HDTV Axi-vision Camera

- An HDTV camera capable of capturing depth information in real-time -

STRL recently constructed an HDTV Axi-vision camera that can simultaneously capture an ordinary HDTV color video image and depth information per pixel of the subject at the video frame rate.

The basic principle that allows this camera to obtain the distance to the subject is this: The camera projects an intensity-modulated near-infrared (N-IR) light on the subject; the reflected light is then used to detect the delay generated by the optical reciprocating time difference of the optical intensity variation, from which the depth can be calculated. Figure 1 shows the camera's configuration. This system projects N-IR light on the subject by using light emitting diode (LED) arrays. The N-IR light reflected from the subject is separated by a dichroic prism such that it is incident on an N-IR imaging system that includes an image intensifier (I.I.) with a nanosecond-order shutter speed. The N-IR image of the subject is amplified by three to four orders of magnitude in the pulse driven I.I. A CCD camera then shoots the image output from the I.I., and a signal processor calculates the depth information and outputs a depth image for which the depth information has been converted to a luminance video signal. The visible light components from the subject pass through the dichroic prism, for shooting color video images with a color camera.

To upgrade the camera system for HDTV, the following three enhancements were made to achieve a high enough signal to noise ratio (SNR) for the depth image. First, improvements were made to the lens and optical component characteristics of the camera's optical system, in order to secure the quantity of light necessary for depth detection and to minimize the effect of any factors other than the target light. The optical system was designed to be zooming function compliant. Second, we enlarged the radiation range and detection depth range by increasing the quantity of light to twice that of the conventional NTSC system, by reducing the size of the optical system and increasing the number of LED light sources surrounding the lens. Third, improvement of the I.I.'s internal structure, in addition to development of an I.I. using a new photoconductive film that can obtain a sensitivity approximately eight times that of the conventional prototype system, has led to an enhanced resolution. These changes have improved the SNR such that the system has a detection resolution of 1.7 cm (distance to the subject, 2 m), which is compliant with HDTV image presentation.

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I joined NHK in 1990 and have been with NHK STRL since 1993. I have studied liquid crystal devices and optically addressed spatial modulators. My recent research interests include a three-dimensional camera that can produce more realistic three-dimensional synthesized images by using the depth information in real time. It also makes it possible to create virtual effects without using the conventional blue back screen or camera support tasks in postproduction.

Studies implementing the camera system as a virtual studio elemental technology confirmed the following characteristics.

1. The system's capability to extract the image of the subject by using depth information will eliminate the need for the special blue background required in the ordinary chroma-key method of image composition.
2. It will create a new type of three-dimensional image composition using depth information.

One example of virtual studio image composition is the combining of an actual shot image with a computer graphic (CG) image (Figure 2 (a)), which realizes a more natural three-dimensional image expression taking fore-and-aft relationships relative to the subject into consideration, such as in the scene where CG butterflies fly around a person's arms (Figure 2 (b)). We are going to apply this system to actual program production, and we will attempt a further depth detection noise reduction to make higher accuracy image composition feasible.

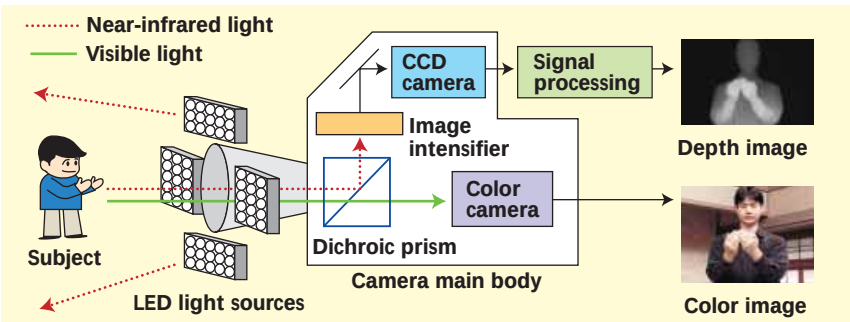

Figure 1: HDTV Axi-vision camera configuration

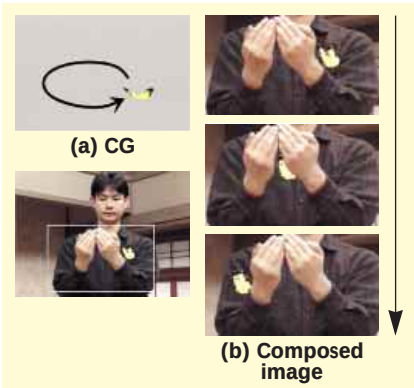

Figure 2: Images that combine a camera output image and a CG image