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DESCRIPTION AND TEXTS FOR THE AUXILIARY PROGRAMS FOR PROCESSING VIDEO INFORMATION ON THE YeS COMPUTER. PART 3. TEST PROGRAM

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Translation of " Opisaniye i Teksty Vspomogatel'nykh Programm Obrabotki Videoinformatsii na YeS EVM. Chast' 3. Programma Testa", -- Polucheniye Statisticheskikh Kharakteristiki Mnogokanal'noy Videoinformatsii, Academy of Sciences USSR, Institute of Space Research, Moscow, Report Pr-426, 1978 pp. 1-25

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16. Abstract In the present monograph, we describe the functions and give the operating instructions, the block diagram and the proposed versions for modifying the program for obtaining the statistical characteristics of multi-channel video information. The program implements certain man-machine methods for investigating video information: it permits representation of the material and its statistical characteristics in a form which is convenient for the user.

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CONTENTS

	Page
INTRODUCTION..	1
2. Description of the functions implemented in the program..................................	3
3. Instructions for working with the program..........	14
4. Suggested ways to modify the program...............	16
APPENDIX..	19
REFERENCES..	23

1. INTRODUCTION /3*

The problems involved in studying the earth's natural resources, just as any other problem, are connected with the processing of large files of information needed primarily in the visual representation of this information. The quasi-photography of video information obtained on the alphanumeric printer of a computer [1] gives the researcher a convenient opportunity not only to evaluate the content of the incoming information, but also to identify the data recorded on magnetic tape and the image of the earth's surface with a precision down to the element of resolution.

However, even at the very beginning stage of research, it is necessary to study the material numerically. Such a study is impossible without an extensive use of computer technology. The construction of graphs, histograms, digital print-outs, computation of elementary statistical characteristics, etc.--this is far from a complete enumeration of the problems which the researcher has to know how to solve when processing large data files.

The data recorded on magnetic tape from remote sensing of the terrestrial surface are color vectors assembled in a line [2]. The number of vectors in a line can vary--this depends on the properties of the recording apparatus. Each sequence of lines recorded on tape is an image.

Each color vector $a_{ij}=(a_{ij}^1,\dots,a^e)$ can have up to eight components which characterize the intensity of the electromagnetic radiation reflected from an element of resolution in one of the spectral ranges. During recording of the radiation, the signal /4
is modulated in such a way that each of these components a^s can have a maximum value of 255 nominal units, i.e., it can be placed in a single byte.

*Numbers in margin indicate foreign pagination.

The position of an element of resolution from an image is determined by the number of the line and the number of the color vector in the line. Thus the entire image can be regarded as a matrix whose elements are the color vectors a_{ij} .

The proposed program makes it possible to obtain a chart of the change in the signal (along a line or a column of the image) in digital or graphic form; to calculate the vector magnitudes of the mathematical expectation and dispersion; to construct histograms of the distribution of the signal in each spectral range. The program consists of several blocks written in the languages ASSEMBLER and FORTRAN for the Disk Operating System of electronic computers of the Unified Series (ДОС/ЕС) [3]. The reading of magnetic tape (МЛ) , storage, rearrangement of files and the development of charts is carried out by blocks written in the ASSEMBLER language. This makes possible more complete use of the machine's capacity. The storage files are transferred for subsequent processing by FORTRAN modules, which facilitates programing processing.

Preliminary processing in the ASSEMBLER language results from the fact that an element of information on МЛ occupies one byte, and a minimally addressable field from the problem-oriented language (ПОЯ) FORTRAN occupies two bytes. The program admits an increment of the functions being executed both at the stage of file formation, as well as after the storage procedure is completed.

The results of the operation of the program can be used to determine and compare the statistical characteristics of various fragments of an image, and also for qualitative and quantitative analysis of materials obtained from remote sensing of the earth's surface.

2. Description of the functions implemented in the program /5

We shall call a set of elements from several neighboring lines which includes elements with the same number of columns an oriented image fragment. The program makes it possible to process an arbitrarily chosen oriented fragment of any magnitude, up to the entire image.

In the version of the program to be described the following functions are implemented:

R - executes successively digital read-out of the values of the signal in all spectral ranges for all lines of the given fragment;

C - constructs a chart of the line-to-line change in the mathematical expectation of the color vectors for the elements which are between the extreme columns of the given fragment;

S - interprets graphically the change in the color vector of each element along the lines of the given oriented fragment, beginning with its first line.

M - computes the vector value of the mathematical expectation of the signal for the entire given fragment;

r - executes digital read-out of the files for the frequencies of the intensities of the fragment in all spectral ranges;

x - computes the components of the vectors for the mean value M^{ℓ} and the dispersion $\mathfrak{D}^{\ell}$ of the signal in the ℓth channel in the given range involved in the signal change;

F - graphs the frequencies K_i and the relative frequencies P_i involved in the intensities of the elements of a fragment in any given channel;

G - prepares a file with elements of the type INTEGER*2 , representing a line of a fragment or its part; /6

B - computes the self-covariational and self-correlational functions of the line.

The program described consists of three sections of ASSEMBLER (TESTAM , INTRE , MACCHB) [file]) and several modules of the type SUBROUTINE , written in the ПОЯ FORTRAN (Fig. 1). In order for the program to begin operating, initiation on the part of the calling program is necessary in whose function there is also a storage reservation for the operating file IAR . The scale of the file is determined by the number of spectral ranges. It must be determined for the functions M,C,X,F by the formula 256*KCHAN , and for the function G--the formula is the length of the part of the line X KCHAN , where KCHAN is the number of channels of video information. The file IAR for the functions X,F must be described as INTEGER*4 , and the file for G, as INTEGER*2 . From the operator CALL TESTAM (IAR) control is transferred to the section TESTAM which reads the MM , searches for and isolates the given fragments, implements the functions R, C, S, M, r, and also prepares the files used by the algorithms of the functions F, B, X and G. The sequence of operations for the blocks and modules TESTAM (Fig. 2) is determined by the symbol for choosing a function which together with the coordinates of the fragment being processed must be printed on the control punched card. The coordinates of a fragment are the number of the initial and final lines СТРОК NBSTR and NESTR and the columns NBSTO and NESTO . The control parameters of this punched card also include the number of spectral ranges (channels) KCHAN .

Let us consider in more detail the possibilities represented by the program. To implement all the functions of the program after entering the control card, the next line is read and the given initial number is compared with the number which is in the /9 first four bytes of the line on NW . If the number read is less than the given number, then reading proceeds until the numbers coincide. If the initially read number is greater than the given number, then fictitious reading of a group of lines backward occurs (the number of lines is determined by the formula (NK-NASTR+1)), and the group is read once in the forward direction in the standard mode (checking the numbers).

When the symbols R,C,S are given, printing on the АЦПУ begins immediately after the next line of the given oriented fragment is read.

In the case of the function G, the subprogram transforms the multi-spectral data of a single line into the form INTEGER·2 and returns control to the initiating program for further processing of the file IAR . In this case the length of the output file is determined by the formula (NK-NB)KCHAN (here KCHAN characterizes the number of color vectors of the initial line). The file created is organized as follows: the first (NK-NB) elements correspond to the first spectral channel, the second, to the following channel, etc. To implement the remaining functions, files are accumulated for all the given fragments.

By means of the function R in one line on an АЦПУ are printed the digital values of the elements of a line in the first spectral range (but not more than 30 items); in the following line, the values of the elements of the next spectral range, etc. If the number of elements in a line of the fragment under consideration exceed 30, then again the KCHAN of the lines is printed, etc., until all the elements of the line are printed out. The

