Computer generated closed circuit TV displays with remote terminal control

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INTRODUCTION

In a large interactive computer system, most users with remote terminals will have a primary interest in their own specific queries. These same users may also have a common interest in or requirement for general information which is being concurrently processed. While they can individually query the computer from their own terminals, this procedure can be time consuming and inefficient, particularly if the time of availability of the general information is not known in advance. The suggestion to explore the use of closed circuit TV was a natural one since a closed circuit TV system was available.

The use of closed circuit TV offered a number of advantages. A TV display is easy to use, and each monitor can be viewed by a group rather than by only a single individual. The inherent familiarity with TV made user acceptance almost automatic. There were cost advantages not only because the system was available but also because TV monitors and their maintenance are relatively inexpensive.

There were two disadvantages which initially caused some concern. The first was the read-only nature of closed circuit TV. This was overcome pragmatically by allowing TV viewers to interact with the system by telephoning any questions to the Display Control Operator who could obtain and input the replies to these queries for subsequent display and also by co-locating the TV displays with a remote interactive terminal wherever possible. The second disadvantage was the possible exclusion of remote users who did not have access to the closed circuit TV. This generated the requirement that general information, such as that displayed on the TV monitors, should be able to be directed to any, or all, remote terminals.

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The system described in this paper was developed within the constraints imposed by the equipment available for the terminals and by the characteristics of the available computer. The design was intended to satisfy an operational need, but the resulting system contains considerable generality and flexibility. In the second section, we state the design philosophy underlying the development; in the third section, the system is described; in the fourth section, the software, a display sub-program, callable from any main program, is discussed; in the fifth section, the performance of the system is briefly outlined; and in the last section, brief mention is made of possible improvements and future developments.

Subsequent to the completion of the work described in this paper, our attention was called to the work of Bond, et al., at the Carnegie-Mellon University. They describe an interactive graphic monitor program for use in a batch processing computer system with remote entry. Their system, although considerably different from our system, is nonetheless of general interest.

DESIGN PHILOSOPHY

The system was developed over a four month period to meet a specific operational need. This schedule dictated that only currently available equipment would be used, since hardware development or modification was not feasible in the time available. We wanted to display, on an available closed circuit TV system, a combination of pre-stored data, results of computations and data inserted from a remote terminal.

The system had to be simple to operate and convenient to use. A permanent record of each display was required, as well as the ability to review each display prior to placing it on the closed circuit TV. The length of time during which a display remained visual was to be under the control of the Display Control Operator who
was to have the option of aborting any display, either prior to its appearance on the TV circuit or at any time after it was displayed.

It was important that the desired information be displayed in a timely fashion and that the design of the system should not limit the number of closed circuit TV monitors. Desirable features of the system included the capability to replace only a portion of a display as well as the capability to display a fixed pattern or table with changeable data. Some form of emphasis at the option of the Display Control Operator was considered useful.

It was desired to write the handler for the displays in such a manner that any user program written in FORTRAN, COBOL or any other higher-level language, could supply results of computations, data and information for the display. Finally, it seemed desirable to write the program in a modular fashion in order to facilitate the introduction of additional features or improvements suggested by experience in actual operation.

SYSTEM DESCRIPTION

The system was developed for implementation on the Office of Emergency Preparedness' UNIVAC 1108 digital computer. The computer has four banks (262,000 words) of main high-speed core storage. The operating system used on the 1108 is EXEC 8 which has the capability of operating in real time and demand modes as well as in remote batch and local batch modes. The OEP computer system currently handles up to 15 or 20 low-speed remote terminals (e.g., teletype) in an interactive demand mode as well as a number of high-speed terminals (operating at 2400 or 4800 baud). The low-speed remote terminals are connected to the computer by voice telephone links interfaced with acoustically coupled modems and the high-speed terminals use standard data sets.

The teletype was selected as the display control terminal because it combined the advantages of low cost and ready availability, and met the requirement of providing a hard copy of each display shown on the closed circuit TV monitors. The teletype was connected to the computer in the usual way through a telephone line. Although the operator at the Display Control teletype would manage the information to be displayed, the main program, which generates the displayable material, could be initiated from any remote terminal, low speed or high speed.

