

ENHANCED 4:3 ASPECT RATIO TELEVISION SYSTEMS

(Question 42/11)

(1986-1990)

1. Introduction

Since the development of electronic television, the art has experienced a continuous evolutionary development which has produced a stream of improvements in the quality of pictures displayed to the viewer. A quantum step in quality occurred with the introduction of colour. New digital technology now offers storage, filtering and processing capabilities that will permit separate scanning standards for the picture source, emission and in the display, thereby providing increased quality through conventional television systems. New distribution media having wider bandwidth, such as broadcasting satellites, will permit new services with increased definition and wider aspect ratios.

2. Definition of terms

The term *enhanced television* designates a number of different improvements applicable to 525/60 and 625/50 television systems, providing an aspect ratio of 4:3 or wider, either with unchanged or with new emission standards.

The term enhanced television is used here to include all television systems (from source to display) not covered by Report 624 (Conventional television systems) and Report 801 (High definition television). It is noted that the signal format may change at different parts of the signal chain.

Enhanced television systems may be classified according to the following parameters:

Aspect ratio - either normal aspect ratio (4:3) or wider aspect ratio (for example, 16:9). Enhancements not involving a wider aspect ratio are described in this report. Wider aspect ratio systems are described in Report 1220.

Signal format - either composite (based on NTSC, PAL or SECAM) or component (for example, MAC systems).

It should be noted that there exists no clear definition of some of the terms widely used in the description of enhanced television systems. For example:

Compatibility: Various degrees of compatibility are possible. These range from full compatibility with existing systems, through systems that share the same scanning formats, to systems that have no direct compatibility with existing systems. The compatibility can also apply only to parts of the systems, for example, receiver compatibility.

Resolution: Enhanced television systems do not necessarily imply the provision of increased resolution; in some circumstances the resolution may be reduced as a result of other enhancements, such as provision of a wider aspect ratio.

3. Areas of possible 4:3 enhancements

Enhancements to conventional television systems are expected to be introduced in the areas listed below, all of which will contribute, in a varying degree, to improving the overall quality of the received television picture:

- alias effects generated by the scanning process;
- luminance/colour difference cross-effects;
- signal processing capability;
- generation of moiré and non-linear signal distortion in video tape recorders;
- immunity to transmission impairments;
- receiver decoding and display techniques.

4. Enhancement ———— of various signal formats

4.1 *Composite formats*

The composite signal formats NTSC, PAL and SECAM suffer from noticeable signal impairment due to cross colour and cross luminance. Significant quality improvements can be achieved by the use of multi-dimension separation filters based on line stores or frame stores. Complementary pre-filtering of the video before colour encoding can further improve picture quality.

Methods for achieving some of these improvements are discussed in the references [Khleborodov, 1971; Wendland, 1979; Clarke, 1981; Jackson and Tan, 1981; Tonge, 1981; Schönfelder, 1983].

The British Broadcasting Corporation demonstrated the use of picture stores for PAL decoding to a joint EBU/SMPTE Meeting in London in April 1980 [Clarke, 1981] and the effects of motion-adaptive luminance/chrominance separation methods at the International Broadcast Convention (IBC) in 1982 [Clarke, 1982].

The picture quality possible from the use of field stores in the receiver to process conventional PAL signals was demonstrated by Philips N.V. at the International Television Symposium at Montreux in 1983.

When appropriate filtering is applied ahead of the display, further improvements in the effective vertical resolution can be achieved by filtering at the source. The so-called Kell effect, that results from the excess Nyquist margin in the vertical sampling (scanning) of the image that must be allowed at the camera to avoid aliasing, reduces the effective vertical resolution of a television system.

Studies in the Federal Republic of Germany have shown that oversampling (double line-rate scanning) at the camera, followed by vertical filtering and aperture corrections, followed by subsampling (selecting alternate lines) for transmission, can increase the Kell factor to a number approaching unity, thus increasing the effective vertical resolution of a television system by a factor of 30-40%. When this technique is combined with display filtering (§ 6), much larger increases in vertical resolution should be possible [Wendland, 1979].

The theoretical aspects of source and display filtering are presented in [Tonge, 1981].

Work has been reported in numerous publications in the United States, Japan and in other countries on investigations to devise enhancements to the composite NTSC system. Some of these ideas are applicable to PAL and work on them is proceeding in research institutes in Europe.

In Japan an NTSC-compatible enhanced television system, known as EDTV-1, described in [CCIR, 1986-90a] has been operational since the end of August 1989. The new system includes hardware for five key techniques: Higher resolution signal sources, pre-compensation of detail in highly saturated colour pictures, adaptive emphasis of high frequency components in the luminance signal, insertion of a ghost-cancelling reference (GCR) signal for ghost

reduction in television receivers as shown in Report 478, and receivers with 525 line progressive display and three dimensional Y/C separation filters. Subjective tests using 18 still pictures showed an improvement of about 1.5 grades on the CCIR 7-point comparison scale. Ghost interference, evaluated as grade 2.5 on a 5-point impairment scale, was improved to better than grade 4 at most of the locations tested.

4.2 ——— Component formats

Further improvements in picture quality can be obtained by the use of signals in analogue component form due to the absence of luminance/chrominance cross-talk, the possible expansion of colour difference bandwidth and the elimination of artifacts caused by the high-frequency and high-amplitude sub-carrier present in composite systems.

The digital television experiments that preceded the adoption of Recommendation 601 clearly showed the advantages of handling video signals in component rather than composite form.

The use of analogue components may be viewed as either an evolutionary step towards the all-digital studio based on Recommendation 601 or as a system which in itself provides an adequate level of performance except in certain specialized areas. In both cases a high level of compatibility should exist between the digital component signals, the analogue component forms used in many portable equipments, the analogue component forms used in the studio and for satellite broadcasting, and the relevant composite signals.

When the main concern is to maintain compatibility with existing equipments and infra-structures, the work reported in [CCIR, 1982-86a, b] indicates that subject to further study a MAC 3-1-0 time compression and time-division multiplex coding is feasible with slight modifications to existing equipment, and that a MAC 4-2-0 coding is feasible with more major modifications. Experiments have shown that the pictures obtained with a MAC 3-1-0 coding are clearly superior to those obtained with SECAM coding. Existing analogue recording, distribution and switching equipment was used in the studio, and mixing options were proposed. Re-utilization of existing equipment would permit a flexible transition to digital operation.

The use of video, in component form, has many advantages for the studio compared to composite video, when critical operations such as colour matte and picture manipulation are considered. The CCIR has already defined a signal format (see Recommendation 601) and suggested an interface arrangement (see Recommendation 656) for a digital component signal and there is now a need to define equivalent signal forms and interfaces for the analogue component signal, thus allowing the benefits of components to be realized at an early date. The technology for analogue component equipment is a small extension from current designs and leads to a logical progression towards the digital component studio [Baldwin, 1983]. In Study Programme 42A/11, the essential issues are outlined. In the United States of America, SMPTE has already set up a Working Group on Analogue Component Video charged with arriving at a draft standard for studio application at an early date. There is general agreement among those active in the field, that a signal form employing time-compression and time-division multiplexing is the most attractive one.

In the case of the recorder, the benefits have already been demonstrated in both 525-line and 625-line countries, through modifications to existing recorders which show improved quality with no increase in tape consumption.

[CCIR, 1982-86c] describes the hardware implications and problem areas when recording multiplexed analogue signals derived from a family of digital standards as described in [CCIR, 1982-86b] on conventional 25.4 mm video tape recorders. It concludes that only MAC signals of the form 4-2-0 or 3-1-0 lend themselves to an economical modification of existing recorders.