

NASA TECHNICAL MEMORANDUM

NASA TM-75618

## DISPLAY SYSTEM FOR IMAGING SCIENTIFIC TELEMETRIC INFORMATION

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Translation of "Displeynaya sistema otobrazheniya  
nauchnoy telemetricheskoy informatsii," Academy of  
Sciences USSR, Institute of Space Research,  
Moscow, Report Pr-425, 1978, pp. 1-11.

(NASA-TM-75618) DISPLAY SYSTEM FOR IMAGING N79-23687  
SCIENTIFIC TELEMETRIC INFORMATION (National  
Aeronautics and Space Administration) 11 p  
HC A02/MF A01 CSCI 09B Unclass  
G3/61 20919



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON, D.C. 20546 MAY 1979

## STANDARD TITLE PAGE

1. Report No. NASA-TM-75618		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle DISPLAY SYSTEM FOR IMAGING SCIENTIFIC TELEMETRIC INFORMATION				5. Report Date May 1979	
				6. Performing Organization Code	
7. Author(s) G.I. Zabiyakin and S.N. Rykovanov, Academy of Sciences USSR, Institute of Space Research, Moscow				8. Performing Organization Report No.	
				10. Work Unit No.	
9. Performing Organization Name and Address Leo Kanner Associates Redwood City, California 94063				11. Contract or Grant No. NASw-3199	
				13. Type of Report and Period Covered Translation	
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration, Washington, D.C. 20546				14. Sponsoring Agency Code	
15. Supplementary Notes Translation of "Displeynaya sistema otobrazheniya nauchnoy telemetricheskoy informatsii," Academy of Sciences USSR, Institute of Space Research, Moscow, Report Pr-425, 1978, pp. 1-11.					
16. Abstract A system for imaging scientific telemetric information, based on the M-6000 minicomputer and the SIGD graphic display, is described. The system provides two dimensional graphic display of telemetric information and interaction with the computer; in analysis and processing of telemetric parameters displayed on the screen. The "running parameter" information output method is described. It consists of output of sections of extended graphs on the graphic display screen, during programmed movement of the screen along the horizontal (time) axis. User capabilities in the analysis and processing of telemetric information imaged on the display screen and the user language are discussed and illustrated, with the example of dialog processing of information of the Soviet-French gamma burst search experiment aboard the Prognoz-6 satellite.					
17. Key Words (Selected by Author(s))			18. Distribution Statement  Unclassified-Unlimited		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 11	22. Price

## Annotation

A system of imaging scientific telemetric information, based on the M-6000 minicomputer and the SIGD graphic display, is described in the work. A system provides graphic presentation of telemetric information, in the form of two dimensional graphs, and the interactive mode of operation with the computer, in analysis and processing of telemetric parameters, presented on a screen in the form of graphs.

A method developed for information output called the "running parameter" is described. It consists of the output of a certain portion of extended graphs on the graphic display screen, during programmed movement of the screen along the horizontal axis (time axis) of the graph. The capabilities presented to the user by the system, in analysis and processing of telemetric information imaged on the display screen, and the user language of intercourse with the system are discussed.

The capabilities of the display system are demonstrated, with the example of dialog processing of the information of the Soviet-French gamma burst search experiment aboard the Prognoz-6 satellite.

## DISPLAY SYSTEM FOR IMAGING SCIENTIFIC TELEMETRIC INFORMATION

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One of the basic methods of physical research in space is the time sequential recording of measurable parameters aboard a space vehicle, data dumping by radiotelemetry lines in digital form and recording of the information on magnetic tape at the ground measurement station. As a rule, in management of data dumping on board, time division multiplexing of the measurement circuits is used, with the traditional cyclic switches of telemetry [1]. The switched measurement circuits often are called telemetry channels, and the sequence of parameters which corresponds to one measurement circuit interrogation cycle, a telemetry frame [2]. In the event of the utilization of channel multiplexing, the group signal reaching the radiotelemetry line input carries information of the group of sequentially switched telemetry channels. Therefore, the telemetric information recorded by the ground measurement station is a block of ordered structure, a standard element of which is the telemetric frame. /3\*

The processing of telemetric information includes transformations, which are the reverse of those which the information undergoes in the onboard system and the radio channel. At all stages of processing, right up to extraction of the instrumental data, as a rule, the structure of the telemetric information block which corresponds to the sequential cyclic onboard measurement parameter interrogation (telemetric frame sequence) is preserved. The traditional form of presentation of telemetric information is graphs of the telemetric parameters as a function of time. This form of telemetric information imaging, especially in /4

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\* Numbers in the margin indicate pagination in the foreign text.

the initial stages of processing, is most convenient for estimation of the quality of the information and quick processing of the data.