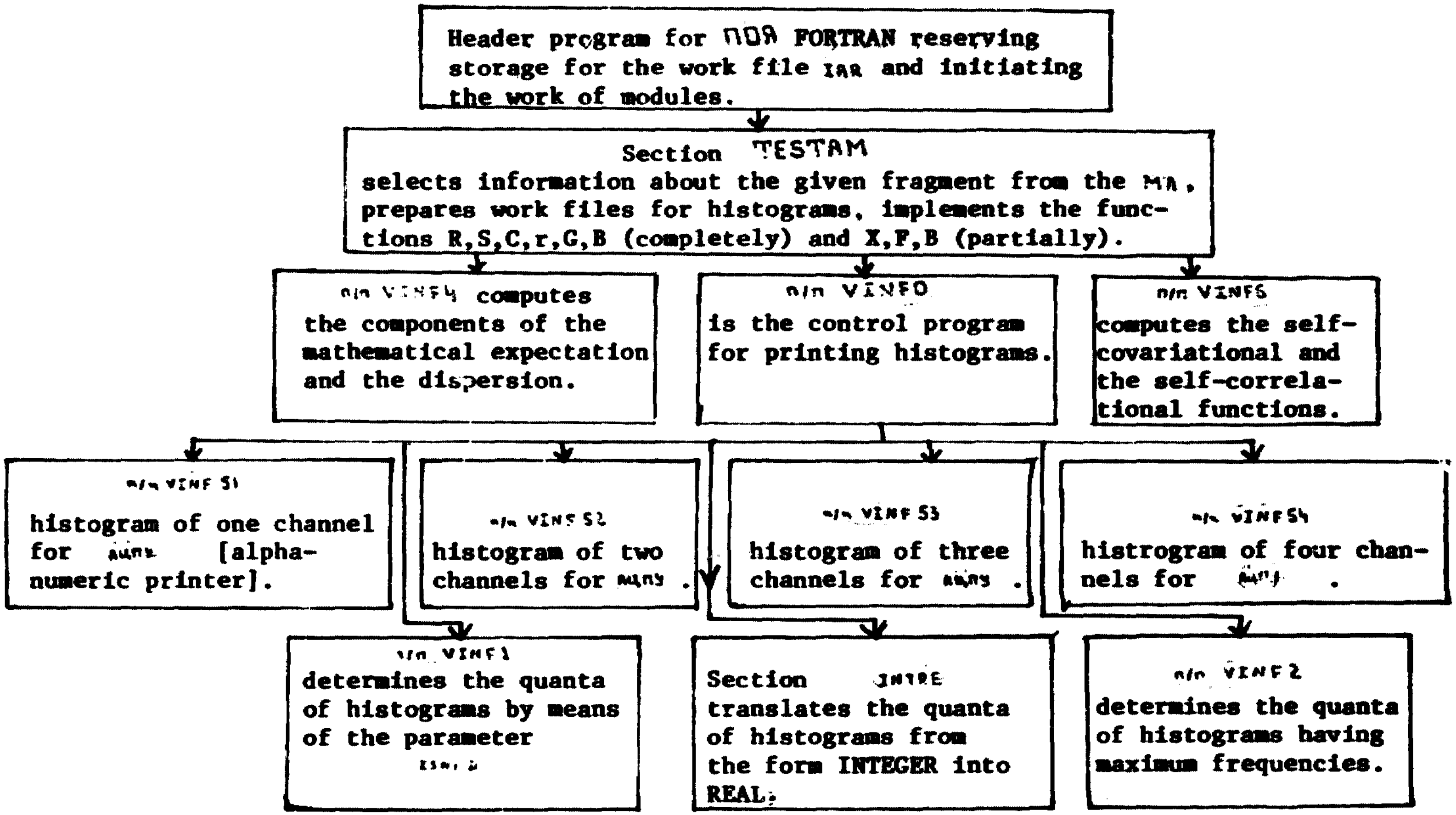
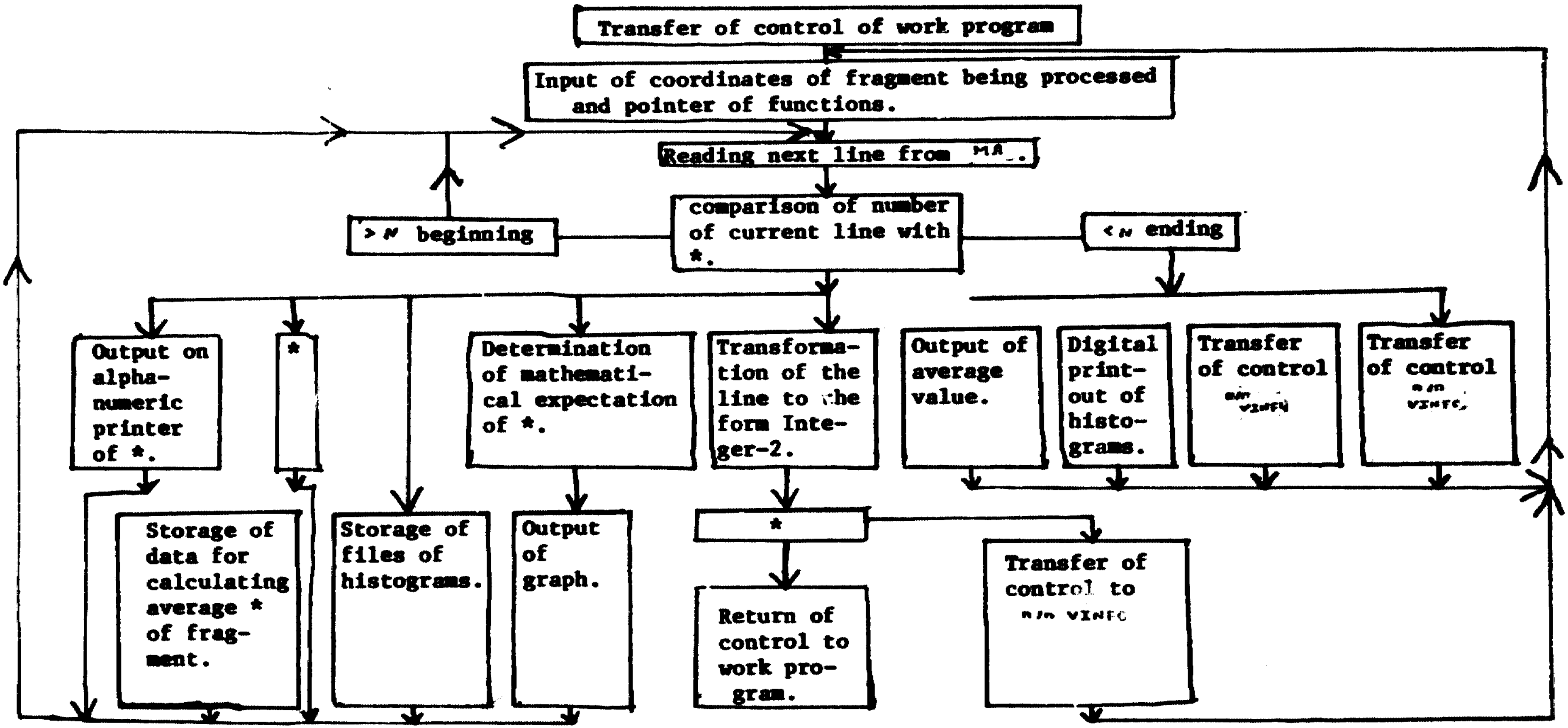


Fig. 1. Hierarchy of the blocks and modules of the program.



*Illegible in foreign text.

Fig. 2. Microenlarged block diagram of n/n TESTAM.

number of the line and the number of the initial column are printed before the beginning of the line corresponding to the first spectral range. Then from the ПЛ the following line is printed, and the process is repeated until the last line of the given fragment has been read. After this, control is shifted to the input block of the next control card.

<u>As a consequence of the function S</u> each line of the АЦПУ is /10
a mapping of a color vector for the given fragment. Since the width of the АЦПУ belt makes it possible to accommodate only 128 symbols (and the value of an element, as stated above, can amount at most to 255 conventional units), the values of all the components of a color vector are divisible by 2. Before the first multi-channel element of each line of a fragment is printed on the АЦПУ, the numbers of the mapped line and the initial column of the fragment are printed. In the positions determined by the values of the components of a color vector, from 1 to 8 symbols are printed. If the intensities of the signal in various channels coincide, then on the print the symbols are superimposed on each other. Thus all the elements of one line are printed, then all those of another, etc., until the last element of the last line in the given fragment is printed out. To facilitate inspection of the material, a coordinate network is printed over the graph (through 20 elements along the axis of abscissas and 40 conventional units along the axis of ordinates of the graph). In the nodes of this network, on the axes of coordinates along the perforations are printed the numbers designating the number of the color vector in a line, and in the perpendicular direction, its intensity. During a single access to the function S it is possible to map graphically an arbitrary number of lines of a fragment.

<u>Implementation of the function C</u> after reading through the next line in the module TESTAM the file:

$$\mathrm{col}(e) = \sum_{j=NBSTO}^{NESTO} a_{ij}^{e} \tag{1}$$

is stored, and the value

$$c(e) = \frac{\mathrm{col}(e) + 0.5}{NESTO - NBSTO} \tag{2}$$

is printed out on the АЦПУ .

The range of change of each component c(e) also cannot exceed 128 conventional units (i.e., the entire width of the АЦПУ belt is used). Reading the next line of information calls the АЦПУ to print one line, analogous to the function S. The number of a line is printed only on the axis of abscissas, and before the entire graph is printed, the number of the element is printed with which averaging begins. The number of elements of a line which can be averaged is arbitrary, and the number of lines is limited only by common sense in the consumption of paper. /11

As regards the function M the АЦПУ print out the text "the mathematical expectation of a color vector of the fragment", and in succession all the КНАН of the components of the vector for the mathematical expectation g^e are printed. These components are found by means of the formula

$$g^{e} = \frac{1}{NESTO - NBSTO} \times \frac{1}{NESTR - NBSTR} \sum_{i=NBSTR}^{NESTR} \sum_{j=NBSTO}^{NESTO} a_{ij}^{e} \tag{3}$$

The results of executing the function r is the digital mapping of the file κ_i^t , prepared by the module TEXTAM . This file contains the frequencies with which particular values of each component of all the color vectors involved in a given fragment appear. A single line of such a file contains 255 numbers, corresponding to the entire intensity range for each channel. But during printing on the АЦПУ the quantity of these numbers may be reduced by preliminary averaging with any multiplicity KPAT . The value of the multiplicity is determined by the positions on the control card.

