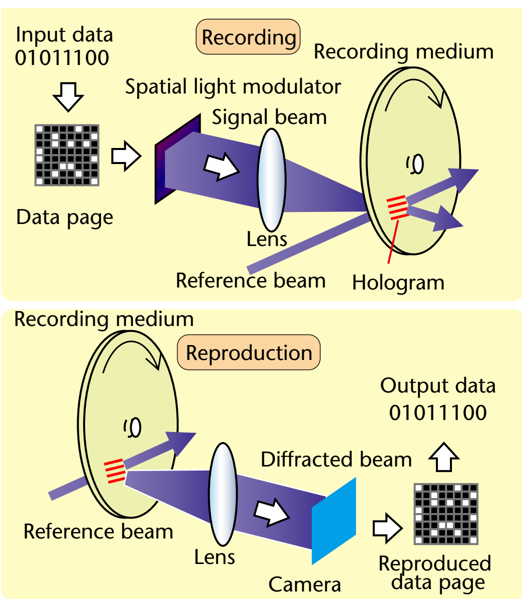


Figure 1: Holographic memory recording/reproduction principle

GPU-based parallel signal processing

We developed a parallel processing technology for restoring a signal based on a graphics processing unit (GPU) with the goal of enhancing the data transfer rate of the holographic memory.

Holographic memory differs from conventional memories, such as optical disks and magnetic disks, in that data page from the restored signal can be handled as an image. Signal processing algorithms such as data position detection and interpolation are operated in parallel, along with de-interleaving[*1] and error correction, on an image process-specific GPU. These operations are pipelined[*2] and a data transfer rate of 100 Mbps or higher can be achieved (Figure 2).

Our future work will improve the transfer rate/recording capacity with the aim of enabling the early construction of a recording device for archiving SHV.

[*1] De-interleaving: an operation to restore a permutated data array during recording (interleaving). It is used to diffuse a bit error sequence for easier error correction.

[*2] Pipeline: a technology to increase the multi-stage signal processing speed by parallel processing individual stages by accepting the next piece of data before completing the entire stage.

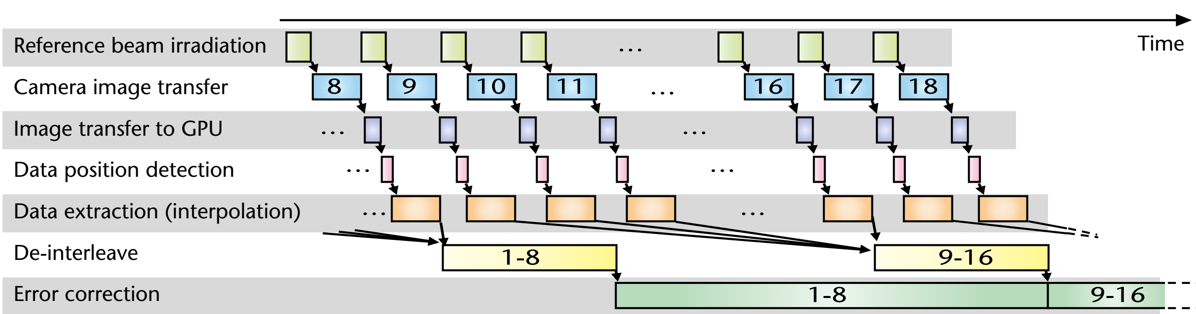


Figure 2: Pipelined parallel processing for reproduced signals (number indicates the processing order of individual data page sets)