Mastering and Archiving Uncompressed Digital Video Test Materials

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Abstract

This is a report on the status of a Society of Motion Picture and Television Engineers (SMPTE) Ad Hoc Group charged with creating a master set of images for subjective testing of electronic systems. The images are to be sold at cost by SMPTE for use in the evaluation of electronic systems. The first task is creation of a master representation of the image sequences to enable preservation of the images in a consistent and stable storage environment. Once the many images available to the Society are restored and returned to a pristine image state when possible, they will be provided to the SMPTE in a digital file format. The Society will then offer the video sequences for sale in various formats [both in digital data media and uncompressed digital videotape] for the purpose of subjective testing of electronic systems. This report also includes representative images from the image sequences in a set of standard definition materials, the first fruits of the Ad Hoc Group. Finally, the report is a request for feedback and suggestions on the quality of, and the interest in, this process.

1. A Strategy for Preserving High Quality Moving Images

The Ad Hoc Group (AHG) on Television Evaluation Materials has been concerned over the preservation of high quality images and the process for mastering and archiving them. It has decided on a strategy that recommends the usage of uncompressed digital representations for image masters. This approach is believed to increase the likelihood of preserving the images in an error free record.

Although the standard definition materials that have been made available to the AHG were delivered in the D-1 [1] uncompressed videotape format, the restored images will be archived in data media, such as data tape or disk. Hopefully, active management of the archive on data media should facilitate future migration to new archival storage without the cost of further restoration and without generational losses. See Zwaneveld's recent article [2]. SMPTE will continue to use D-1 and other suitable uncompressed digital video formats as a distribution format.

Because the AHG expects the materials to be used in evaluation and testing, it sought materials that are available for public demonstration. It is expected that the materials presented here will be of direct use in testing compression systems and other high quality imaging processing applications. Those requiring test materials in compressed formats are served only indirectly by this effort.

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2. Generating the Archive

Producing the SMPTE test image archive involves the collection of source materials, the selection of images for inclusion in the archive, restoration of visibly corrupted images, and transfer to the archiving data media.

2.1 Sources. The two sources for these Standard Definition Television Evaluation Materials are the "CCIR Test Tapes" documented in ITU Recommendation 802 [3] and materials contributed by Radio Televisione Italiano (RAI). All contributions are natively in D-1 format. Two CCIR Test Tapes are available, one in 525-line and the other in 625-line formats. The 625-line materials from RAI provided sports action imagery not already available in the 625-line CCIR Test Tape.

2.2 Selection of the Test Materials. Each of the two CCIR Test Tapes contains numerous 60-second video frame sequences [3]. The current materials were selected:

- to be the most heavily used of the originals,
- to represent the range of attributes in the originals, and
- to fit on a 20-minute videotape.

In some cases, it was not possible to correct visible errors in sequences which otherwise met the criteria for selection. As an example, the still image "Kiel Harbour 1" from the CCIR Test Tapes, which is similar to Figure 8-P, was found to have only one field on the tapes available to the AHG. Such materials were not included.

The AHG prepared a list of desirable attributes for subjective evaluation materials to guide the selection. Broadly, the attributes being sought included ranges of:

- resolution and detail patterns,
- image and camera motion,
- luminance variation,
- color saturation and hue,
- skin tones,
- noise,
- graphics and titles, and
- the sensation of reality and depth.

This list reflects the variety of uses to which uncompressed materials have been put, particularly for the evaluation of video compression. Future uses of the materials may have very different requirements.

Most of the video sequences are 40 seconds in length: 5 seconds of Black, 5 seconds of Title slate, and 30 seconds of active video. Some of the shorter RAI sequences are expanded with Black frames, so as to have a length that fits on 5-second boundaries.