Each element r_j^ℓ of the file being mapped is calculated by means of the formula

$$r_j^\ell = \frac{1}{KPAT} \sum_{i=KPAT(j-1)+1}^{j \cdot KPAT} K_i^\ell \qquad (4)$$

The prepared file is printed on the АЦПУ , channel by channel, and the spectral channels are separated from each other by a line consisting entirely of the letters Ж . For the ℓth channel, the values of the file r_j^ℓ are printed successively in a line by the АЦПУ , and for each element *. If the number of file elements exceeds 30, then the remainder are transferred to the following line, etc., until all 256 KPAT values of the file r_j^ℓ are withdrawn. To make it easier for the investigator to study the distribution of the intensities, the values of the intensities corresponding to the first element j of each line are printed in the first four positions of that line. They are separated from the digital values of the frequencies by the symbol % . /12

<u>In order to implement the function X</u> (calculation of the mathematical expectation and the dispersion) we begin by storing the file K_i^ℓ which determines the frequency with which the intensities of the corresponding components for the color vectors a_{ij} appear. Then in the subprogram MAPL we compute the components of the vectors of the first and second moments, using the formulas

$$M^\ell = \sum_\ell \left[\frac{\sum_{s=0}^{255} s \cdot K_s^\ell}{\sum_{s=0}^{255} K_s^\ell} \right], \qquad (5)$$

*Illegible in foreign text.

and

$$D^{\ell} = E\left[\frac{\sum_{s=0}^{255} K_s^{\ell}}{\left(\sum_{s=0}^{255} K_s^{\ell}\right)^2 - 1} \sum_{s=0}^{255} K_s^{\ell} \cdot (s - M^{\ell})\right] \tag{6}$$

Here E denotes the integral part of the given expression, and ℓ is the number of the channel.

When calculating the characteristics of the change in the signal in a selected part of the intensity range, rather than in the entire range, we take as the lower and upper limits of summation, the minimum and maximum values of the signals for the portion of the intensity under consideration. The subprogram VIAF4 uses the following additional control parameters:

NCHAN - the number of the spectral range;

MINVAL, MAXVAL - the minimum and maximum values of the intensities of the chosen signal change range.

The ATsPU prints the line in which appear the number of the spectral range of the channel, the limiting values of the signal, the value of the mathematical expectation and the dispersion (together with the explanatory text).

<u>The result of executing the function F</u> is the files of histograms which make it possible to analyze the probability density distribution functions of the signal with respect to the intensities. /13

For the width of the ATsPU belt, the program permits the output of one, two, three and four histograms. The printing error is determined by the width of the field removed for the histograms. Just as in the case of the function X, it is possible to put out a selected part of the signal intensity range, rather than all of it, and to construct histograms with an average relative to a given parameter. Here as the quantum for a histogram we take the average value with respect to several quanta, the number of which is given by the averaging parameter ISRED . During operation of the algorithm for the function F, the module TESTAM , after forming the histogram files, transfers control to the subprogram VINFØ which is the control program for printing histograms. This subprogram uses the following control parameters which assign the mode for constructing graphs:

NGIST - the number of histograms for the АЦПУ belt width;

NNNNC - the number of spectral ranges which must be mapped on the АЦПУ simultaneously according to NGIST;

NBEG$^{\ell}$, NEND$^{\ell}$ - the beginning and ending quanta of the mapping $(\ell = 1, \ldots, KCHAN)$.

ISRED - the averaging parameter;

VIDG - the type of histrograms (the frequency of impact (A) or the relative frequency (F)).

When constructing histograms reflecting the frequencies K_i^{ℓ} , the i-го quantum represents the number of elements of the given fragment with an intensity of i units. The quantum O_i^{ℓ} in a histogram of relative frequencies is calculated by normalizing the quanta K_i^{ℓ} so that

$$O_i^{\ell} = \frac{K_i^{\ell}}{\sum_{i=0}^{255} K_i^{\ell}} \; [\%]. \tag{7}$$

The АЦПУ prints the number of the channel, the greatest frequency in the file and the number of this quantum, and also a digit on the axis of ordinates. The intensities are printed along the /14 axis of abscissas (the conventional unit of intensity is a quantum of a histogram). The digital network is laid off on the axis of ordinates. The frequency in the chosen quantum can be calc lated by multiplying an ordinate digit by the number of pad symbols, " Ӿ ". For example, in channel 1 (cf. Russian P. 23) on the histogram constructed by means of the parameter VIDG=F an intensity of 88 has the frequency 9 x 0.004313 = 0.03882.

As the result of executing the function B (which determines the self-covariant and the self-correlational functions of a line of a fragment or its part) the line with number j which has been read forms a file with elements INTEGER*2 (Cf. function G) and control shifts to the module VINFG, written in FORTRAN. The following are computed: the average signal M^t for a given portion of the line (cf. formula 3) and the values of the self-covariant function, using the formula

$$C_s^t = \frac{1}{N} \sum_{i=1}^{N-K} (a_{ij}^t - M^t) \cdot (a_{i+s,j}^t - M^t).$$

The self-correlational function is calculated from the formula

$$r_s^t = \frac{C_s^t}{C_0^t},$$

where $s = 0, 1, \ldots, K$.

On the control card the user assigns the limiting value of the delay K and the portion of the line along which the characteristics are calculated. The АЦПУ prints: the number of the line, the number of the column between which the portion of the line is located, and the values of the functions for all delays from the 0th to the Kth. Control is returned to the module ZESTAM for input of the coordinates of the following fragment and the new function.

In an appendix we present examples illustrating the mapping /15
of the results obtained by processing several fragments. In a separate appendix we give the complete text of the section in the ASSEMBLER language, together with the necessary commentaries and the texts of all subprograms, written in ПОЯ FORTRAN.

3. Instructions for working with the program

The program TECTA is controlled by means of symbols and numbers fed in on punched cards.

Each control card represents a sequence of whole numbers, arranged in succession, beginning with the leftmost position on the punched card.

To implement any of the functions, it is necessary to specify on a card the coordinates of a fragment, the number of spectral ranges and the symbol of the chosen function. The data are printed in the following sequence, each of the first five involving 4 positions per punched card:

NBSTR - the number of the beginning line of the fragment;

NBSTO - the number of the initial column of the fragment;

KCHAN - the number of spectral ranges;

NESTR - the number of the final line of the fragment;

NESTO - the number of the final column of the fragment;

* - the symbol indicating that in the next position a function will be given (1 position per card);

VIDFUN - for the choice of a function (one of R,c,S,M,G, X,r,F,B). /16

In the case of the functions X and F, additional parameters must be fed in.

The function X (for computing the mean value and estimating the dispersion of the signal in the given spectral range) uses the following parameters:

NCHAN - the number of the spectral range (1 position);
MINVAL - the minimum intensity in the chosen signal change range (3 positions);
MAXVAL - the maximum intensity (3 positions).

All these parameters are printed on one punched card. There can be any number of such punched cards (with additional parameters). In order to shift to feeding in the coordinates of a new fragment and/or specifying another function, it is necessary to insert a punched card with a zero in the first position. When executing the function X, if the next card in the first column is the digit 9, then the program concludes the operation.

The control punched cards determining the functions F and r (graphical or digital output of histograms) have a format different from that of other punched cards: in position 21 is printed the averaging parameter ISRED (for F or KPAT) (for r) (each occupying 4 columns), rather than the service symbol ",". Next comes the symbol *, characterizing the conclusion of the numbers; then the symbol of the chosen function (F or r), and, in the case of the function F, the additional symbol of VIDG, which determines the form of the histogram. This is the symbol (A), if the frequencies κ_i^t , and F -- in the case of the relative frequencies -- are calculated and mapped. Next comes the punched card which successively determines the initial $NBEG^t$, the final NKN3' quanta of the mapping, beginning with the first channel. Each of the parameters NNKG' and NFN3' occupy 4 positions. Then comes the punched card on which is given: the number of histograms on the width of the АЦПУ belt NGIST, and the number of the channels relative to which histograms must be constructed. After the parameter NGIST comes a space; all the parameters of this punched card occupy 1 position. /17

The results of processing the fragments presented in the Appendix were obtained by means of the pack of control cards pictured in Fig. 3 (p. 18).

