REPORT 1229*

RECORDING OF HIGH-DEFINITION TELEVISION PROGRAMMES ON CINEMATOGRAPHIC FILM

(Question 18/11, Study Programme 18T/11)

(1990)

1. Status of equipment

1.1 Introduction

The use of HDTV to produce films for the international exchange of television programmes and for other uses, such as direct projection in the cinema, is of increasing importance. The intrinsic high quality of the HDTV image, and the accompanying sound, allows film recordings of high quality for programme exchange. The development of the methods to perform this transfer with a low level of impairment is advancing rapidly. This equipment must include both image processing, to adapt the video signal to the film emulsion characteristics, and transformation from the HDTV scanning parameters to those of conventional 35 mm film. In particular, frame rate converters may be necessary, which require sophisticated processing. The equipment must also include high quality sound recording capability.

Two methods have been identified that offer the desired levels of image quality:

Laser beam recording

The colour film stock (positive or negative) is exposed directly by three modulated laser beams (corresponding to R,G,B) scanning the film frame. This method can operate in real-time and provides a resolution limited principally by the size of the focussed laser beams.

* This Report should be brought to the attention of the ISO, the IEC and the SMPTE.

Electron beam recording

The HDTV image is separated into the three components (R,G,B) and a separate monochrome inter-negative film is made for each component by direct exposure to a modulated and scanned electron beam in a vacuum chamber. The deflection and modulation of the electron-beam is very similar to that occurring in a CRT. Subsequently, the processed inter-negative films are synchronized and printed through appropriate colour filters onto a colour film-stock in a conventional optical printer of high stability. The process is confined to non-real-time applications, generally operating in conjunction with an incremental HDTV reproducer and a frame memory.

In all such processes, high quality images can only be achieved by careful matching of the processed video to the colour and gamma characteristics of the colour film stock.

Note. - Report 469 concerns the recording of 525/625 television on cinematographic film.

1.2 Laser beam recording

[CCIR, 1986-90a] describes a 35 mm film recording system for high-definition television which has been developed in Japan using three laser beams of red, green and blue. Since substantially high outputs can easily be obtained with sharp beams from these lasers, films of fine grain, yet low sensitivity, can be used as recording media for real-time write-in. Thus high-resolution pictures can be obtained on colour films with low granular noise and high colour saturation. To obtain high-quality in moving areas of the image, the equipment uses motion-adaptive scan conversion techniques.

Colour films for the recording can be selected from various types such as negative, inter-negative, intermediate or positive (print film), and the loss of quality in an optical printing process can thereby be minimized.

The sound is also recorded by using a laser beam with a recording system of variable-area type. The equipment has been developed for this purpose. This system, as in the case of video recordings, utilizes the high intensity of laser which enable the use of low sensitivity high resolution film. The colour print film can be used as well as the ordinary 35 mm sound negative film, and an excellent sound quality can be obtained with good frequency response and good signal-to-noise ratio. This recording system, combined with a noise reduction system, provides suitable high quality sounds, well matched to the picture of HDTV.

1.3 Electron beam recording

[CCIR,1986-90b] describes an electron-beam recording (EBR) for transfer of high-definition television pictures onto 35 mm cinematographic film which has been developed in Japan. In this method, the electron beam stimulates the emulsion of the film directly. No optical system is needed. The depth of focus of the electron beam is large enough to allow the film plane to drift for as much as 3 mm without affecting focus. In addition, as the electron beam does not penetrate into the film base, there is no problem of halation. The electron beam is easily deflected electromagnetically to form a raster, thus a sharp and precise latent image is made on the film, although the recording must be performed in a vacuum. In order to make a sound track of better quality, electron beam recording for the sound tracks has also been developed. Electron beam recording improves transient characteristics and gives an overall distortion of less than 1% at 1 kHz, and frequency characteristics of -3 dB at 25 kHz.

