XXV. COGNITIVE INFORMATION PROCESSING

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1. NATURAL LANGUAGE PROCESSING

Jonathan Allen

The text-to-speech system for converting unrestricted English text to synthetic speech has been made available under license, and continues to attract new industrial and academic users. Documentation for this system has been revised and extended prior to publication. Since the algorithmic basis for this system is well established, attention has been turned to implementation considerations. A custom NMOS integrated circuit is being designed to convert parametric information (updated every 5 msec) to an output speech waveform. The circuitry which previously required 150 dual-in-line TTL packages is now being instantiated on one chip. Consideration is also being given to implementation of the complete text-to-speech system on a single wafer.

As part of a new effort in speech recognition, a unique speech research facility has been constructed. Starting with an MIT Artificial Intelligence Laboratory LISP machine, a comprehensive interactive system has been built. This includes high-resolution black-and-white graphics, a large (24-bit) address space, a 300-mbyte disk, an FPS-100 array processor, A/D and D/A subsystems, and a flexible keyboard and "mouse" display pointer. The keyboard, CRT monitor, mouse, and audio I/O are placed in a soundproof room. Substantial software has been written that provides the researcher with many convenient subroutines for phonetic analysis and algorithm development. The system is viewed as a powerful "phonetician's assistant," and is central to our new research in speech recognition.

The initial emphasis in the speech recognition area is to construct the means to acquire and analyze large amounts of speech data, coupled with the study and codification of allophonic rules in speech reproduction deduced, in large part, from the study of spectrograms. As these facts are described, they are cast in new formal representations using LISP. These rules can be thought of as a set of local constraints, and current research focuses on programs that can propagate these constraints in a way that establishes connected sequences of phonetic segments. The representation of these rules must include a measure of their correctness, and both numerical and categorical means for this need have been examined and are being evaluated.

Finally, since we want our techniques to be extensible to large vocabularies and "habitable" syntax, we have studied means for lexical representation. A robust scheme is to mark strong syllables in the lexicon, and focus initial search on gross match at these "islands of reliability." Once a reduced set of lexical candidates is obtained, algorithms then focus on a (possibly new) set of cues to optimally discriminate between these and select the best match candidate. The way in which cues are selected, integrated, and utilized forms a major part of our current research activity.

2. DIGITAL WIREPHOTO SYSTEM

Associated Press (Grant)

Donald E. Troxel, William F. Schreiber, Jason Sara

Since August 1970, we have been developing a news picture (Wirephoto) distribution system that is entirely new for the Associated Press. It is being introduced in stages, in such a way that at least the present standard of quality and service will be maintained everywhere, with improvements spreading gradually to all locations.

Pictures are stored under computer control. An editor can view any picture on a TV display in order to select, discard, edit, transmit, or store that image for later automatic dispatch. Editing may include cropping, enlarging, reducing, tone-scale enhancement, sharpening, combining, and addition of captions. No additional chemical photographic work will be required for any of these picture-processing operations.

Transmission over the "backbone" system linking AP bureaus and large metropolitan newspapers that have substantial computer facilities will be via high-speed digital links and will originate and terminate generally at computer-controlled digital storage devices. Transmission to subscribers will be analog or digital and at speeds and scanning standards appropriate to the existing transmission facilities. Complete control will be exercised by the New York network monitor. In the absence of manual interventions, transmission to all points among the bureaus, from point to point, and to regional networks, will be accomplished automatically.

We have implemented some of these procedures in the laboratory, using a PDP-11 computer (300-megabyte disk). The input may be a picture from the AP network, from a local analog transmitter, or from magnetic tape, and is stored on a disk. Pictures may be transmitted from the disk to comparable receiving points. Pictures stored on the disk may be viewed on a TV display utilizing a full-frame storage system. Editing facilities already in operation include cropping, enlarging or reducing, combining several pictures into one, addition of captions, and sharpening.

The multitask software operating system permits new picture-processing routines to be integrated easily, and we plan to keep incorporating additional picture-processing routines into the system.

We are particularly interested in picture-processing operations in which the processing depends on the local content of the picture. That is, the detailed parameters of a coding or enhancement scheme vary for different local areas. In this type of processing it is of prime importance to avoid artifacts such as contours outlining these local areas. We are also accelerating our interest in color picture processing, both from the viewpoint of coding for bandwidth compression and enhancement or manipulation.

The Associated Press has now installed the computer-based image processing system in New York City. It is initially being used to coordinate the newsphoto transmissions between the domestic and international Wirephoto networks.

3. DATA PROCESSING FOR THE GRAPHIC ARTS

Providence Gravure, Inc. (Grant)

William F. Schreiber, Donald E. Troxel, Leonard Picard, Robert R. Buckley, Malik M.A. Khan, Sudhindra N. Mishra, Hapet A. Berberian, Jay N. Livingston, Armando Garcia, Yao-Ming Chao

The aim of this project is to explore the feasibility of digital processing and computer manipulation of graphic arts quality images which are intended to be duplicated on printing presses. Specific areas of investigation include data compression, tone-scale reproduction, enhancement, input/output hardware and software, and the economical storage and retrieval of very large amounts of pictorial data.

4. IMAGE PROCESSING FOR THE GRAPHIC ARTS

Taylor Publishing Company (Grant)

Donald E. Troxel, William F. Schreiber, Jason Sara

Taylor Publishing Company is developing a computer-based system for producing printing plates for yearbooks and similar publications. This type of printing is characterized by a very large number of different pages, most containing many pictures, and by small runs compared with most other publishing. Thus the cost of plate preparation is a high proportion of the total production cost. The purpose of the MIT project is the development of an improved system for the input and processing of the graphical elements — pictures and other nontypographical matter — to be included in the final pages. The improved system is to feature lower cost, higher speed, and no loss of quality through the application of interactive computer techniques.

The work to be done at MIT consists of the design of a scanner station and its operating system. Physically, the station, which itself will be a satellite of the Taylor Publishing Company's publishing system, comprises a small computer with associated peripherals. These include a picture display, full-frame memory, disk memory, tablet and Autokon scanner. The operating system will permit the station operator, sitting in front of the computer console, to perform, interactively, the following operations:

1. Receive layout instructions for each page, from the central system, including location and size of graphical elements.

2. Scan pictures into the system using parameters derived from the layout information.

3. View scanned pictures on the display and perform aesthetic corrections, if required. View entire page on display to verify layout.

4. Organize graphical data in local memory as required by page layout and initiate data transfer to the central system.

The novel features of this system revolve around the use of a small computer, in combination with a graphics arts quality laser scanner and some special-purpose

digital hardware, to permit input of graphic elements, aesthetic corrections, and the organization of data for each page according to layout information, all on an interactive basis, and in a cost-effective manner.