4. Suggested ways to modify the program

In the version described, the initiating program, written in ПОЯ FORTRAN, executes only a function reserving storage for preparing files accumulated during the operation of individual modules. From our standpoint it is advisable to extend its capabilities, committing to it the semi-automatic processing of results obtained during implementation of other functions. For example, it may be necessary for a user to compare the characteristics of individual fragments (coefficients of correlation, moments, etc.) in order to decipher thematically the information obtained. Therefore it is necessary to make provision for transmitting an initiating program for calculating the characteristics of fragments. They can be processed by means of algorithms written in ПОЯ FORTRAN in the form of subprograms called by an initiating program after the next fragment has been processed by the module TESTAM (or one of its auxiliary modules--the file, VINFØ ÷ VINF6).

An even higher degree of automated processing under the supervision of an initiating program can be achieved by means of the following modification of this program: the section TESTAM is altered so that the file of control parameters (coordinates

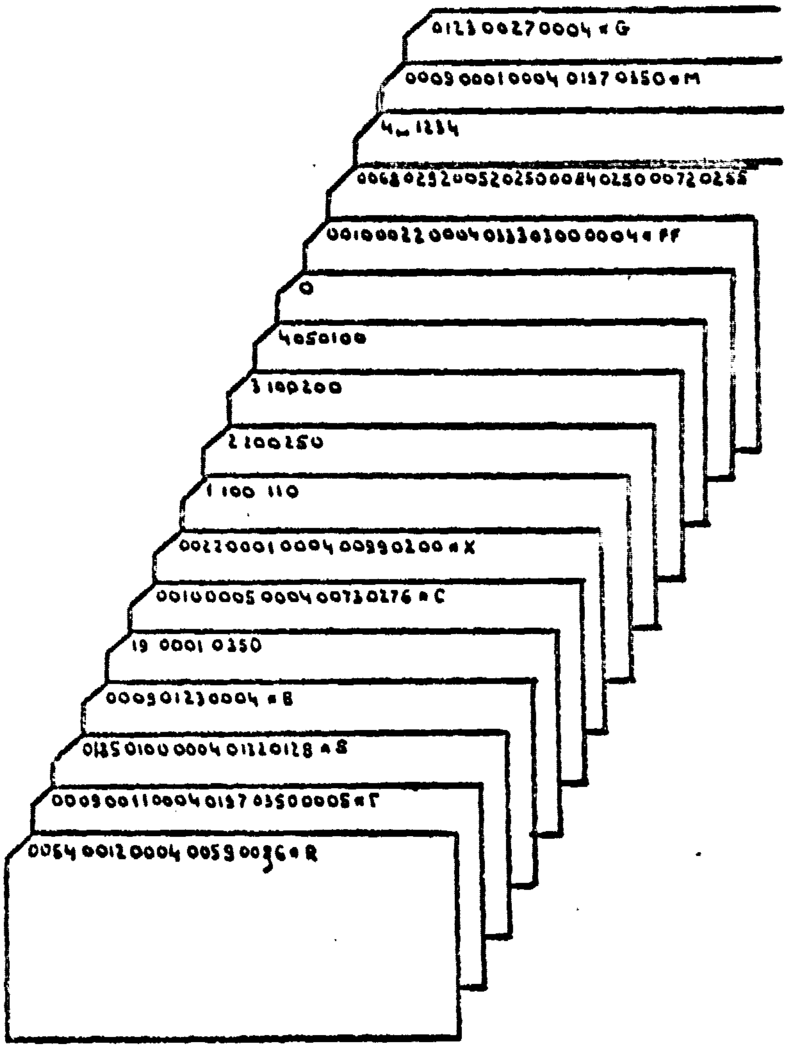


Fig. 3. An example of a pack of control punched cards.

of an oriented fragment and a type of processing function) are also transmitted by the initiating program. This makes it possible to form these parameters immediately in the initiating program (without feeding them in from punched cards). /19

One of the simplest methods for modifying an initiating program is to enlarge the function G. This can be achieved by adding an arbitrary processing program. (In the version described, a processing subprogram is nominally present). Such a subprogram obtains from the module TESTAM a file of lines of the type INTEGER*2 and then it may implement any processing algorithm which is conveniently programmable in FORTRAN.

Besides enlarging the function G, it is advisable to modify it so that a transmitted file of the type INTEGER*2 will contain information about the entire fragment, and not about an individual line of the fragment. This makes it possible to process immediately the entire fragment by means of a problem oriented language (for example, to apply a binary processing file for comparing the textural characteristics of various fragments).

The set of implemented functions must also be supplemented by a function for constructing two-dimensional histograms: the plane sections of multidimensional histograms will make it possible to analyze the correlational connections of various spectral channels.

00540012000400590086*R 0054 0012 0004 0059 0086

54 12	139	131	151	123	137	161	149	151	161	157	109	137	103	165	143	164	177	183	156	137
	146	155	167	155	151	141	125	133	133	128	125	139	135	132	127	125	113	128	125	125
	142	153	155	164	137	113	107	105	113	117	117	117	113	115	109	105	97	107	117	125
	26	116	123	109	121	117	109	108	102	111	109	113	120	102	117	111	109	105	109	121
54 42	139	149	141	149	137	102	177	193	181	185	173	124	135	107	87	93	111	88	98	109
	141	155	137	139	129	121	111	117	114	115	144	161	143	130	134	125	124	117	120	113
	133	130	124	117	97	89	81	87	81	103	141	153	135	117	116	115	100	105	97	96
	117	113	115	109	97	95	99	105	105	109	117	105	106	101	101	93	91	80	99	85
54 72	161	157	163	143	161	145	101	157	175	185	181	177	105	164	147	152				
	117	121	135	131	130	134	110	115	114	105	113	109	109	113	111	119				
	103	105	113	119	113	100	86	89	81	87	89	93	89	90	93	101				
	113	101	97	109	93	85	100	105	113	105	104	101	111	97	93	101				
55 12	141	133	141	137	133	144	149	157	153	145	141	140	145	140	141	149	169	173	173	177
	157	163	165	167	145	131	125	117	127	128	147	137	129	131	137	125	120	123	117	118
	157	166	169	164	134	105	107	99	111	121	134	125	113	117	117	109	97	100	97	112
	121	126	127	113	131	109	101	109	101	107	115	124	117	100	101	111	107	101	100	105
55 42	149	125	139	147	139	137	131	147	149	140	178	120	145	171	153	153	125	121	121	93
	141	125	131	128	133	129	141	133	129	125	125	141	120	117	121	131	137	140	141	137
	121	109	105	104	118	109	117	118	107	99	105	121	93	97	97	109	123	123	134	141
	115	105	115	113	109	97	101	116	105	93	100	104	104	95	103	101	111	104	93	97
55 72	133	121	141	139	134	153	151	149	181	177	201	177	177	180	161	153				
	141	137	139	141	121	127	135	125	121	113	105	111	120	101	107	119				
	133	124	120	112	105	111	105	93	85	87	89	93	89	80	95	105				
	121	116	109	115	109	105	111	113	109	107	105	111	109	91	99	109				
56 12	139	131	141	123	145	147	151	145	130	130	141	153	157	155	161	161	101	169	156	155
	153	165	169	177	144	125	135	125	120	137	161	137	125	131	125	123	124	125	109	118
	166	165	172	161	119	110	109	109	113	128	153	123	117	109	103	108	101	96	96	103
	123	119	124	141	105	[illegible]	109	101	108	113	109	109	111	113	112	109	107	97	107	111
56 42	145	144	125	140	142	165	153	[illegible]	153	145	139	135	125	153	145	141	142	141	141	120
	165	117	119	103	103	111	117	[illegible]	134	121	130	133	117	107	119	110	114	121	117	147
	143	93	87	85	81	85	89	101	113	120	121	123	97	104	101	97	101	102	109	149
	112	103	81	95	93	88	95	97	99	103	109	105	99	108	105	97	103	103	97	108
56 72	95	113	121	131	133	120	137	115	120	167	165	173	173	170	179	158				
	137	127	141	141	135	133	141	147	125	121	122	117	117	113	105	120				
	119	121	137	121	111	130	134	121	105	101	97	93	89	81	92	105				
	105	105	109	105	103	113	107	101	108	103	115	105	105	109	112	113				
57 12	137	131	135	131	153	145	157	149	153	129	147	165	145	160	161	173	173	189	173	157
	159	157	145	149	131	133	125	125	139	137	152	138	129	124	128	125	121	109	121	121
	153	144	143	141	113	115	109	105	115	135	157	121	117	105	107	97	95	104	93	102
	123	120	111	120	115	113	105	109	96	119	125	113	111	111	116	101	105	115	101	93

```
     0C09001100040197035 0C005*r                    0009   0011   0004   0197   0350   0005
      65131   Math. Expect. of Color Vector                         112    135    144    134

   1427   1855   1032   1209   1035   1278   775   634   324   225   68   39    21
                                                                                21
                                                                                21
 5                      25                             45                  65   21
*****************************************************************************************
                                                                            2   50
   612    769    447    539    460    525    412   431   381   509   333   388  374
   208    250    111     76     32     25      2                                 374
 5 209    250    111        25  32     25      2         45                  65 374
*****************************************************************************************
   351    742    694    912    804   1008    713   807   584   770   492   537  456
   185    146     49     27     12     16      9     6     2     4     2        456
 5 185    146     49        25  12     16      9       45  2     4     2     65 456
*****************************************************************************************
                                                     3      5     6     5      7
   308    682    570    858    889   1255   1047  1296  1030  1410  747   747   541
     6      3                                                          78643   541
 5   6      3           25                             45              786  65 541
*****************************************************************************************
```

