Development of ultrahigh-sensitivity HDTV camera for deep-sea exploration

Our research on ultrahigh-sensitivity image pick-up tubes is intended for HDTV cameras that is usedfor reporting breaking news at night and producing nature and science programs. On the basis of this research, we have developed an ultrahigh-sensitivity HDTV camera for 3000-m-class deep-sea exploration, in cooperation with the Japan Marine Science and Technology Center (JAMSTEC). This camera is the first of its kind.

Deep underwater, sufficient brightness is often unobtainable, even if artificial illumination is used because the light intensity greatly decreases the deeper one goes. If a normal-sensitivity camera is used under such conditions, it will not yield an adequate depth of field since the camera would have to have a low F-number lens. Therefore, clear images cannot be produced. In contrast, the New Super-HARP image pickup tube we developed does not suffer from this problem. We employed it in the HDTV camera for deep-sea exploration. Our HARP pickup tube makes use of the "avalanche multiplication phenomenon" in its photoconductive film. The thicker the HARP film, the longer the avalanche multiplication process, which results in a higher multiplication factor. We achieved a factor of 200, which is about four times higher than that of conventional 8-μm-thick HARP film, by almost doubling the thickness to 15μm, and improved the heat resistance of the film by doping it with impurities.

Our camera for deep-sea exploration is housed in a compact housing capable of withstanding the high pressure of the deep-sea environment. This compact housing also enables us to pan and tilt the camera widely. Thus, the camera itself needs to be compact enough to fit in such a housing. As shown in Figure 1, we developed a special prism system that reduces the dimensions of the camera including the pickup tubes. The prism divides incident light into blue, green and red beams, and reflects them 180 degrees. This enables us to arrange pickup tubes in parallel in the space around the zoom lens, resulting in a compact camera.

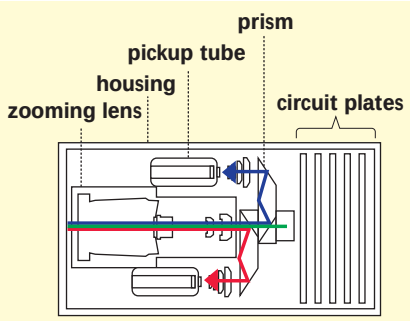

Figure 1: Special prism system

Figure 2 shows the completed camera. Its sensitivity of 2 Lux F1.8 is 30 times higher than that of an HDTV CCD camera, and it measures just 19 cm in diameter and 45 cm in length, including the zoom lens.

On November 15 and 16, the world's first HDTV live relay broadcast from the deep sea was conducted from the seabed at a 1200-m depth off the coast of Hatsushima Island in Sagami Bay. We mounted the camera on JAMSTEC's 3000-m-class unmanned submersible, called "Hyper Dolphin" (Figure 3), and shot underwater scenes with it.

Figure 2: Ultrahigh-sensitivity HDTV camera for deep-sea exploration

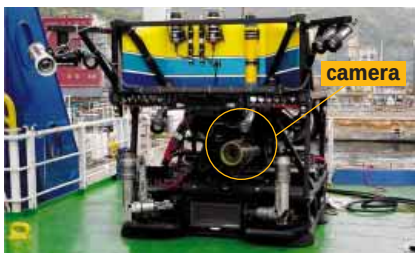

Figure 3: Hyper Dolphin


Figure 4: Relayed image (fish and rocks)

The HDTV video shot by Hyper Dolphin was sent to the control room in the mother ship via an optical cable. An NHK outside broadcasting van containing equipment to automatically track a communications satellite was loaded onto the mother ship's deck. It relayed the images from the deep-sea to the studio. The result was a broadcast of excellent HDTV images of the clams, fish, and crabs that inhabit the deep sea. As you can see in Figure 4, we obtained well-focused HDTV images, even of nooks and corners, by using the camera's high F-number lens and its ultrahigh sensitivity.

* This camera belongs to JAMSTEC.