Development of high-definition infrared color night-vision imaging technology

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Figure 1 : Example of images of objects taken in darkness by using the newly developed infrared color night-vision camera.

Researchers at the National Institute of Advanced Industrial Science and Technology, and Toshitaka Ohta, NRI, have developed 3CCD full high-definition (HD), infrared color night-vision imaging technology.

This technology has been developed by employing an infrared imaging technique using three charge-coupled-device (CCD) image sensors and an image-processing technique. It is based on the original technology of AIST that can record color images even in dark conditions. The new technology makes it possible to record clear, high-frame-rate color videos even in darkness (Fig. 1). It is expected to be applicable to broadcast cameras used for nighttime recording, as well as to on-board vehicle cameras and security and surveillance cameras.

Details of the technology will be exhibited and demonstrated at SEMICON Japan 2012 to be held at Makuhari Messe, Chiba-shi, Chiba, from December 5 to 7, 2012.

Infrared night-vision cameras are used widely to record images in darkness, but for a long time only monochromatic images have been available. In fields where night-vision recording is indispensable (e.g. security, on-board vehicle cameras, and nocturnal wildlife observations), HD cameras are beginning to be used to collect detailed image information, but still as monochromatic images. If color images that are similar to those under visible light can be recorded by using only infrared light, then information that is qualitatively different from that currently available can be obtained and new developments in the above-mentioned and other fields can be expected.

Figure 2 : The newly developed HD infrared color night-vision camera The black rectangular block on top of the camera is the infrared projector.

AIST has been engaged in the development of highly sensitive photo-detectors and imaging techniques. Development of an image-processing

technique that allows us to reproduce colors of objects from infrared imaging is one such example. In this development, the principle of the infrared night-vision camera that can record infrared images, which are shown monochromatically so far, as images with colors similar to those observed under visible light has already been demonstrated (AIST Press Release on February 8, 2011). This technique has been enhanced, and the device that can record high-resolution infrared color videos sufficient for HD digital broadcasting has been developed.

In this unprecedented new imaging technology, objects in darkness are illuminated with infrared light, and the infrared light reflected from the objects is detected with a unique, highly sensitive infrared imaging technology. Then, by coloring the detected infrared image based on the correlations between reflective properties of objects under visible light and those under infrared light, which exist although being weak, color video recording of the objects can be obtained with colors which are equivalent or similar to the colors of the objects under visible light. Shown in Fig. 2 is the newly developed HD infrared color night-vision camera. The infrared color night-vision system is fitted inside a conventional HD color broadcast camera without changing the camera's overall size and weight. The camera functions as an ordinary HD color camera under visible light, but in darkness infrared light is projected from an infrared projector fixed to the top of the camera to record infrared images and the camera's internal image-processing system converts them into color images. To enable much finer and faster image processing, a 3CCD recording method has been developed, and the frame rate of previous infrared color night-vision image-recording, 10 frames per second, has been improved to 30 frames per second, which is a typical frame rate for television cameras. In addition, the image sensors have been upgraded from VGA class (640×480 pixels) to full HD class (1920×1080 pixels) to enable HD color image recording.

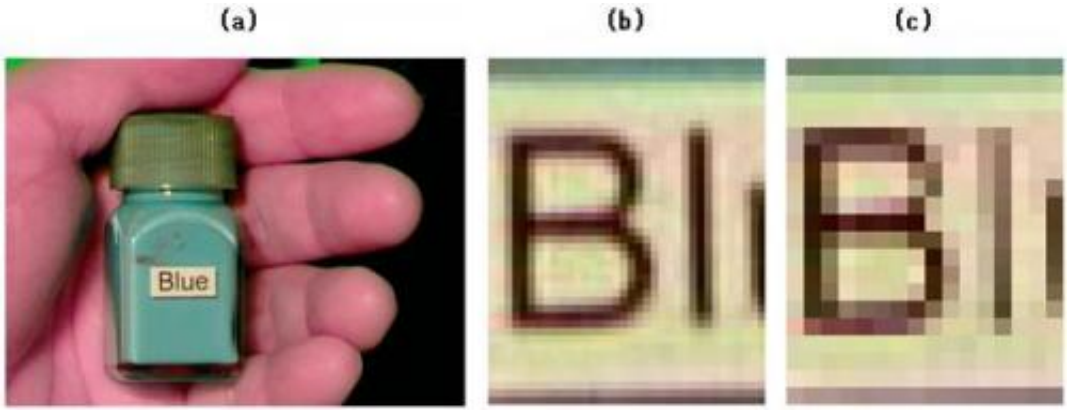

Figure 3 : (a) A portion of Fig. 1 that could be recorded by the previously developed camera. (b) Enlargement of a portion of the image in (a). (c) An image obtained by converting the image in (b) to the same resolution as with the previously developed camera.

Figure 1 is an image recorded by the newly developed HD infrared color night-vision camera in darkness by using only infrared lighting. Like the camera developed previously by AIST, the newly developed camera can reproduce colors of objects under visible light. Figure 3(a) shows a portion of Fig. 1 that could be recorded by the previously developed camera; the area recordable by the new camera is obviously much larger. Figure 3(b) is an enlargement of a portion of Fig. 3(a), and Fig. 3(c) is the same image as in Fig 3(b) but converted to the resolution of the previously developed camera. As shown, the newly developed infrared color night-vision camera can record a much finer and more detailed image.

The infrared color night-vision camera previously developed by AIST records at a frame rate of 10 frames per second; for this reason, images of fast-moving objects are sometimes blurry. In contrast, the newly developed camera records at 30 frames per second (the normal frame rate for TV broadcasting), resulting in a more natural video image.

Because the images recorded by using the new full HD infrared color night-vision imaging technology are in color, they contain much more information than monochromatic images recorded by conventional night-vision cameras. Moreover, because the frame rate is improved to 30 frames per second, it can record fast-moving objects well. For example, animal behavior can be recorded as HD color videos throughout day and night. The technology is also expected to be useful in a wide range of applications, including highly detailed security cameras that can distinguish colors, on-board vehicle cameras that give enhanced visibility, and safety cameras in medical and care fields.

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