Another advantage of EBR for sound is that a fine grain low sensitivity film such as Fuji 71337 can be used which improves the S/N ratio. Since the electron beam does not penetrate into the film base, there is no need to use the gray base to eliminate halation.

2. Experiences of motion picture production using HDTV electronic means

[CCIR, 1986-90c] describes an experiment of motion picture production using HDTV electronic means. In fact, the encouraging results obtained by earlier experiments have induced RAI to produce in 1986 its first HD feature film. The production entitled "Julia & Julia" has used an international cast and a highly skilled technical team composed of specialists belonging both to RAI and to the Italian cinema. The movie has been distributed on a 35 mm film and on magnetic tape around all the main international circuits; its distribution on video disks is foreseen.

2.1 Tape to film transfer.

The image transfer from magnetic video tape to 35 mm. film is among the most delicate processes of the production cycle.

An EBR system as described in item 3. has been used.

2.2 Production of the electronic master

2.2.1 Shooting

The techniques and the equipment used for the shooting have been the following :

- the shooting in the studios and outdoor has been done with two cameras, two VTRs, one video mixer and other auxiliary equipment.

- the film cameras have been used when it was necessary to frame the scene from more than two angles simultaneously and to make slow motion or helicopter shots;

- since the production was destined to be projected in cinemas, a HD large screen videoprojector has been widely used (120" diagonally) in order to be able to evaluate better the quality of the pictures;

- for the outdoor shooting the equipment have been installed in a van and in a camera-car;

- for the studio shooting the chroma-key technique has been largely used to simulate outdoor scenes visible from windows.

2.2.2 Video post-production

The electronic editing has been done in two stages : off-line editing with NTSC equipment and on-line editing with HD equipment.

The reason of this choice was the cost and the lack of availability of an adequate number of HD VTR as well as the possibility to separate the moment of the artistic from the technical decisions.

The working copies for the off-line NTSC editing have been obtained by optical conversion, reproducing the original HD recordings, with a 59,94 Hz field frequency instead of 60 Hz.

A video mixer has been used in the on-line editing mainly to dissolve, and a colour corrector has been used to balance the colorimetry in some scenes.

2.2.3 Sound post-production

The audio work has been done with conventional techniques. The necessity to produce sound tracks in different standards (60 Hz, 59.94 Hz, 50 Hz, 24 photogramme/s) has engendered a considerable amount of synchronizing and dubbing work.

The final sound track has been successively recorded in dolby stereo on the video tapes belonging to the various standards and has been optically printed on the filmed copy.

2.3 The results

From a technical and a production point of view, the most important results have been the following:

a. despite the lack of experience with TV techniques, the director and the director of photography have easily learned how to use electronic means and have appreciated the advantages of being able to control in real time the artistic and technical choices.

b. the existing technology is enough to satisfy the majority of the production needs; nevertheless it would be useful to use additional equipment, such as :

- a portable VTR in order to record in particular conditions, i.e. for helicopter shots, shooting on boats, etc.

- a system which will allow to correlate the position and the movement of images in the background and foreground, in order to produce more realistic chroma-keys and more complex special effects.

c. The performances of HDTV equipments have been generally positive and adequate to the needs; nevertheless, some aspects have not been completely satisfactory, in particular the lag of camera tubes which limits the motion in dark scenes, and the low S/N ratio of the analogue VTR which does not allow to go any further than the third generation.

d. The passage from 30 frames per sec. of the electronic system to the 24 frames per sec. of the film, may lead to an uncorrect motion portrayal (judder). Since this defect is visible only after the transfer on film, a judder simulator has been used during the shooting in order to control and, if necessary, modify the camera and actor's movements in the most difficult scenes.

The problems mentioned in "c" above have already been partly overcome by a new generation of equipment, characterized by cameras with a major sensitivity (an additional 1f/stop in comparison to the former model) , and by digital component VTR with a bit-rate of 1,2 Gbit/sec. and with a multigeneration capability satisfactory even for the most complex post production. When HD CCD sensors will be available the lag problem will be solved as well.

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