The video signal necessary to drive the closed circuit TV system is tapped off the Computer Communication Inc. CC30 cathode ray tube display terminal. This terminal consists of a Sony TV set, a keyboard, a buffer memory, and associated power supplies. The CCI terminal is directly coupled to the computer through a 1600 baud line. The signal is transmitted to the TV studio where the video distribution to the closed circuit TV monitors is made.

The actual distance from the CCI terminal to the TV studio was about 75 feet, but transmission over distances of several hundred feet is feasible using RG 59/U coaxial cable. Four lines connect the CCI terminal to the studio. The first line carries the video signal, already mentioned; the second and third lines are for the vertical and horizontal drive pulses; and the fourth line, which is optional, is a standard twisted pair of wires for voice communication. With this voice circuit, the operator at the Display Control terminal can provide “live” voice narration or pre-recorded audio tape messages for any display. A diagram of the system is shown in Figure 1.

The fact that the CCI terminal contained a TV receiver as its display element, made it relatively simple to obtain the useful video signals required. The display consisted entirely of alphanumeric information. The quality of the display was very satisfactory and the picture obtained on the closed circuit TV monitors was also of very good quality. Figure 2a is a photograph of the CCI terminal equipment including a display on the cathode-ray tube, and Figure 2b is a photograph of the same display on the closed circuit TV monitor. The picture of the TV monitor screen was taken using a 4 second shutter speed. The normal TV set jitter is clearly visible, but has no effect on the legibility of the display.

Although the keyboard of the CCI terminal could have been used to introduce data into the closed circuit TV display, it was not actually used in our system since...
it would have bypassed the Display Control teletype and not have furnished the required hard copy. The last two lines on the face of the cathode-ray tube of the CCI terminal were not used for the computer generated display in order to allow for variances in the picture size on the TV monitors. Probably one line would be sufficient protection, and the other line could be used for special one-line messages.

The only significant difficulty encountered in developing this system was in achieving hardware compatibility. Some experimentation and adjustment was required to obtain proper synchronization of signals between the CCI terminal and the TV studio. The direct coupling of the CCI terminal to the 1108 computer required bypassing the normal data set interface. This was accomplished by designing a data set bypass circuit. The circuit diagram is shown in Figure 3.

A minor, but important, problem was the format of the data to be displayed. Any of the programs written for the 1108 computer can be used to provide data for display on the CCI terminal. Most of these programs are written to furnish an edited output of 120 to 132 characters per line. The line length is 72 characters on a teletype and 40 characters on the CCI terminal. For a suitable display on the TV monitors available to us, the data had to be reformatted to fit on 20 lines of 36 characters each. The number of lines and the line length will vary somewhat among closed circuit TV systems.

THE DISPLAY SUB-PROGRAM

The sub-program is written in assembler language and contains approximately 500 lines of code. The system requires that a main program, before it may call the display sub-program, initialize the data or information to be displayed. This output data is stored in a buffer containing a maximum of 720 characters, formatted in 20 lines of 36 characters each, and must be in FIELDATA computer code (octal). Since the CCI terminal requires ASCII code, the sub-program contains a FIELDATA to ASCII conversion table. The main program is any user program modified by adding an option to permit bypassing the old output instructions and substituting for them the display sub-program output instructions. Except for formatting, these output
instructions are essentially the same for all main programs. A flow diagram of the display sub-program is shown in Figure 4.

In the sub-program there are a number of external calls or functions which enable the operator to control the system and exercise the various options available within the system. The first of these calls is OPEN, which performs the initialization of the CCI terminal display and the initialization of the auxiliary teletype (aux TTY), if this feature is included. The OPEN call also establishes the entry of the system into the real time mode in the computer. The call, CLOSE, takes the system out of the real time mode and terminates the CCI terminal as well as the auxiliary teletype. Thus the CCI terminal and hence the closed-circuit TV displays operate in the real time mode. The control teletype operates in the customary demand mode.

The OUT, or output, call is the one which determines whether the information on the control teletype will be transmitted to the closed circuit TV monitors or not. If the output is requested (approved) by the Display Control Operator, then the information is displayed on the CCI terminal display, sent to the auxiliary teletype, if required, and the appropriate video signals are transmitted to the TV master control for distribution to the monitors.

