HDTV, PAST AND PRESENT

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The title of this overview paper does not refer to the most important period in the development of high definition television – the future. That honor is reserved for the papers which follow; they represent the future of high definition television. This paper summarizes HDTV research during the past decade, reviews the worldwide effort to achieve a single standard for HDTV production and introduces the applications papers.

Introduction

Since the main economic impact of television is in consumer electronics and broadcasting, when the word "television" is mentioned most people think of television broadcasting. There are other uses of television. There could be many more. Many possibilities have not been exploited due to the limitations of television systems and the cost of developing alternative systems.

There is a single world-wide high definition image standard which is used in such situations – 35mm film.

Now there is an electronic equal to 35mm film – high definition television. With over 1000 scanning lines, matching horizontal resolution and a wide screen format now available in a television system, high resolution image users will find applications for HDTV previously reserved for film. While HDTV has great potential for broadcast television, many significant non-broadcast applications will be found.

Current television systems were developed primarily for broadcasting services for the public. Broadcasters used the same signal format for program production as for the final transmission. Most programs were aired live. Following the invention of the video tape recorder, the broadcasters' options increased. Broadcasters could produce programs, using VTRs, which were very difficult to produce directly on air. Today, most programs are broadcast from tape. Most prime time programs are shot on film.

Research Background

The bulk of HDTV research has been conducted by NHK, the Japan Broadcasting Corporation. Over 15 years ago NHK began a program to define the next step in television. They conducted psychophysical studies to determine optimum viewing angles, screen sizes and aspect ratio of the image. Their research was directed toward techniques which would cause the viewer to become more involved in the scene being viewed.

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Psychophysical studies completed, NHK began to define the technical parameters of a system which would meet their resulting requirements. They recognized that there were applications of a high definition television system other than broadcasting. One major area of emphasis was production.

Technical Standards - Domestic

In the past, technical standards for television have been developed by five different organizations in the United States. They are the Institute of Electrical and Electronic Engineers (IEEE), the Society of Motion Picture and Television Engineers (SMPTE), the Electronic Industries Association (EIA), the National Association of Broadcasters (NAB) and the National Cable Television Association (NCTA). The Engineering Vice-Presidents of these groups make up the Joint Committee on Inter-Society Coordination (JCIC) which monitors the standards work of each group to avoid duplication and resolve any jurisdictional disputes. Each organization has responsibility for a portion of the total standards work; no one organization has total responsibility. In 1983, the JCIC formed a new organization, the Advanced Television Systems Committee (ATSC), and designated the five organizations as Charter Members. The role of the ATSC is to coordinate and develop U. S. national technical standards for advanced television systems and propose national positions to the Department of State for their use within international standards organizations.

Technical Standards - International

One of the international bodies involved in television standards is the International Radio Consultative Committee (CCIR). This body, consisting of about 150 nations, first began studies of high definition television in 1974. It subsequently agreed that a standard for HDTV studios should be decided upon by 1986 (unfortunately, this decision was postponed) and that broadcasting standards for HDTV should be established by 1990.

A significant point, which is generally agreed upon, is that there should be only one HDTV production standard. Current television standards have two different sets of scanning parameters and three basic systems for encoding the color information. Altogether there are more than a dozen variations of these basic systems around the world. If HDTV is to serve as an electronic equivalent to 35mm film many people argue that there must be a single standard, just as there is a single standard for 35mm film.

Technical Standards - Parameters

Television engineers in the United States were aware of the HDTV research proceeding in Japan and, while visiting NHK, were often given demonstrations of progress. The SMPTE, recognizing that the technology was rapidly advancing and would soon result in products, organized the SMPTE Study Group on High Definition Television in 1977 and appointed Donald Fink as its chairman. The results of the group’s studies were published in the SMPTE Journal in early 1980.

An important point must be made. Other factors, in addition to broadcasting, must be considered in selecting a system for HDTV. Because of our desire to make the most efficient use of the spectrum, broadcasting does not have to be the highest priority in the selection process as long as the production standard can be easily converted, with high quality, into a transmission format.

What, then, are the factors that must be considered when developing a standard for HDTV? One objective is to convert a real image into an electronic signal with sufficient headroom that, following post-production, the displayed image will be equivalent to 35mm release prints. Resolution becomes one of the primary factors. The SMPTE Study Group adopted the premise that the standard of comparison is the 35mm release print as projected on a wide screen. This could be obtained, they concluded, with about 1100 scanning lines per frame. The CCIR criteria state that HDTV should have twice the vertical resolution and twice the horizontal resolution of current television systems. This would imply 1100 to 1200 scanning lines and more than five times the luminance bandwidth of current systems.