The use of graphic dialog systems for processing scientific telemetric information offers new possibilities for the conduct of data analysis and processing. A dialog telemetric information imaging system, based on the M-6000 minicomputer and the SIGD graphic display, equipped with a light pen and alphanumeric keyboard, is described in the article.

In the development of the display system, the effort was made, first, to preserve the graphic presentation of telemetric information, in the form of two dimensional graphs and, second, to provide user interaction with the computer, in analysis and processing of the telemetric parameters, presented in the form of graphs on the screen.

To image telemetric information received in a communications session with a facility, several tens of meters of paper tape frequently are required. Of course, in analysis of such a volume of data, the experimenter is unable to take in all the graphic material immediately and analyze it in the small parts which enter 15 the field of vision. In this case, the field of vision of the experimenter (the graph perception portion) moves along the horizontal axis of the graph, as it were. This feature of the work of man with extended graphs has been reflected in the organization of the telemetric information output on the display screen.

A method has been developed, which is called the "running parameter." It consists of the output of some portion of extended graphs on the graphic display screen, during programmed movement of the screen along the horizontal axis (time axis) of the graph. The y coordinates of the points of all graphs presented for one moment of time constitute a "section" (it corresponds to the parameters of one telemetric frame). The illusion of movement of the screen along the horizontal axis is achieved by programmed shifting of the image of one section to the left (with the extreme

left section going beyond the limits of the screen) and the replacement of the extreme right section by new data. The shift of the images of the graph in one section is provided by recalculation of the x coordinates of the graph points simultaneously displayed on the screen, with regeneration of the image on the display screen.

The input information for the system is a block of telemetric frames. The values of those parameters which are to be imaged on the screen are selected by telemetric channel number (or parameter number in the frame). The rate of scanning the information on the display screen depends on the complexity and volume of the display file output on the screen, the image regeneration method, etc. In the variation utilized (four one hundred point graphs), the maximum scanning rate was on the order of four sections per second, which is in approximate agreement with the throughput capacity of a man [3]; it could be decreased by programming. The increase in scanning rate was limited by the high speed of the minicomputer processor. /6

The standard information carrier of the display system is magnetic tape. However, other available carriers (perforated tape, operational memory of the coupled computer, etc.) can be used. The system was used effectively for processing telemetric information, for logical control of it during data reception over a telephone communications channel.

In development of the program support of the imaging display system, the mathematical support of the SIGD graphic display, developed at the Joint Institute of Nuclear Research, was used [4].

Graphs of four telemetric parameters, obtained by quick processing of information of the Soviet-French gamma burst experiment aboard the Prognoz-6 satellite [5], are presented in Fig. 1. Together with the telemetric information graphs, service information was displayed on the upper part of the screen: current number of the extreme right section; ground recording time corresponding to

this section; number of the communications session with the facility, as well as the number of the block containing the information presented on the display screen. The service information can be used for identification of events recorded in the experiment. For convenience of observation of the telemetric parameters on the display screen, the regions of the image of each graph was separated by horizontal axes. The graph identifier, measurement range and unit of measurement identifier of the parameter imaged also are displayed.

The display system can be in one of two modes: automomous (scanning) mode or in the mode of interaction with the user.

Switching of the system from the scanning mode to the dialog mode is accomplished after instructing, with the light pen, "stop" of the light keyboard, displayed in one frame with the image of the "moving" graphs. As a result of the instruction, it becomes possible for the user to interact with the system, by means of the light pen and instructions entered with the alphanumeric keyboard of the display. Return of the system to the scanning mode is provided by the corresponding instruction. /7

A possible set of actions made available to the user during work with the system is conveniently divided into the following groups:

- changes in composition of the telemetric parameters imaged on the display screen and control of the scanning mode;
- dialog processing of information presented on the display screen;
- documentation of the imaged information and processing results;
- obtaining information during interaction with the system.

The first group includes such actions as a change in the set of parameters imaged, the number of them, the boundaries of the imaged regions on the screen, the range of measurement of the imaged parameters, identifiers of the graphs put on the screen and unit of measurement identifiers. The system user is able to

change the rate of "movement" of the graphs over the screen, pick out graphs presented on the screen by brightness and flashing, and set a "limit" line at a specified point on the screen, for convenience of visual observation of the telemetric parameters. In the event the initial information is recorded on magnetic tape, the user is able to skip a specific amount of the recording, in order to speed up scanning, or to return to a specified recording, /8 for rescanning of telemetric parameters.