The call, BLINK, provides the means to cause each new display to turn on and off for a fixed number of blinks when the display first appears. This method is used to call attention to the fact that a new set of data or information is being displayed. Blinking can also be omitted at the discretion of the operator. The TIMER call permits the automatic sequencing of a series of displays with a predetermined time delay in milliseconds between each individual display. It is also possible to retain each display on the TV screens until the next display is available, or, after a pre-set time, to remove the display and allow the screens to remain dark until the next display.

Another function, currently available, enables the operator to add information to an existing display or to remove a portion of the data on a display. This feature was developed to permit the display of tabulated data with the capability of updating data while retaining the tabular format.

The simple and modular character of the sub-program allows easy modification and straightforward addition of desired features. The approach adopted here was to retain an essential simplicity and to add only such features as experience in operational use clearly showed to be desirable.

**PERFORMANCE**

The system operates interactively permitting data or information displays to be prepared and selected for viewing on closed circuit TV as requested and is under the full control of an operator. A main program which either contains or generates the data to be displayed must be initiated and accessible to either a teletype (control TTY) or a remote batch terminal. The main program retains complete control over the operation of the system and performs all data handling and computations. Any data verification or modification must occur within the main program. The display subprogram only activates the display on command. In the operational system we developed, control is exercised with a display control teletype. This teletype could be located anywhere, and is acoustically coupled to the computer by a regular telephone. The data and control flow within the system is shown schematically in Figure 5.

The operation of the system is straightforward. A request for data from the main program is made at the display control teletype. The main program then enters the requested data, which must be a single screen or page of data, into the output buffer. At the same time, the data is transmitted to the control teletype where the data can be reviewed. At the control teletype, the operator can make a decision either to display or reject the data sent for review. A "go" decision is made by typing G and a "no-go" decision by typing X. A "go" instruction from the teletype transfers control of the data to the display sub-program which then clears out the previous display and initiates the real time mode display of the data on the CCI terminal.
Simultaneously, the video signal from the Sony TV set in the CCI terminal is transmitted to the TV studio and from there distribution is made to the TV monitors in the closed circuit TV system. Television broadcast of the data could be accomplished in a similar way.

In addition to accepting or rejecting, for display, the data from the main program, the operator at the control teletype can insert an addition to a display or originate an entire message for display. If auxiliary teletypes are permitted access to the system, the request (an OPEN call) from the control teletype (for data) also activates the auxiliary teletypes. The display sub-program then continues to poll the auxiliary teletypes for an input or request and acts on any inputs or requests received. The polling continues until a CLOSE call terminates the connection to the auxiliary teletypes. The auxiliary teletypes may request transmission of the current and subsequent displays, or request the discontinuance of the displays. They may also transmit messages for display.

The system described here was tested operationally over a 12 hour period in a dynamic situation during which information was continuously received and data values were rapidly changing. Ten TV monitors and four auxiliary teletypes were used. A fixed schedule for the display of general information was established, in this case, the first ten minutes of each hour. Each of the ten groups (one for each monitor) had a five minute time slice during which their special data requests were displayed. Interruptions to display messages were made at the discretion of the Display Control Operator. Each group had direct telephone access to either the Display Control Operator or an auxiliary teletype and could easily submit a request for data or information update. The test successfully demonstrated the capabilities of the system, satisfying the requirements of the user groups.

FUTURE DEVELOPMENTS AND IMPROVEMENTS

A number of improvements to the system have been considered and, should the need arise, would be incorporated into the system at a future date. Among the more significant new developments are the ability to include graphic material in addition to the alphanumeric, the use of overlays which can be selectively introduced and removed, and the introduction of special messages from any telephone. It also seems worthwhile to have the capability to queue a series of displays and then be able to select any of them in an arbitrary order.

The addition of a graphic capability would permit the introduction of maps and the presentation of output data in the form of curves, and would remove much of the present limitations on the type of information to be displayed. It would also exploit the ability of a TV monitor to present actual pictures together with data and text. It seems easy enough to introduce pictures or even live action using a standard closed circuit TV camera. However, formatting the data and text to appear properly with the picture has not yet been worked out.

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REFERENCE

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