19

FOLDOUT FRAME

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 0054  0012  0004  0059  0086

109 137 163 165 163 166 177 183 156 137 137 173 1 9 131 131 137 167 167 169 131
125 139 133 132 127 125 113 128 125 125 142 113 1 5 145 145 125 113 121 126 158
117 117 113 115 109 105  97 107 117 125 135 105 1 1 121 135  99  81  97 120 144
109 113 120 102 117 111 109 105 109 121 121 101   9 105 107 107  95 106 109  97

173 124 135 107  87  93 111  88  98 109 101 126 1 3 119 124 142 147 149 151 157
144 161 143 130 134 125 126 117 120 113 121 148 1 0 126 136 140 145 129 125 125
141 153 135 117 116 115 109 105  97  95 113 130 1 9 135 133 131 117 104 103  97
117 105 100 101 101  93  91  80  99  85  97 105 1 9 116 117 113 101 106  89 107

181 177 105 164 147 152
113 109 109 113 111 119
 89  93  89  90  93 101
104 101 111  97  93 101

161 160 145 146 161 140 109 173 173 177 145 159 1 7 121 121 147 135 133 143 161
147 137 129 131 137 125 120 123 117 118 146 129 1 2 127 131 117 105 120 121 141
139 125 113 117 117 109  97 100  97 112 129 107 1 3 125 133 105  81  93 111 125
115 124 117 100 101 111 107 101 100 105 115 119 1 9 105 116 111  89  93  99 117

178 120 145 171 153 153 129 121 121  93 105  80   1 100  88 103 103 105 119 124
125 141 120 117 121 131 137 140 141 137 125 149 1 5 142 129 133 136 153 141 147
105 121  93  97  97 109 123 123 134 141 121 127 1 5 115 116 128 137 141 165 141
100 104 104  95 103 101 111 104  93  97  99 105   7 101 100 106 105 115 109 113

201 177 177 180 161 153
105 111 120 101 107 119
 89  93  89  89  95 105
105 111 109  91  99 109

141 153 157 155 161 161 101 160 156 155 167 165 1 3 128 113 147 130 151 150 145
161 137 125 131 125 123 124 125 109 118 135 113 1 9 137 124 143 107 113 113 139
153 123 117 109 103 108 101  96  96 103 113 107 1 3 121 122 120  81  89  93 130
104 109 111 113-112 109 107  97 107 111 109  91 1 1 101 107 115 105 101  99 109

139 135 125 153 145 141 142 141 141 120 105 101 1 5 129 105 104 101  87  99  95
130 133 117 107 119 110 114 121 117 147 147 137 1 3 135 165 161 157 153 133 146
121 123  97 104 101  97 101 102 109 149 137 133 1 1 157 165 157 145 121 131 121
109 105  99 108 105  97 103 103  97 108 112 105 1 1 109 119 105 111 103 105 101

165 173 173 170 179 158
122 117 117 113 105 120
 97  93  89  81  92 105
115 105 105 109 112 113

147 165 145 160 161 173 173 189 173 157 163 173 1 7 113 120 151 141 153 143 131
152 138 129 124 128 125 121 109 121 121 127 111 1 9 133 130 119 101 109 109 125
157 121 117 105 107  97  95 104  93 102 108  89 1 6 125 133 101  77  80  85 113
125 113 111 111 116 101 105 115 101  93 119 109 1 5 113 113 101  95  95  97 101

      0009   0011   0004   0197   0350   0005
                     112    135    144    134
                                                      1        7       47     130     613     828    1443
775   634   324   225     68     39      21      15       4        3       1       1
                                         21      15       4        3       1       1
       45                           65   21      15       4           85   1       1
.......................................................................................................
                                    2    50     228     205      06     371     697     540     657
612   431   381   509    333    388   374     553     365      35     445     608     323     336
  2                                     374     553     365      35     445     608     323     336
  2    45                           65  374     553     365        85 445     608     323     336
.......................................................................................................
                                                                        4      61     100     250
713 / 807   584   770    492    537   456     680     420      81     403     585     344     355
  9     6     2     4      2          456     680     420      81     403     585     344     355
  9    45     2     4      2      65  456     680     420         85  403     585     344     355
.......................................................................................................
               3     5      6     5     7      15      15      32      42     100     110     235
047  1296  1030  1410    747    747   541     512     206      55      80      54      21      10
                            78643     541     512     206      55      80      54      21      10
       45                   786   65  541     512     206         85  80      54      21      10
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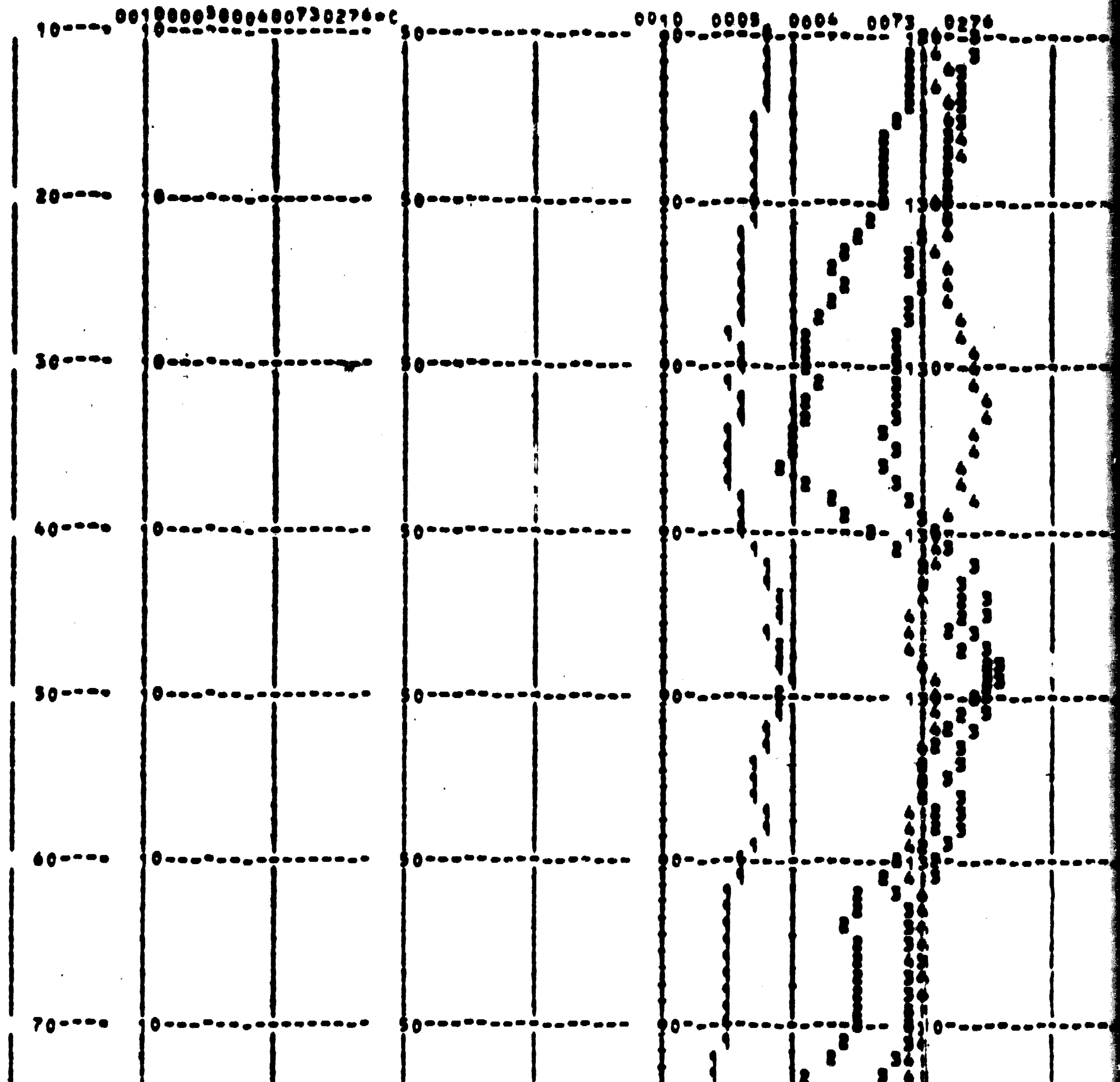
FOLDOUT FRAME 2 20