The display system developed presents the user with the capability of dialog processing of the data presented on the screen. For example, a series of telemetric parameters can be combined before their output on the screen, values of a point specified with the light pen can be calculated (digitized), calculations by formulas can be carried out, etc. At the present time, the combination of two telemetric parameters and digitization of any graph points pointed out with the light pen are used in the system. The result of digitization of a point carried out by the system is presented in Fig. 1.

The final purpose of any data processing is to obtain results in the form of a document. The system provides for output of information imaged on the screen and processing results by digital printout and magnetic tape. This selective documentation, based on visual analysis of the information presented on the display screen, provides for logical compression of the data.

Documentation of the graphic information is easily accomplished, by photographing the images on the display screen (see Figs. 1, 2). However, the system acquires special flexibility in the production of "hard" copies of the screen on a plotter. The system described provides for the use of two coordinate computer plotters, as well as specialized (telemetric) plotters connected to the M-6000.

The user language for the computer consists of actions connected with pointing out elements of the image on the screen with the light pen and the input of the corresponding instructions on



the display keyboard. In the development of this language, the psychological bars which frequently prevent full inclusion of the user in the interaction were taken into account [6].

To prevent the development of a feeling of disappointment and inconsolability of the user, the forgiveness of errors committed during the interaction is provided for in the system. Thus, in the case of incorrect instruction input, output of the appropriate diagnostic information on the screen is provided for in the system. In the event of error, the user is able to insert the correct instruction, or to begin the interaction with the system from the very start.

For the convenience of the user, a reference list is provided in the system, which contains all the permissible system instructions and descriptions of the actions carried out as a result of their interpretation. The reference list can be displayed on the screen at any time, as desired (Fig. 2).

At the present time, the program support of the system occupies about 12 K of the M-6000 memory. The system is open to further expansion. Its capabilities can be expanded by the incorporation of new processing programs and enlargement of the system input language.

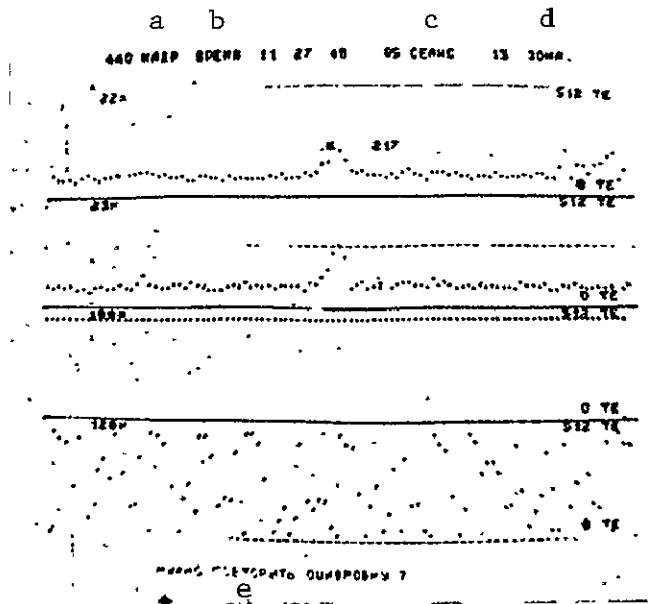


Fig. 1.

- Key: a. frame  
 b. time  
 c. session  
 d. [illegible]  
 e. [2 words illegible]  
 digitization?

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Telemetric information imaging system presents  
 dialog capability:

- | Instruction | Meaning                                      |
|-------------|--|
| SZ          | - change scanning mode,                      |
| RD          | - light pen editing                          |
| NK          | - start copy                                 |
| KK          | - end copy                                   |
| NG          | - start graph documentation                  |
| KG          | - end graph documentation                    |
| NL          | - magnetic tape rewind                       |
| OTS         | - digitization of specific point             |
| IS          | - work with standard instructions            |
| DP          | - work with supplementary instructions       |
| SN          | - reset                                      |
| NP          | - start frame scan                           |
| KP          | - end frame scan                             |
| ED          | - change scan rate                           |
| UD          | - set limiting value                         |
| VG          | - bring out graph by brightness and flashing |
- Specify point (modes OTS and UD) with light pen  
 During operation follow system information  
 Answer yes/no to semantic questions  
 Continuation of work - input [letters illegible]

Fig. 2.

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