25. Cognitive Information Processing

Advanced Television Research Program

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Sponsorship

Members of the Center for Advanced Television Studies, an industry group consisting of American Broadcasting Company, Ampex Corporation, Columbia Broadcasting Systems, Harris Corporation, Home Box Office, Public Broadcasting Service, National Broadcasting Company, RCA Corporation, Tektronix, and 3M Company
William F. Schreiber

25.1 Goals

The purpose of this program is to conduct research relevant to the improvement of broadcast television systems. Some of the work is carried out in RLE and some in other parts of M.I.T., including the Media Laboratory by Prof. Andrew Lippman, Prof. Stephen Benton, and Adjunct Prof. Arun Netravali. Audience research is carried out by Prof. W.R. Neuman in the Political Science Deptartment Reporting is by means of theses and published papers.

25.2 Background

The Japan Broadcasting Company (NHK) has demonstrated a high definition television system of 1125 lines, 30 frames, 60 fields, 5:3 aspect ratio, 25 MHz bandwidth, with image quality comparable to 35 mm motion pictures. Substantial improvements in image quality over that of the existing NTSC and PAL systems have been demonstrated by laboratories in Europe, Japan, and the United States which require only signal processing and the use of special electronic components, such as frame stores, at the receiver. These systems do not require increasing the present 6 MHz bandwidth. Still other systems have been demonstrated that achieve nearly NHK

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quality by adding a second channel to the present broadcast signal. In view of all these developments and of the economic importance of the US television industry, it was deemed appropriate by the sponsors to fund a research program at an American university.

25.3 Research Activities

So far, research has concentrated on fundamentals of signal processing with emphasis on the special case where the signals are functions of two space variables and time. In addition, we have been assembling a computer simulation facility in the Media Laboratory and building an audience research facility at the Liberty Tree Mall in Danvers, Massachusetts. A small amount of work is being done on high resolution TV cameras and displays.

Topics under study at the present time include optimum and adaptive filtering in two and three dimensions, representation of motion video signals, motion defects in temporally sampled images, adaptive enhancement and restoration, and various applications of motion compensation.

Publications

Pian, Donald T., "Image Interpolation and Enhancement," M.S. Thesis, Department of Electrical Engineering and Computer Science, M.I.T., June 1985.

Hsu, Stephen C., "The Kell Factor, Past and Present," SMPTE Journal, Vol. 95, pp. 206–214, February 1986.

Display Architecture for Interactive Graphics

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Our research during the past three years has focused on the architecture of interactive graphics work stations, the user interface, the manipulation of sub-images, algorithms for shading, texture mapping, and anti-aliasing, and the raster display itself. Initially we used a raster display developed primarily for continuous tone images. While this was capable of displaying high quality images (e.g., 512 x 512 x 8-bits for red, green, and blue), the display has no graphics hardware and thus it is not well suited for interactive graphics. This past year we have acquired an IRIS 1200 display terminal and an IBM PC/XT equipped with a YODA display. The IRIS terminal is attached to a VAX 750 via both an Ethernet interface and a 19.2 Kbaud serial line. The PC/XT is also equipped with a 370 board and appropriate software so that it is possible to compile microcode for the YODA display.

We have developed novel shading algorithms suitable for realistic image synthesis on graphics work stations. Hierarchical object modeling and ray tracing techniques are combined with efficient hidden surface algorithms to produce images that approximate the quality of pictures now produced by conventional ray tracing algorithms, but at considerable reduction in computation time. These new algorithms implement rendering, reflection, and shadowing, and have been programmed to run on both a DEC VAX-11/750 with an IRIS graphics terminal, and an IBM-PC/XT with the YODA attachment. For the most part, the algorithms are device independent, and simply make use of the IRIS/YODA hardware for drawing polygons and single pixels.

We continue to investigate the problem of producing anti-aliased displays in conjunction with our investigation of shading algorithms. There has been considerable literature and increasing use of anti-aliasing in order to generate more pleasing displays for a given spatial sampling grid. This, of course, impacts architectural considerations as the size of the required image refresh memory can be reduced, thus altering the trade-offs. An interesting question concerns the trade-off between the spatial and gray scale resolution; i.e., how should available memory be allocated to optimize quality.

The issue of color adds an additional dimension to the problem. Present practice is to apply anti-aliasing algorithms separately to the red, green, and blue separations. This has the unfortunate effect of producing color fringes on anti-aliased lines. This does not appear to be optimum; however, it is not obvious what color space should be used when calculating anti-aliasing in order to maintain both a pleasing display and true colors. Another way to look at this problem is to ask what trajectory in color space should one use in performing the anti-aliasing computation.

We are also working on ways to reduce the computation time for ray traced images by developing an algorithm for time-dependent rendering of computer generated images. This algorithm is based on a hybrid scheme using an existing shading algorithm (e.g., Phong's) as an approximation to the final image. The results of coarsely spaced ray tracing will then be used to modify and thus improve the original computed approximation.

A recently completed S.M. thesis was concerned with non-linear sweep patterns for a raster display. These raster patterns reduce the frequency bandwidth of the horizontal deflection power amplifier necessary to display an image with a given resolution. Also of interest is a software implementation of an algorithm developed for determination of the digital control signals for the video timing generator.