/



0C22000100040099020 0*X

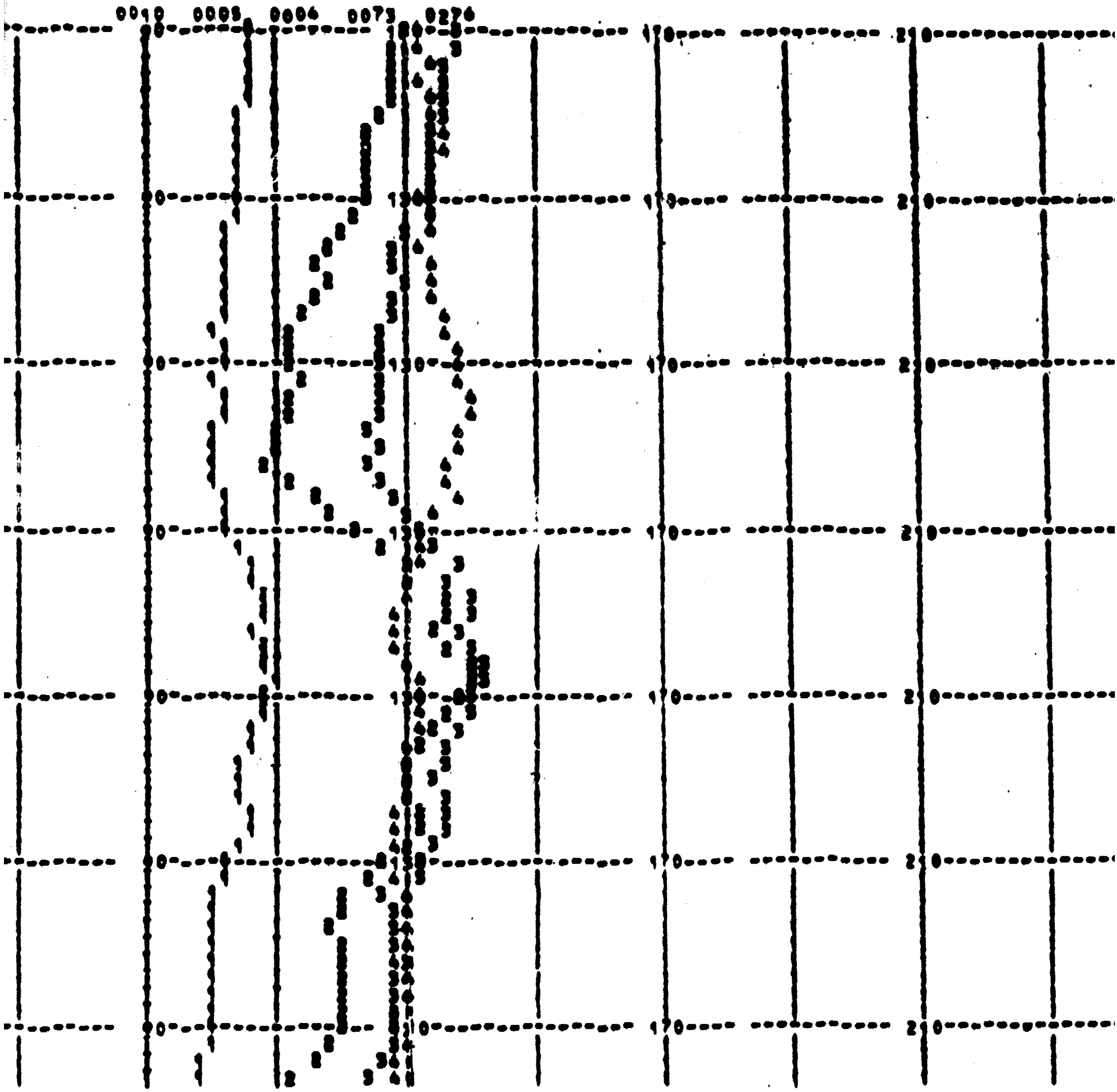
0022 0001 0004 0090 0200

Channel$_1$, Range of intensities (100,110) Math expectation =104; Dispersion=

Channel$_2$, Range of intensities (200,250) Math expectation =206; Dispersion=

Channel$_3$, Range of intensities (100,200) Math expectation =133; Dispersion=

Channel$_4$, Range of intensities (50,100) Math expectation = 91; Dispersion=



022 0001 0004 0099 0200

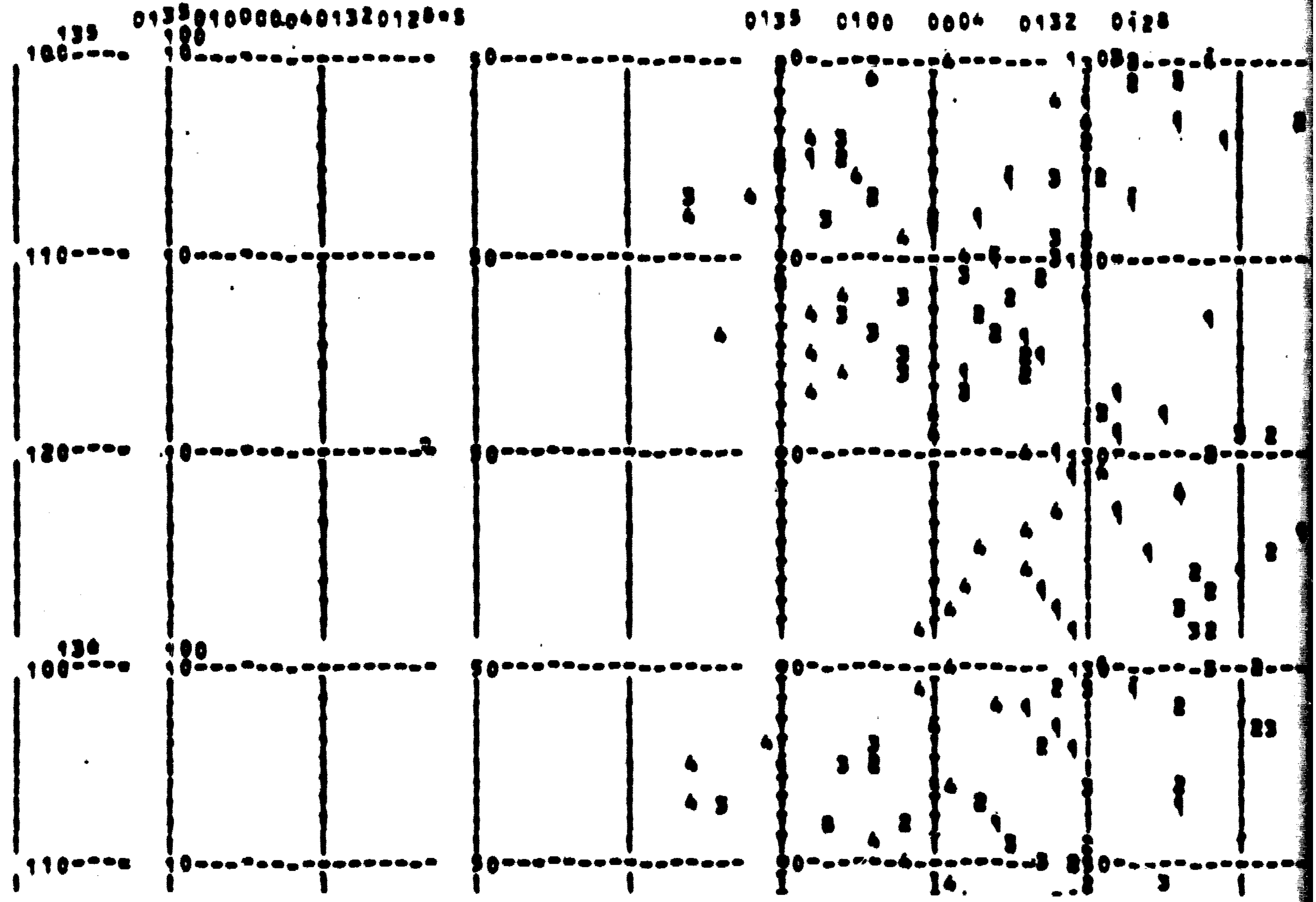
) Math expectation =104; Dispersion= 10

) Math expectation =206; Dispersion= 28

) Math expectation =133; Dispersion= 7

) Math expectation = 91; Dispersion= 12

2

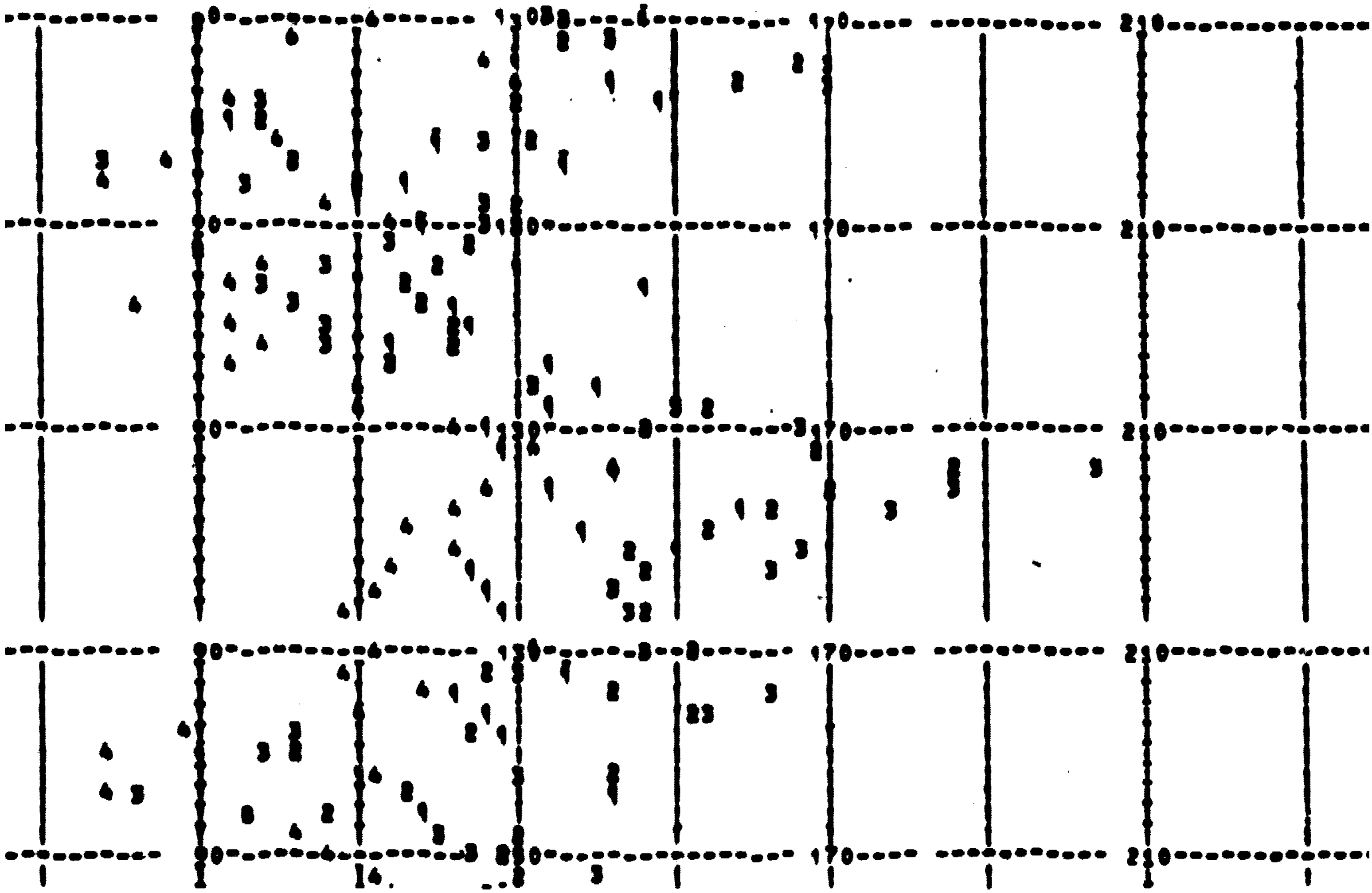


ORIGINAL PAGE IS
OF POOR QUALITY

000 0123 0004

S#	1	2	3	4	5	6	7	8	9	10	11	12	13	[illegible]
Chan .# 1														
R#	1.000	1.000	1.064	0.969	1.020	0.969	0.936	0.821	[illegible]	0.936	0.92[illegible]	0.969	0.[illegible]17	0.[illegible]
