VIDEO DISC SYSTEM ALTERNATIVES

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EDITOR'S NOTE: Dr. Adler's paper records his summary and introduction to four other papers presented at the Videodisc session of the Spring Conference on June 8, 1976. The first of the papers was published in the August Transactions (Vol. CE-22, No. 3), and the other three are included in the current issue.

The video disc is not the first source of recorded TV signals; we have had video tape for quite a while. What makes the disc so interesting is a combination of three properties: very low cost, very high information density, and the possibility of instant access to any portion of a long recording.

The manufacturing cost of a video disc can be quite low: how low depends on the particular system --there are thin, flexible discs, thick rigid discs, discs with and without coatings, self-protecting discs and discs that require a protective package. In any case, disc cost will be strongly dependent on quantity. Like audio discs, video discs must be mass-produced to be economical. At least this applies to discs that are pressed or molded; for optical players, discs can also be made one-at-a-time by photographic recording.

The information density of a video disc is spectacular. Each TV frame occupies an area of a little less than one square millimeter. Even with recent advances in technology, video tape cannot match this.

Discs are recorded so there is one complete frame, or an integral number of frames, for each revolution of the disc. Therefore, all points on the disc located along a given radial line show up in the same location on the TV screen.

This makes it possible, with some of the proposed systems, to move the pickup radially across the record at an arbitrary speed without losing synchronization. The effect is perhaps best compared to flipping rapidly through the pages of a book. It is quite easy to run quickly through portions of a program that are of no interest, then slow down when things get interesting, and finally land exactly on the scene that we want to see. We can watch while we search, and our eyes catch just enough of each frame to tell us whether we should keep going or slow down.

It is also possible, with some of the proposed systems, to stop any frame completely by jumping back one groove 30 times a second. Thus, a half-hour disc with one frame per revolution can carry 54000 different still pictures.

The interesting possibilities just described -- search-while-watching and stop-frame -- have so far only been demonstrated with optical players, where radial motion of the focused beam across the grooves or tracks causes no mechanical damage. Thus we may say that as of today, optical players can offer more features; they are also more complicated.

In the future, the video disc could have an enormous variety of uses: Full-length entertainment of all kinds, home study, detailed information on many subjects; but also news of the week, sports, travel guides, catalogs, and more. Once most people have disc players, why would anyone print travel folders, if for much less money one can press video discs on which those faraway vacation resorts will come to life?

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Some of these proposed uses require stop-frame, and for many of them the ability to search while watching may be valuable. Just how valuable, only the experience of many users with a variety of programs can teach us. The question is quite important because some of the proposed player systems make no provision for these extra features. At this moment opinions differ, not only with respect to the importance of these features but also on the more fundamental question of what the playing time of a disc should be. There are even some who seriously doubt that the video disc in any form will become an important consumer item. I am sure we will have more definite answers to these questions at the 1986 Spring Conference.

Let me now turn to the technical alternatives.

Three systems have been widely demonstrated. They all use the TV signal to frequency-modulate a carrier and then record this modulated carrier on a continuous spiral track. Two of the systems use a stylus riding in a groove; one picks up the signal mechanically, the other detects tiny changes in capacity. The third system replaces the stylus point by a focused laser beam. This has the advantage that nothing touches the rapidly spinning disc, so there is no stylus wear or disc wear; but it has the disadvantage that the focused beam does not automatically ride in the groove like a mechanical stylus; it takes a servo system to hold it there, and usually a second one to keep it in proper focus.

The mechanical Teldec-Decca or TED system was the first to be demonstrated to the public. Its outstanding accomplishment, I believe, was the realization that the ancient method of having a needle follow the contortions of a groove is not the only mechanical method of picking up recorded information. Many of us had calculated the acceleration a stylus would experience if it were to move with an amplitude of, say, one-tenth micron at a frequency of several megahertz. Finding accelerations of several million G, we gave the matter no further thought. The people who developed TED solved the problem with their pressure pickup. Basically, the TED system is very simple: a thin, flexible disc, without any special coatings, its rotation aerodynamically stabilized, cooperates with the pressure pickup. Because bandwidth in this system is at a premium, an ingenious system of signal encoding was developed. I am sorry that the originally planned paper on recent improvements of this system will not be given.

