

## “Imaging”

# Camera Used for High-definition Broadcasting of Islamic Pilgrimages in Saudi Arabia to Countries Around the World

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*OVERVIEW: The adoption of high definition digital technology for terrestrial broadcasting has now spread from the major countries of South-east Asia to the Middle East and Africa also, and use of high definition digital equipment at TV stations is growing. Hitachi Kokusai Electric Inc. has an extensive track record of supplying equipment to countries around the world and is contributing to the advance of television broadcast technology in emerging economies by supplying its high-end production-quality SK-32B high definition camera and other products. The SK-32B has also been adopted by the Broadcasting Service of the Kingdom of Saudi Arabia which uses 32 of the cameras to produce live broadcasts of the pilgrimages to Mecca and Medina that are the first and second most significant holy sites respectively in Islam. From December 2008, these broadcasts have been beamed around the world in high-definition video.*

## INTRODUCTION

THE Kingdom of Saudi Arabia is the location of Mecca, the birthplace of the prophet Muhammad who founded the 1.1-billion-strong religion of Islam, and of Medina, the religion’s second holy city. Adherents of Islam are obliged to face Mecca to pray five times each day and to undertake the Hajj pilgrimage to Mecca once in their lives. Each year, more than two-million Muslims visit Mecca and Medina. Since December 2008, the Broadcasting Service of the Kingdom of Saudi Arabia has been broadcasting extended coverage of the pilgrimage to countries around the world in high-definition video

(see Fig. 1).

These broadcasts are captured using the high-end production-quality SK-32B high-definition camera which is part of the SK-3200 series produced by Hitachi Kokusai Electric Inc. (see Fig. 2). In switching to high-definition from a standard definition broadcast system based on a European standard, the Saudi Arabian Ministry of Culture and Information entered into a contract with Saudi Arabian system integration company First Gulf Company (FGC) for a turn-key project covering equipment and installation. The SK-32B was selected as the production camera for the project.



*Fig. 1—Islam’s Holy City of Mecca. Each year more than two million pilgrims from around the world visit the cities of Mecca and Medina in Saudi Arabia. Images of the pilgrimage are broadcast to countries around the world in high-definition video using the high-end production-quality SK-32B high definition camera.*



*Fig. 2—High-end Production-quality SK-32B High-definition Camera. The SK-32B broadcast-standard camera is small, light, and very reliable.*

Commenting on the successful coverage of the pilgrimage, FGC's COO (chief operating officer) Mr. Walid AlMoukhtar expressed his satisfaction with the SK-32B by saying "it is a unique camera that satisfies our broadcast standards and also has the ability to withstand high temperature and dust that is essential for use in the harsh outdoor conditions of the Middle East. Thanks to this camera, not only were we able to configure our system, but the demonstration, technical support, and service organization put in place by Hitachi also allowed us to gain the trust of the Saudi Arabian government."

One large hurdle faced by this project was that installation of cameras in holy places that are forbidden to non-moslems could only be performed by Moslem technicians who have little technical experience. The method adopted to deal with this problem was first to assemble the total system in the Riyadh workshop of FGC for overall fine-tuning and testing, and then to break it down into its individual components for transport to the two installation sites. Also, a system identical to the actual system to be installed was set up at FGC headquarters so that installation instructions could be given to each site via a teleconferencing system. In this way, the installation was successfully completed within schedule.

This article gives an overview of production cameras and explains HDTV (high-definition television) systems, the SK-32B camera system supplied to the Broadcasting Service of the Kingdom of Saudi Arabia, and the concepts behind the latest cameras.

## OVERVIEW OF BROADCAST CAMERA

Hitachi has been producing production cameras for the last 50 years and has supplied systems to broadcasters in 70 countries around the world. In addition to the requirement to transmit high-quality images with accurate color reproduction and low noise, production cameras also require excellent operating characteristics to satisfy the demands of professional camera operators and video technicians who are continuously striving to capture crucial moments and stirring images. Most of the cameras used by television stations around the world are produced by one of five main producers, of which Hitachi is one, and these companies undertake ongoing technical development to ensure they can meet these demands.