2.3 Restoration. Some of the sequences on the available source tapes were mildly corrupted, but were still regarded as potentially useful. To improve the utility of the selected sequences, they were restored to be free from visible dropouts or other visible errors**.** This restoration was carried out using professional post-production tools. Best professional effort was used to insure the digital video Recommendation 601 [4] samples were accurately reproduced from the D-1 tapes. Videotape recorder playback was without the need to apply error concealment. Although the restored sequences differ from the sequences on the CCIR Test Tapes, the only differences apparent to a subjective viewer should be potential defects on the unrestored versions of the tape, which are missing on the restored ones. Aside from these restorations and the color space conversions required by the posting tools, no other processing or lossy compression was applied to these materials.

2.4 Archiving. The last step of this process was the creation and validation of the digital data media masters. The archival tapes were produced using Recommendation 601 format. The materials were converted to RGB and, after restoration, were recorded on digital linear tape (DLT). Also, the post-produced materials were backed up to D-1 tapes. SMPTE is currently seeking a copying service for dubbing the distribution copies. The AHG is ready to deliver masters when we know the requirements of the vendor.

2.5 Review. The Standard Definition Television Evaluation Materials were exhibited for public comment at the Fall SMPTE Technical Conference in November 1999, in New York, NY. They were balloted to the SMPTE Image Technology Committee at the Technical Conference and at the December 1999 Television Engineering Meetings in San Jose, CA. The comments that were received noted image impairments, which have since been corrected.

3. Table and Selected Frames from the Standard Definition Television Evaluation Materials

The Table summarizes the characteristics of the 525-line and 625-line materials. The descriptions of the attributes are derived from previous documentation (Rec. 802) where available. The categories in the Table are defined below.

Material identifiers: **Scene index** is a single number for video sequences #01 - #12, which are available in both 525- and 625-line formats. Clip numbers followed by "-N" are on the 525-line format tape only and those followed by "-P" are only on 625-line format tape.

Attributes of source: The selection of particular video sequences for inclusion was based on a list of desirable attributes. The **Attributes to be examined** and **Motion** are based on the original documentation of the CCIR test materials, where available, and on the review of the AHG. **Attributes to be examined** indicates those properties that may make the material useful in evaluating digital systems. The degree of **Motion** in the clip is noted.

Source of scene: In the **Source** column six identifiers are used. These terms are defined as:

Slide -	film-based material scanned, filtered, and sampled to Rec.601 resolution.
Video -	existing video clip
Component -	RGB component signals
Camera -	generated by camera
Camera/CG -	generated by camera and character generator
Camera/SE -	generated by camera with special effects

All of the 525-line materials (sequences #01 - 20) and sequences #01 - 12 of the 625-line materials are derived from ITU test tapes. For historical and archival purposes, the corresponding sequences on the ITU tapes [3] are designated as **ITU index**. Scenes numbered 13 –18 for the 625-line system were obtained from RAI and are not indexed to prior standards.

Table: SMPTE 525- and 625-line Test Pictures and Sequences Derived from "CCIR test tape" ITU-R BT.802 and "RAI test tape"