RCA's capacitive system -- unfortunately, also not represented in this meeting -- uses tiny capacity variations to convey the signal information. The disc is coated with three films -- metallic, dielectric and lubricant. The capacity involved is that between the metallic film and a thin metal coating on the trailing edge of the stylus; this capacity decreases whenever the trailing edge glides over a pit. The information is carried by the pits in the form of spatial frequency and duty cycle. To reduce stylus wear, RCA has selected a rotational speed four times smaller than the other systems -- 450 rpm versus 1800 -- and so the spacing between adjacent pits becomes smaller than one micron. The RCA disc is about as thick as an LP record, with 30 minutes of recording on each side. With both sides coated with 3 films, it is fairly complex. It is normally stored in a rigid package to protect it from handling. Available bandwidth is larger than in the TED system, but to make the best use of the bandwidth the NTSC color subcarrier is displaced downward from its normal position. This "buried subcarrier" system gives full NTSC resolution on most pictures.

Optical systems are well represented on today's program. They provide considerable freedom of choice: it is possible to use discs that transmit light or discs that reflect it, to modulate the amplitude of the laser beam or its direction, to stabilize the disc aerodynamically or use a focus servo. These choices have repercussions on how much the discs cost and how well they are protected against handling; they also influence player costs. With so many alternatives available, different laboratories may reach different conclusions.

Papers D, E and F this afternoon deal with a particular combination which was chosen by engineers from Philips, MCA and Zenith on the basis of the following objectives:

(1) The system should have full NTSC capability, so that even graphic material (for instance small lettering) can be reproduced with the maximum resolution of which the NTSC system is capable.

(2) Flexible and rigid discs should both be useable for maximum commercial versatility.

(3) Discs should have a measure of inherent protection against handling, fingerprints and scratches, without the use of a cassette or protective envelope.

(4) The system should allow for the later introduction of discs produced by a photographic process. Such discs could be made in small quantities, perhaps even in the home.

It is perfectly possible to choose a different set of criteria, or leave out some of the objectives just stated. This is illustrated by today's paper C from the Central Research Laboratory of Thomson-CSF in France, which presents a survey of optical readout work done in that laboratory.

None of today's papers covers what may well be a very important step in optical players -- the replacement of the helium-neon laser by a semiconductor laser. A number of laboratories have experimented with this, and the structural simplification achieved appears to be remarkable. Perhaps we will have a paper on this subject next year.

BIOGRAPHY

Robert Adler was born in 1913 at Vienna, Austria. He received the Ph.D degree in physics in 1937 from the University of Vienna. The following year, he was assistant to a patent attorney in that city. From 1939 to 1940, he worked in the laboratory of Scientific Acoustics, Ltd. in London, England.

After one year with Associated Research, Inc. in Chicago, he joined the research group of Zenith Radio Corporation in Chicago in 1941; he became Zenith's Associate Director of Research in 1952 and Director of Research in 1963.

Dr. Adler has been active in two fields-- electron beam tubes and ultrasonic devices. His work in the vacuum tube field includes the phasitron modulator used in early FM transmitters, receiving tubes for FM detection and color demodulation, transverse-field traveling wave tubes, and the electron beam parametric amplifier. In the ultrasonics field, his work includes an electromechanical I.F. filter at an early date (1943) and later, the development of ultrasonic remote control devices for television receivers. In recent years he has been active in the fields of acousto-optical interaction (light deflection and light modulation), of acoustic surface waves (filters and amplifiers), and of video disc recording and playback.

Dr. Adler has been a Fellow of the IEEE since 1951 and a member of the National Academy of Engineering since 1967.