High-Rate Telemetry Preprocessor for the SFOF 360/75 Computers

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The concluding phase has been reached for an advanced development task to determine the feasibility of implementing a computer-based system to preprocess digitally encoded block-formatted video data at serial rates up to 250 kilobits per second. A software model has been completed showing that under typical mission conditions the SFOF 360/75 primary computer would be virtually preempted by raw video data at this rate. A High-Rate Telemetry Preprocessor or some similar concept would relieve the primary computer in the Central Processing System of the severe loading that could result from injecting unpreprocessed video information directly into the SFOF 360/75 serial input channels in a real-time or near-real-time environment. A recommendation is made that the technique of video preprocessing be pursued in order to meet the known objectives of future missions.

I. Introduction

A study of presently known flight project telemetry requirements for future missions indicates that there will be an increasing need for the SFOF to accept and process video data at rates considerably in excess of those presently being handled. In the SFOF, current capabilities are limited to receiving this type of information on wideband lines from Goldstone at a 50-kilobit rate. This is clearly inadequate for supporting the objectives of future spaceflight missions.

Preliminary computer-based modeling studies conducted at JPL show that with the currently configured SFOF Central Processing System (CPS), a typical video data processing workload during periods of high picture transmission activity in the encounter phase would require most of the input/output (I/O) capacity of an IBM 360 Model 75 computer to keep up with this flow of data, even with minimal processing and negligible storage of picture elements (pixels).

In order to evolve and perfect the techniques necessary for accommodating high-rate[1] data streams, an SFOF Advanced Development task was defined to investigate the need for a High-Rate Telemetry Preprocessor (HTP) to function as a "front end" for the 360/75 computers. The conceptual phase of this effort is now reaching completion.

[1]High rate = up to 250 kbps.

II. System Concept

The HTP was conceived as the most promising method of keeping pace with future increases in mission video rates with only a tolerable increase in loading of the 360/75 computers. The "preprocessor" approach was selected because it was modular in concept and would cause a minimum of conflict with ongoing CPS operations during implementation. Functioning as an "add-on" external to the 360/75, the HTP would not appreciably impact the functioning of the JPL Operating System (JPLOS) and could further be expected to lessen the overall software "overhead" factor.

Figure 1 shows the design concept for the HTP Assembly. It would operate as an unattended stored-program input buffer to the CPS for the purpose of relieving the 360/75 of the SFOF–GCF data exchange and communications line management functions, and would precondition the data for efficient parallel transfer to the attached 360/75 Central Processing Unit (CPU).

An input/output (I/O) console would be required for performance monitoring and for entering initialization parameters, plus a minimum complement of peripherals for program loading and modification. A moderate amount of main memory would be required for resident and working storage, plus a rotating mass memory for buffering and backlogging a number of complete video frames if this should prove advantageous. If implemented with the present CPS configuration, incoming video data would be directed automatically to one 360/75 or the other as selected at the output interface. This mode of operation would minimize the overhead of bit-by-bit manipulation by software which would otherwise be evident.

III. Task Description

An SFOF High-Rate Telemetry Preprocessor would be expected to accomplish the following tasks:

(1) Accept block-formatted serial high-rate video data from the Ground Communications Facility (GCF).

(2) Establish time alignment of data blocks in conjunction with GCF synchronization signals.

(3) Perform data transmission line management functions previously furnished by communications synchronizers in the SFOF.

(4) Discriminate between various video formats and isolate accordingly.

(5) Accumulate a minimal backlog of video frames, as necessary, to buffer data flow between the GCF and the CPS.

(6) Output the preprocessed data by fixed parallel increments to the 360/75 I/O channel, performing the necessary housekeeping operations required by the interface.

(7) Make available suitable alarm and monitor indications to other SFOF elements, as required.

(8) Respond to remotely initiated control orders for altering system processing limits and modes.

No displaying or logging would be expected of the HTP, as these tasks would be accomplished by other elements of the CPS.

Initially, a developmental version of the HTP would process a single high-rate video data stream. This capability could be tested and refined using simulated video-rate streams or recorded picture data obtained from earlier periods of planetary encounter operations.

IV. Alternative Approaches

The following alternative possibilities were considered during this task and discarded:

(1) Improve the efficiency of telemetry software previously prototyped for the 360/75s. (Not practical for these higher data rates.)

(2) Add the future high-rate telemetry loading to the existing CPS configuration, without changes. (Modeling studies have shown this to be impractical and risky, causing the 360/75 loading factor to be intolerably high.)

(3) Procure a full-scale telemetry-dedicated computer system with operator, displays, and mass storage. (Too costly and difficult to administer.)

(4) Extend the 360/75s with additional front-end 360-compatible hardware. (Would not appreciably lessen the loading on I/O channels and the Operating System. Also would be more costly than the HTP approach which assumes newer technology.)