There is general agreement that the aspect ratio should be wider than the 4:3 ratio that is used in our current television systems. This aspect ratio was probably chosen to match the motion picture practice at the time of the choosing. Very few motion pictures today use such a narrow width to height ratio. Current practice is as wide as 2.35:1. The NHK research shows that a wider aspect ratio, between 5:3 and 2:1, gives viewers a much greater sense of realism.

There is widespread agreement that an HDTV system must maintain separate luminance and color difference signals. Further, the color difference signals, for post-production purposes, must have proportionately higher resolution than current systems.

One parameter which has received its share of debate is the vertical scanning frequency. Many engineers have supported 60 Hz for the field frequency, as compared to 50 Hz, because of the higher temporal sampling rate and the significantly lower flicker when images are displayed. A counter-point is that half of the television equipment in the world uses a 50 Hz vertical frequency and there may be problems introducing a change. Many engineers, even from 50 Hz regions, argue that the benefits of a single standard for HDTV production are more important.

The second parameter which has been strongly debated is the use of interlace scanning. Although interlace scanning has wide support, others have argued that sequential scanning should be used to decrease artifacts and simplify post-production. However, for a given number of scan lines, the bandwidth requirement doubles with sequential scanning. There is general agreement that the number of scan lines should not be decreased below 1000 lines. Considering the bandwidth requirements, then, sequential scanning cannot be accepted in an HDTV standard at this time.

The ATSC agreed in March, 1985 to recommend to the U.S. Department of State that the parameters listed below be proposed to the CCIR as a single world-wide standard for high definition television studios. Those parameters were:

1125 lines per frame

60 fields per second

2:1 interlace

16:9 aspect ratio

1920 luminance samples/active line

960 color difference samples/line

The U. S. CCIR National Committee unanimously agreed and the Department of State then submitted this position to the CCIR as the U.S. position. Similar positions were submitted by Canada and Japan.

The CCIR Plenary Assembly met in Dubrovnik in May, 1986 and agreed to postpone making a decision on a studio standard until the next Study Period. The Plenary Assembly unanimously agreed to attach the proposed parameters to the CCIR Report 801 making these parameters the only parameters acknowledged in Report 801.

Since the time of the CCIR Plenary Assembly, activities around the world indicate that the 1125/60 system will likely become a de facto standard for 60 Hz HDTV studios. It is not clear if this system will be accepted as a single world-wide standard.

No other system has been designed for HDTV production. A European group, part of the EUREKA program, has begun a project to design a system compatible with the 50 Hz MAC system. Their goal is to design the system within the CCIR timetable, by 1990.

Applications Papers

Technical standards are generated in several ways. The first, resulting in mandatory standards, is government regulation. Another, useful for voluntary standards, is the consensus of affected parties. The most common is practice.

While engineers and politicians are debating the HDTV technical standards others are quietly using HDTV equipment and may, in fact, be establishing HDTV standards by their practice.

Special note must be taken of the work reported in the papers which follow. Even though the organizations which sponsored the papers are concerned with the technical standards, they are proceeding with their work because they see benefits in using HDTV. It must be understood that these papers do not represent laboratory research projects but commercial ventures. In line with earlier comments about the multiple applications of HDTV, note that only one of the papers concerns a venture solely dedicated to television broadcasting.

The first paper describes a venture to produce a motion picture, titled “Julia and Julia,” for release in the cinema. Rather than use 35mm film, the producers elected to use HDTV cameras to capture the scenes on video tape and VTRs to edit the production. The master tape will be transferred to 35mm film for release to theatres for projection.

The second paper describes the work of a studio in Paris, the first commercial user and first purchaser of HDTV equipment. They use the equipment to produce commercial messages for television broadcasting and motion picture theatres. Commercial messages produced today normally use 35mm film.

The third paper describes a venture using HDTV equipment to make a program, titled “Chasing Rainbows,” for a world-wide television broadcasting market. Normally the producers would have used 16mm film. The producers want higher technical quality than they would have had with 16mm film. They expect the cost to be lower using HDTV than it would have been if they had used 35mm film.

The fourth paper describes work using HDTV equipment to produce still pictures which are then transferred to paper. Clearly this is an area where one would normally have expected 35mm stills to be used.

Each speaker and his organization should be congratulated for their boldness in undertaking their respective ventures. They are pioneers.