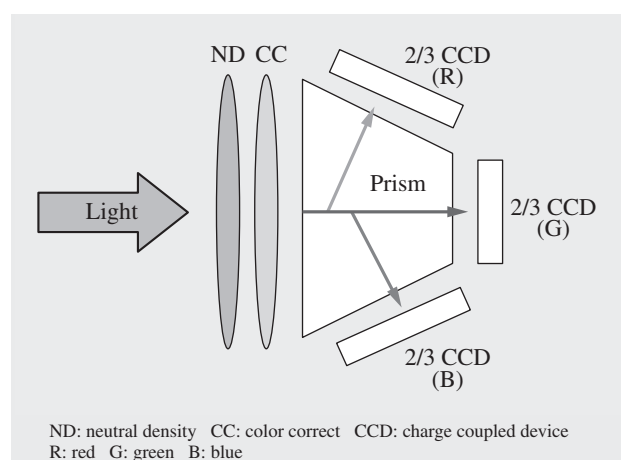
Mainstream of production cameras is the 3CCD

(charge coupled device) camera that uses a prism to split visual image into the three components corresponding to the primary colors R (red), G (green), and B (blue), and then each of these components is converted into an electrical signal by a separate CCD sensor (see Fig. 3). Two optical filters are used to ensure the image is captured with optimum quality regardless of the lens and lighting conditions. These are the ND (neutral density) filter that adjusts the brightness and the CC (color correct) filter that adjusts the color temperature. The size of the lens, CCD sensor, and other optical components on most cameras is 9.6 mm wide × 5.6 mm high which is four times the imaging area of a conventional home video camera. With the advent of digital broadcasting, the trend toward the adoption of HDTV that started in Japan is now rapidly spreading around the world and this is boosting demand for HD (high definition) cameras fitted with CCD sensors with a high pixel count that are capable of capturing high quality images.

Studio and field production cameras are typically made up of a camera head and base station connected by a power cable and hybrid fiber optical cable consisting of two single-mode optical fibers (see Fig. 4).

## HDTV SYSTEM

Influenced by past broadcast standards, most of the HDTV systems adopted around the world use either the 1080i (interlace scan) format in which the image is built up from a total of 1,080 lines that are scanned at different positions in each frame (interlaced), and the 720p (progressive scan) format in which the 720 lines per frame are scanned in order



*Fig. 3—Structure of Production Camera Optics.  
High-quality images are captured on three imaging sensors (CCDs) that comply with the full HD (high definition) standard.*

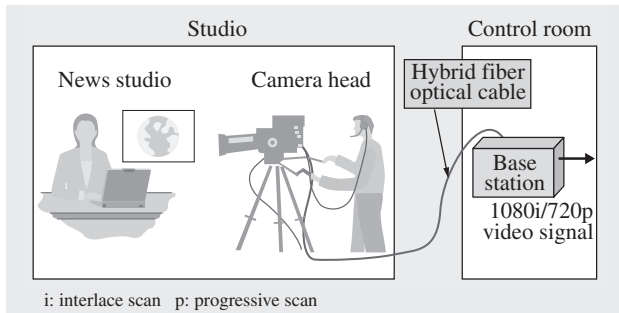


Fig. 4—Structure of Studio and Field Production Camera System.

The SK-32B cameras supplied to broadcast the Mecca pilgrimage have this structure.

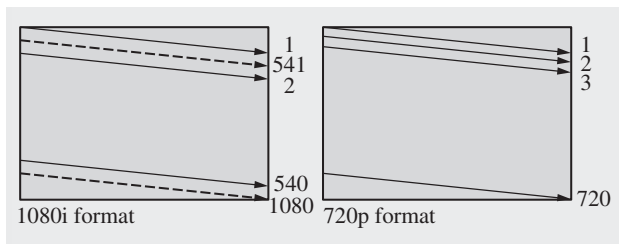


Fig. 5—HDTV System.

The main formats are 1080i in which the solid and dotted lines are scanned in turn and 720p in which the same scan pattern is used each time.

(see Fig. 5). The 1080i format is standard in Japan and the USA whereas Europe and the countries of the Near and Middle East mainly use the 720p format. While bearing in mind future plans to move to 1080p (progressive scan), the Saudi Arabian government has made a formal decision to adopt 720p as an interim step.

Hitachi production cameras are designed to be switchable between 1080i and 720p operation with a format conversion function incorporated into the base station. This means they can output both 1080i and

720p video. This concept was highly regarded by the people involved with broadcasting in Saudi Arabia and was a significant factor in their selection of the Hitachi system.