(5) Use the "backup" 360/75 as a preprocessor to the primary 360/75. (A 360/75 would be mismatched for the job of preprocessing, would be very costly, and would require an operator full time. It would also conflict with other usage, precluding high-rate processing when either 360/75 became inoperative.)

V. Conclusions

To date, in addition to the modeling studies previously accomplished, high-rate video data characteristics have been analyzed insofar as they are presently known, a conceptual design has been completed (see Fig. 1), and commercially available minicomputers have been surveyed. The following preliminary conclusions have been reached:

(1) High-rate telemetry I/O is beyond the current capability of the existing 360/75s.

(2) Changes to the present hardware/software configuration will provide only minimal improvements in overall performance.

(3) A physically independent preprocessor offers the best hope of accommodating the expected higher data rates which will characterize future missions.

It is recommended that the technique of video preprocessing be pursued in order to preclude the necessity for more costly alternatives, such as the acquisition of additional large-scale computers or the extensive restructuring of software.

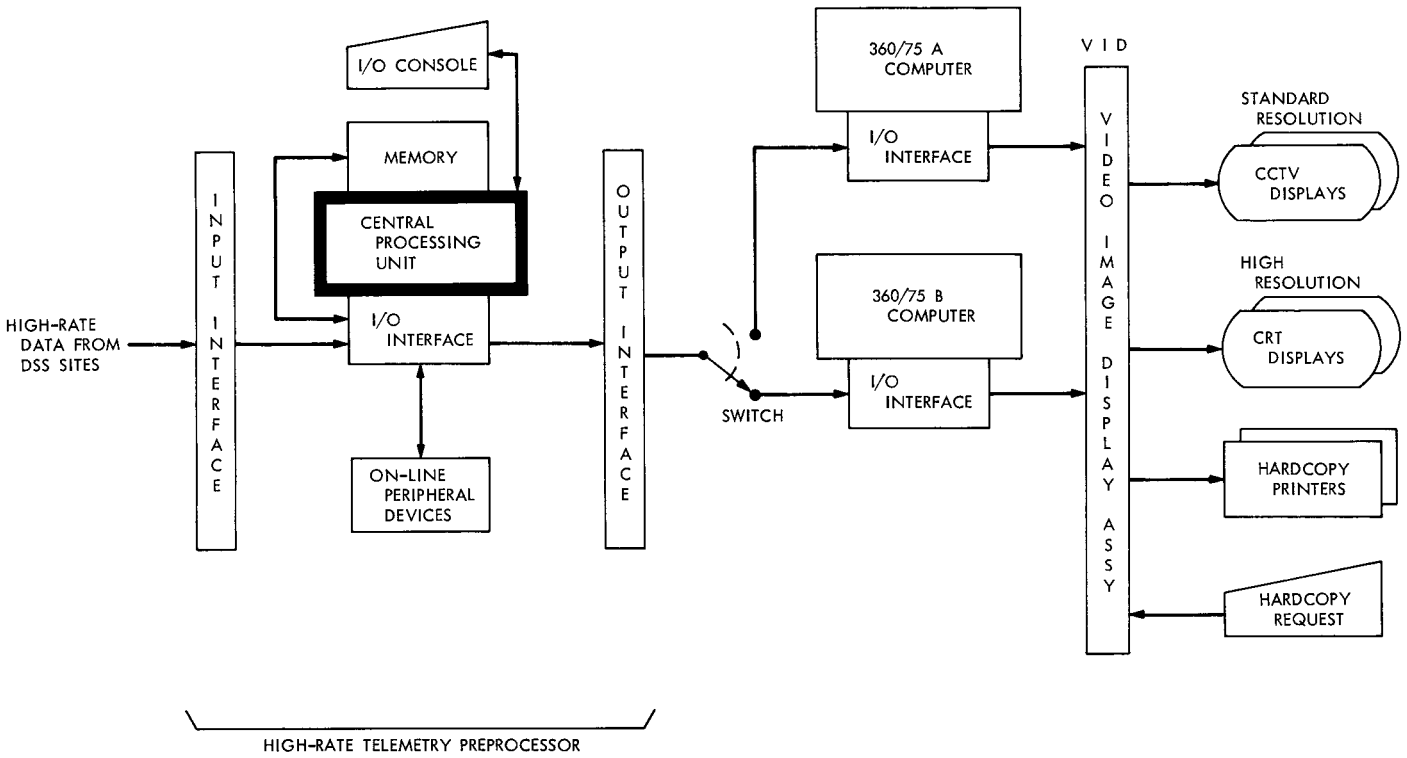

Fig. 1. Design concept of SFOF High-Rate Telemetry Preprocessor