KAH.# 2														
R#	1.000	1.045	0.987	1.065	1.039	1.136	1.110	1.000	0.98[illegible]	1.013	1.000	1.065	1.065	1[illegible]
KAH.# 3														
R#	1.000	0.901	0.967	1.070	1.070	1.132	1.158	1.000	0.987	0.967	0.974	1.072	1.055	1[illegible]
KAH.# 4														
R#	1.000	0.975	1.049	1.033	1.033	1.066	1.066	1.033	0.967	1.049	1.000	0.96[illegible]	1.000	1[illegible]

0135 0100 0004 0132 0128



5
Y

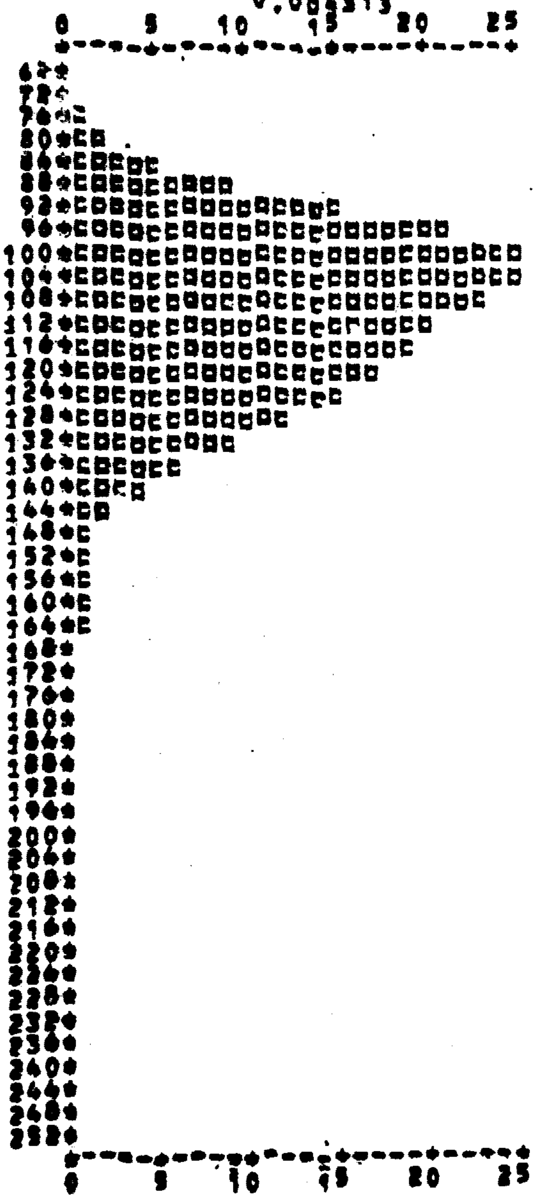
0009 0123 0004

	7	8	9	10	11	12	13	14	15	16	17	18	19
.9	0.[illegible]36	0.821	0.[illegible]55	0.[illegible]36	0.92[illegible]	0.96[illegible]	0.[illegible]17	0.7[illegible]5	0.8[illegible]3	.902	0.9[illegible]0	0.585	0.808
36	1.110	1.000	0.98[illegible]	1.013	1.000	1.065	1.065	1.039	1.09[illegible]	.013	1.052	1.065	1.091
32	1.158	1.000	0.987	0.967	0.976	1.072	1.053	1.046	1.026	.026	1.046	1.033	1.066
36	1.066	[illegible]033	0.967	1.069	1.000	0.96[illegible]	1.000	1.066	0.967	.019	1.000	1.139	0.936