Materials identifiers		Attributes of source		Source of scene			
Scene index	Title	Attributes to be examined	Motion	Source	525-line	625-line	ITU index
01	Formal Pond	Luminance resolution	Still	Slide	x	x	1
02	Clown	Horizontal resolution	Still	Slide	x	x	3
03	Boy With Toys	Skin and color edges	Still	Slide	x	x	4
04	Young Couple	Fine detail, NTSC luma/chroma crosstalk	Still	Slide	x	x	6
05	Blackboard	Color, vertical resolution	Still	Slide	x	x	7
06	Flower Garden	Color details	Slow pan	Video	x	x	15
07	Susie	Skin tones	Slow	Video	x	x	16
08	Kiel Harbour 4	High resolution in horizontal, vertical, and temporal dimensions	Fast pan/ zoom, five cuts	Component	x	x	26
09	Balls of Wool	Moving colors	Medium	Video	x	x	27
10	Popple	Moving colors	Pan/rotate	Video	x	x	28
11	Table Tennis	Multiple rapid motions	Pan/zoom/cut	Video	x	x	29
12	Mobile and Calendar	Random motion of objects	Slow	Video	x	x	30
13-N	Birches	Luminance details, sky	Slow tilt down	Camera	x		33
14-N	Bicycles	Bicycle wheels	Complex, fast	Camera	x		35
15-N	Carnival Ride	Luminance and color details	Fast, complex	Camera	x		36
16-N	Football	Sports	Rapid motion	Camera	x		38
17-N	Cheerleaders	Fast, complex	Zoom	Camera	x		39
18-N	Diva	Cuts on titles/busy scene	Cuts	Camera/SE	x		43
19-N	Tempête	Horizontal and vertical luminance, color details	Random motion	Camera	x		44
20-N	Un Générique	Rolling and crawling titles	Crawl/roll	Camera/CG	x		50
13-P	Bicycle Race	Saturated colors, 1 cut	Rapid motion	Video		x	RAI
14-P	Kayaks 1	Water flow, bright reds, details	Moderate, water flow	Video		x	RAI
15-P	Kayaks 2	Bright reds, background detail	Moderate, water flow	Video		x	RAI
16-P	Cross CountryRace	Three cuts, detail in background	Moderate	Video		x	RAI
17-P	Arrividerci a New York	Three cuts, colors, faces, lettering	Fast	Video		x	RAI
18-P	Formula 1	Saturated colors, motion, lettering	Fast	Video		x	RAI

Selected images: The followed images are presented at quarter-resolution (half-resolution, both horizontally and vertically.) The thirty-eight (38) images are selected from each of the frame sequences described in the Table. Each frame is labeled with the corresponding title and with the scene index, which is a sequence number followed by "-N" for 525-line and "-P" for 625-line formats. There are twenty 525-line and eighteen 625-line images.

Figure 01-N. "Formal Pond"

Figure 01-P. "Formal Pond"

Figure 02- N. "Clown"

Figure 02-P. "Clown"

Figure 03-N. "Boy With Toys"

Figure 03-P. "Boy With Toys"

Figure 04-N. "Young Couple"

Figure 04-P. " Young Couple "

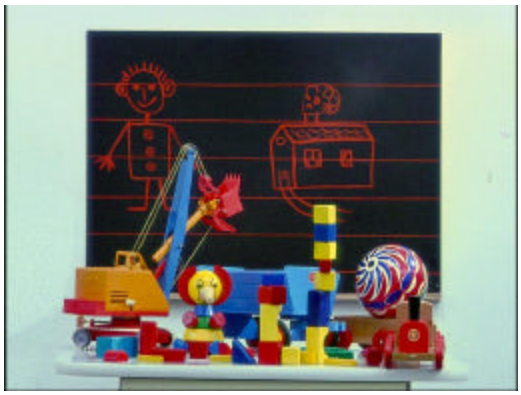

Figure 05-N. "Blackboard"

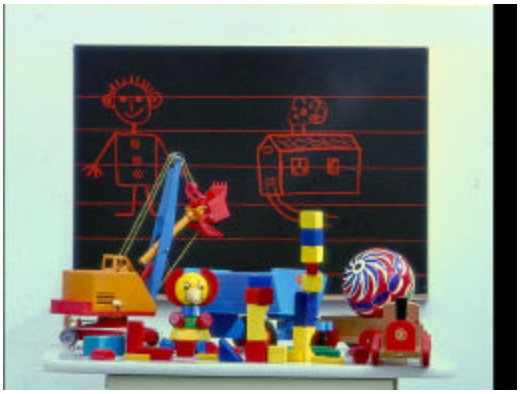

Figure 05-P. "Blackboard"

Figure 06-N. "Flower Garden"

Figure 06-P. "Flower Garden"

Figure 07-N. "Susie"

Figure 07-P. "Susie"