### SK-32B CAMERA SYSTEM

The SK-32B camera was developed for use in news studios and features the functions required by a production camera along with top-class image quality, a simple and compact design, and high reliability (see Table 1). The cameras used to cover the pilgrimages are mounted in a robotic pan and tilt camera housing that allows remote control of camera angle, zoom, and other settings. They are used in a harsh environment where the temperature can swing from nearly 50°C in the daytime to 0°C at night. Also, the cameras are located over a wide area that can only be entered by adherents of the Islamic faith, with camera cable lengths up to 2 km or more. As cameras at some locations are fitted with large lenses capable of a high level of magnification, the essential requirements for the cameras included high reliability, compact design, and low power consumption. Against this background, the Hitachi system was selected based on recognition of its track record at major broadcasters around the world and its ability to satisfy all requirements.

A total of 32 SK-32B cameras are used for coverage of the pilgrimages. All of the images produced by these cameras are linked via optical cable to a remote control room where they are aggregated using digital HD signal transmission. All cameras can be controlled centrally via remote control and the edited images are transmitted to countries around the world (see Fig. 6).

TABLE 1. SK-32B Specifications

The table lists key specifications of the SK-32B, including its imaging sensors and signal formats.

Parameter	Specification
Imaging sensor	2/3 type 2.2/1.0 Mpixel 3-CCD sensor
Signal format	HD format: 720p/1080i conversion function
S/N ratio, sensitivity	58 dB, F10: 2,000 lx
Dimensions and weight	118 mm (wide) × 143 mm (high) × 324 mm (deep), 2.7 kg (head unit)
Power consumption	Approximately 90 W (full system including base station)

S/N: signal-to-noise

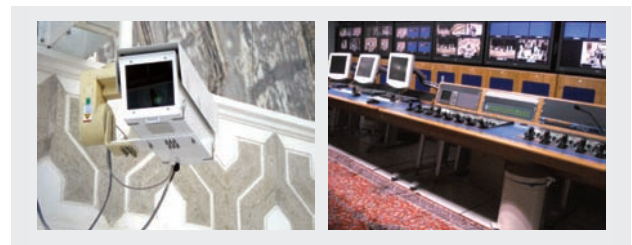


Fig. 6—SK-32B Camera Mounted in Housing, and Control Room at Broadcasting Service of the Kingdom of Saudi Arabia. The photograph on the left shows the SK-32B mounted in a robotic pan and tilt camera housing that allows remote control of camera angle, zoom, and other settings. The photograph on the right shows a control room at the Broadcasting Service of the Kingdom of Saudi Arabia.

## HITACHI PRODUCTION CAMERA SERIES

Hitachi's range of production cameras include the SK-3200 studio camera (see Fig. 7) that can be used with a large lens and the portable SK-3200P model (see Fig. 8). As portable cameras are intended to be carried or shoulder-mounted during use, opinions were gathered from camera operators at key television stations in Japan during the camera's development regarding its weight and balance to improve its ease of use. To facilitate maintenance and interchangeability, the optics, electronic circuitry, functions and performance are essentially the same for each camera, and all incorporate the functions required in production cameras including excellent ease of use and image quality. The performance and underlying concept behind the cameras are highly regarded and Hitachi cameras were also selected for studio use by the Broadcasting Service of the Kingdom of Saudi Arabia.

The DK-H32 (see Fig. 9) is a box camera and is



Fig. 7—SK-3200 Studio Camera.

The SK-3200 is a top-of-the-range camera able to be fitted with a large lens.



Fig. 8—SK-3200P Portable Camera.

Weight, balance, and other usability features are critical in a portable camera.



Fig. 9—Example Use of DK-H32 POV (point of view) Camera. Widely used for sports coverage and similar, the DK-H32 supplies dynamic images.

smaller than the SK-32B. The model is extensively used as a POV (point of view) camera in sports coverage and elsewhere. The camera earned a high reputation for excellent image quality and ease-of-use at the Winter Olympics held in Turin in February 2006 and the Asia Games held in Doha in December of the same year, and more than 70 were in use during the 2008 Summer Olympics in Beijing where they were used to supply dynamic images to countries around the world.