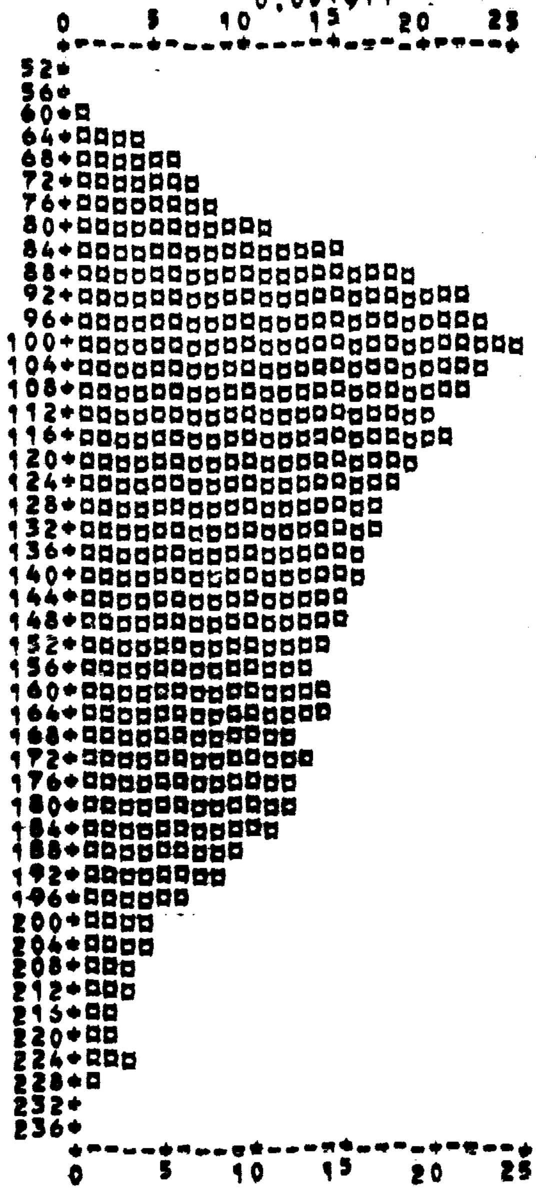
0010002800040333030000004*FF

0010 0022 0004 0333 0300 0004

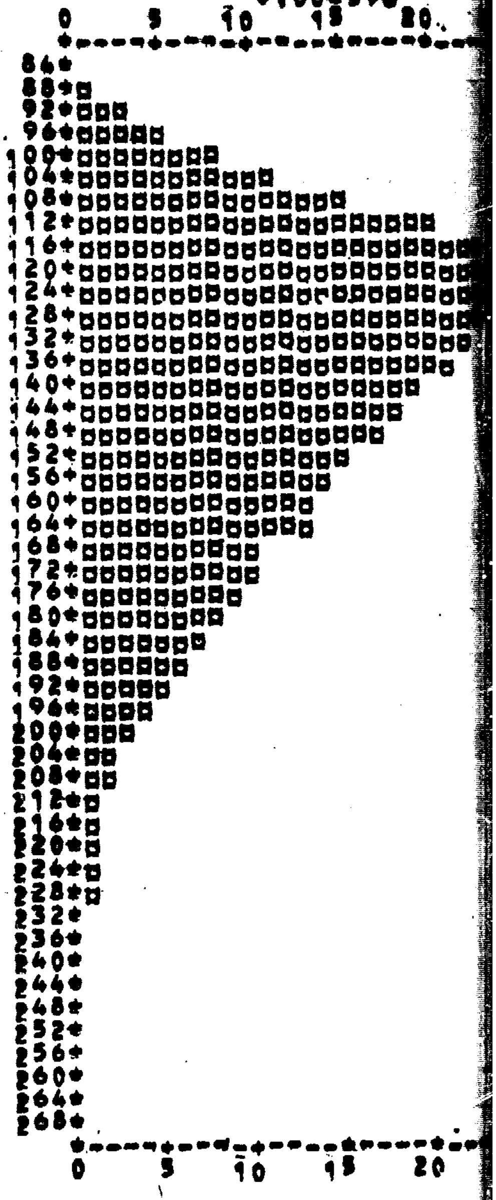
Channel 1
Quantum 100
Has the maximum frequency
0.107817
Value of the quantum of the ordinate
0.004313



Channel 2
Quantum 100
Has the maximum frequency
0.047774
Value of the quantum of the ordinate
0.001911



Channel 3
Quantum 120
Has the maximum frequency
0.064895
Value of the quantum ordinate
0.002596



0009000100040197035004M.

0009 0001 0004 0197 0350

00339 Math. Expect. of Color Vector 111 133 143 134

.1230027000040G

0123 0027 0004

# ВАРИА	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
КАН.# 1	145	173	157	121	119	122	117	125	111	109	97	111	124	120	119	128	126	119	135	12[illegible]
КАН.# 2	0	121	125	133	154	154	133	167	140	120	127	133	121	115	118	119	115	115	134	11[illegible]
КАН.# 3	0	114	0	133	167	161	183	169	123	107	115	120	99	99	97	107	105	111	109	11[illegible]
КАН.# 4	0	152	0	30	113	127	130	125	109	89	103	97	95	100	91	109	97	113	97	10[illegible]

20 7C

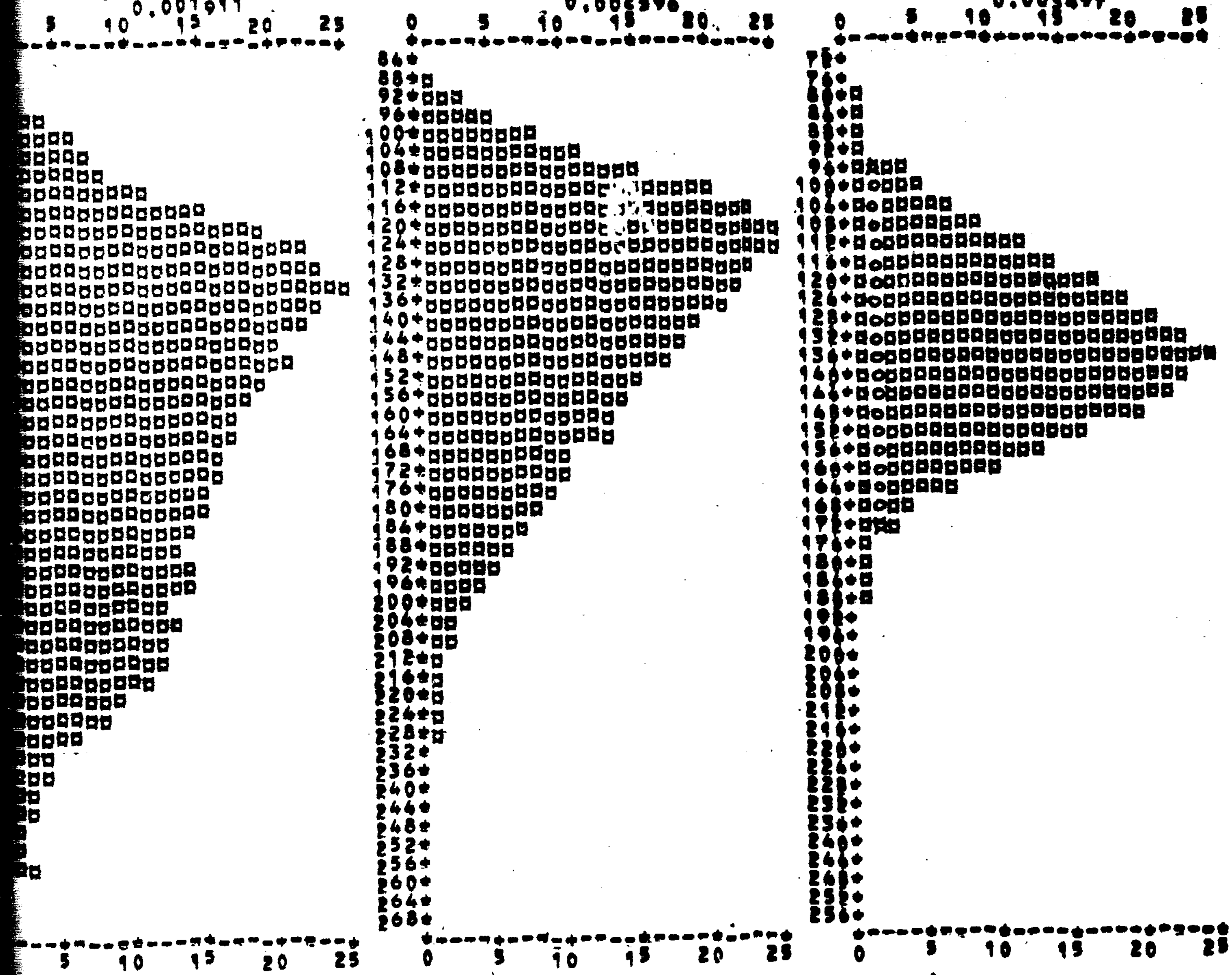
FOLDOUT FRAME

0010 0022 0004 0333 0300 0006

Channel 2
[illegible]um 100
[illegible]he maximum frequency
0.047774
[illegible]f the quantum of the ordinate
0.001911

Channel 3
Quantum 120
Has the maximum frequency
0.066895
Value of the quantum ordinate
0.002596

Channel 4
Quantum 136
Has the maximum frequency
0.087420
Value of the quantum ordinate
0.003497



0009 0001 0004 0197 0350

111 133 143 134

0123 0027 0004

8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
125	111	109	97	111	124	120	119	128	126	119	135	125	125	153	133	105	119	113	121
167	140	120	127	133	121	115	118	119	115	115	134	113	124	127	97	113	131	133	120
169	123	107	115	120	99	99	97	107	105	111	109	116	115	108	89	101	105	109	119
125	109	89	103	97	93	100	91	109	97	113	97	107	115	108	87	94	100	89	101

REFERENCES

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