Figure 08-N. "Kiel Harbour 4"

Figure 08-P. "Kiel Harbour 4 "

Figure 09-N. "Balls of Wool"

Figure 09-P. "Balls of Wool"

Figure 10-N. "Popple"

Figure 10-P. " Popple"

Figure 11-N. "Table Tennis"

Figure 11-P. "Table Tennis"

Figure 12-N. "Mobile and Calendar"

Figure 12-P. "Mobile and Calendar"

Figure 13-N. "Birches"

Figure 13-P. "Bicycle Race"

Figure 14-N. "Bicycles"

Figure 14-P. "Kayaks 1"

Figure 15-N. "Carnival Ride"

Figure 15-P. "Kayaks 2"

Figure 16-N. "Football"

Figure 16-P. "Cross Country Race"

Figure 17-N. "Cheerleaders"

Figure 17-P. "Arrividerci a New York"

Figure 18-N. "Diva"

Figure 18-P. "Formula 1"

Figure 19-N. "Tempete"

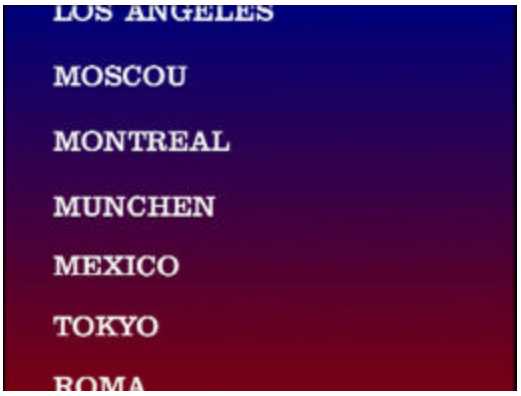

Figure 20-N. "Un Generique"

4. Conclusions and future work

Creating the master set of images for subjective evaluation is a work in progress. Based on viewing by the AHG, the standard definition images were restored to a pristine state. Images for which the best available copy was visibly impaired were replaced with an improved or lower noise restoration. The remaining step in completing the standard definition archive is to transfer the master to the working format of the copyist selected by SMPTE.

Recently it has been suggested [2] that the lack of standards for content exchange limits the useful life of digital assets. Extending the useful life and improving access to high quality images is a main motivation of this work. While it is hoped that data media will provide long-term lossless archives, the AHG has yet to consider a migration strategy for the images.

In addition to standard definition, the AHG plans to produce an archive of high definition images. In this case the requirement that the archive contain uncompressed images must be relaxed because the current offerings of source images are all subjected to moderate levels of mathematically lossy compression. Mastering the archive in data media may be possible. However, doing so on decompressed imagery requires several times more storage. It appears that the greatest challenge lies in developing the high definition image archives.

Acknowledgements

In the contribution of these standard definition materials, the Canadian Broadcasting Corporation, the European Broadcasting Union, and CBS Incorporated have provided copies of the existing ITU test tapes. RAI has provided original sports materials in the 625-line Rec. 601 format. The restoration of these

materials has relied heavily on access to the post-production facilities and staff of Level 3 Company (formerly The 4 Media Company.) Sony Corporation, Panasonic Corporation, Roland House, and Tektronix Corporation have generously contributed technical support for the selection and review of these materials by the Ad Hoc Group.

References

[1] ANSI/SMPTE 125M (1995), *Component Video Signal 4:2:2 Bit Parallel Digital Interface.*

[2] Ed H. Zwaneveld, Standards and New Technology Strategies to Preserve Content on Magnetic and Disc Media, *SMPTE Journal*, pp. 628 – 635, August 2000.

[3] ITU-R BT.802-1 (1994), *Test pictures and sequences for subjective assessments of digital codecs conveying signals produced according to Recommendation ITU-R BT.601*

[4] ITU-R BT.601-5 (1995), *Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-Screen 16:9 Aspect Ratios*