## NEW-CONCEPT CAMERA

The new-concept SK-HD1000 is a multi-use HDTV camera that can be used for a wide range of different applications (see Fig. 10). Although use of optical fiber cable for cameras has started to become more widespread internationally, in many regions, the double-shielded coaxial cable commonly known as triaxial cable (or triax) has been used as production camera cable for a long time. Accordingly, the cable is often laid at sports venues such as golf courses and cannot easily be changed. SK-HD1000 consists of a camera unit and a separate adapter unit that fits to its rear. In addition to an adapter for standard optical fiber cable, an adapter for triaxial cable that uses a proprietary time-division multiplexed bi-directional digital transmission system has also been developed to achieve a design that can be used in a range of different applications. Other accessories currently under development in association with other

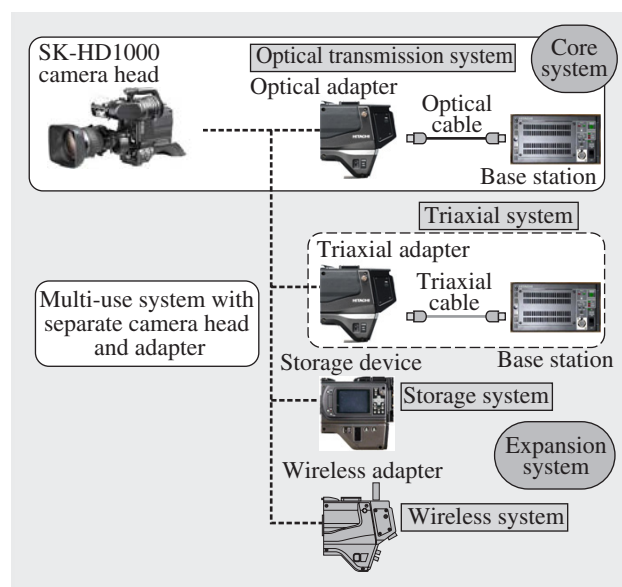
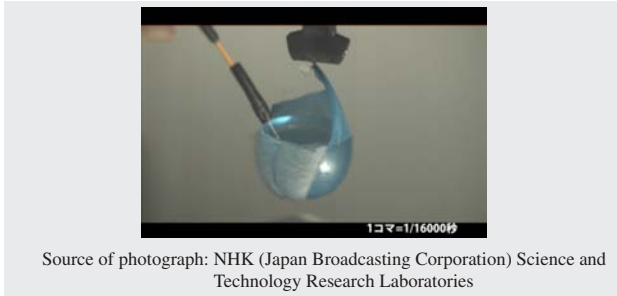


Fig. 10—SK-HD1000 New-concept Camera System.

This multi-use camera is designed for use in a range of different applications.





Source of photograph: NHK (Japan Broadcasting Corporation) Science and Technology Research Laboratories

*Fig. 11—Image Captured using Ultra-high-speed Camera. The bursting of a water-filled balloon is captured at an ultra-fast rate.*

collaborating companies include a wireless system and a dual-purpose storage adapter that supports either flash memory or HDD (hard disk drive)-based iVDR (information versatile disk for removable usage).

### FUTURE TECHNICAL DEVELOPMENTS

In order to deliver vivid and dynamic television programs and moving video that captures breathtaking phenomena to homes around the world, Hitachi has been working with the Japan Broadcasting Corporation and others to develop new technologies such as the commercialization of cameras able to operate at very high speeds of up to 1 million frames per second in order to capture images of things that are too fast for the human eye to see, and cameras with extremely high sensitivity that are able to capture vivid images even under starlight. Hitachi is also working on the development of cameras able to deliver high-definition video using the next generation of HD standards (see Fig. 11).

### CONCLUSIONS

This article has given an overview of production cameras and HDTV systems, and described the SK-32B camera system supplied to the Broadcasting Service of the Kingdom of Saudi Arabia and the concepts behind the latest cameras.

Hitachi high-definition cameras were supplied to the first two high-definition studios at the Riyadh center of the Broadcasting Service of the Kingdom of Saudi Arabia. The success of the system has also been recognized in neighboring countries and a large number of studio cameras and OB-van (outdoor broadcasting van; used for sports and other live broadcasts from outside the studio) cameras have been supplied to the Egyptian Radio and TV Union (ERTU). Numerous other sales have been made including the signing of a contract to supply the latest high-definition SK-HD1000 model cameras to the Turkish Radio and Television Corporation (TRT), a long-time user of Hitachi equipment.

Hitachi intends to continue to work actively to increase sales to countries in the Middle East and Africa by establishing service bases in the Middle East and North Africa to provide comprehensive customer support.

### REFERENCE

- (1) H. Maruyama et al., "Development of an Ultra-high Speed High-sensitivity Color Camera," 2003 Conference of The Institute of Image Information and Television Engineers, 21-10 (2003) in Japanese.

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