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Connection of digital peripheral devices to stereoplotters from JENA

Abstract

For the further automatic of stereoplotting and differential rectification the Jena Works realized the connection of the DT 3454 Digital Drawing Table to the stereoplotters Topocart, Technocart and Stereometrograph and the connection of the Kennedy Model 9832 magnetic tape unit to Coordimeter F, Coordimeter G and to the Digital Control Unit for Orthophot D. The instrument configurations and their applications are briefly explained.

Introduction

Automation of photogrammetric stereoplotting increasingly requires the connection of digital peripheral units for graphical or digital input and output. Such peripheral devices are normally not included in the production programs of manufacturers of photogrammetric equipment. These peripherals are rather produced by companies being mainly engaged in computer and office machine technology. In various countries certain firms are therefore well introduced, and so users often wish to employ products of these well-known companies for digitizing their photogrammetric instruments. Unfortunately, international standardization has not yet progressed so far that instruments of different makers can readily and directly be combined. For this reason adaptations to various peripheral units were already made in the past in Jena (IBM card punch, FACIT tape punch). The range of these instruments was now extended by adding the DT 3454 Digital Drawing Table of Messrs. Data Technology, Woburn (Massachusetts) and the magnetic tape unit Model 9832 of Messrs. Kennedy, Altadena (California).

2. Topocart with DT 3454 (Fig. 1)

2.1. General

The digitally controlled drawing table being directly (on-line) connected to the stereoplotting machine permits of an increase in working productivity of stereoplotting up to 30 %. In comparison with conventional drawing tables with direct mechanical or electrical-analogous coupling with the model carriages of the stereoplotter, digitally controlled drawing tables can solve the following additional tasks:

- Optional choice of scale, separate for X and Y between model and map, e.g. in the range 0.1 ... 9.9 (DT 3454).
- Straight-line connections between measured points.
- Different types of lines (continuous line, dashed or dash-dotted lines).
- Drawing of simple symbols (square, triangle, etc.).

If the drawing table control is extended by additionally connected table-top or minicomputers, the range of solvable tasks may still considerably be increased (alignment of buildings, inscription of numbers and letters on maps, transformation of tilted exposures or relatively oriented models etc.).

2.2. Connection requirements

A prerequisite for the connection of the DT 3454 to stereoplotting machines (Topocart, Technocart or Stereometrograph) is that the coordinate outputs are provided with incremental rotary encoders (IGR). On the Topocart and Technocart the incremental rotary encoders are housed in the IGR box (Fig. 2) attached to the machine, on Stereometrograph G they are directly connected with the spindles of the model

carriages. In older models of the Stereometrograph the connection between the synchros on the model carriages and the IGRs is made by means of the Digitizer Box. The locating faces for the IGRs are in all cases so designed that not only the IGRs from Jena but also the encoders of Messrs. Data Technology may be attached. When using the IGRs from Jena the equipment additionally includes the IGR power supply (Fig. 2). A resolution of 0.01 mm is reached, when an IGR with 500 pulses per revolution is flanged to the 5 mm spindle of the Stereometrograph. However, in the IGR box for Topocart or Technocart IGRs with 1000 pulses per revolution must be used, since the 3 mm spindles to the IGR connection have a reduction ratio of 3 : 10. The connecting cables between IGR and the S-102 Interface of the DT 3454 should be as short as possible so as to achieve the optimum freedom from interferences.

2.3. Brief description of DT 3454

The DT 3454 consists of a box-shaped substructure containing the control electronics and the guiding system for the tiltable drawing table. The latter has a usable format of 142 cm x 86 cm and is provided with an electrostatic paper holding system, which allows the movement of the drawing medium for the orientation of the stereomodel. The tilted drawing table has such a height that the operator can do his work in a convenient attitude. On request the DT 3454 can also be equipped with a vertically adjustable transmitted light table.

Drive of the carriages is effected by stepping motors and toothed racks in X and Y direction. The X carriage moves on the primary guide way. The Y lineal is guided by ball bearings on the X carriage. The end of the Y lineal carries the holders for two drawing tools.

The DT 3454 has an operating console for the input of scale factors, mode of operation, type and length of lines, and symbols to be recorded. Lifting and lowering the drawing tool for the drawing of lines and symbols is released by a double foot switch. A small manual operating console allows the setting of the drawing tool to any positions. By means of this manual operating console the drawing tool holder with the Y lineal can be moved about 70 mm upwards without thereby entailing the loss of correlation, so that the stereooperator may conveniently make entries by hand on the drawing.

In stereoplotting the "track" mode is used by the operator, when contour lines or other natural curved lines have to be mapped. In this case the drawing pen follows directly the movements of the model carriages driven by hand wheels and spindles. In the operating mode "line" the drawing pen draws straight lines between successive measuring points. This is effected in such a way that in the measuring instrument the following point is set without the drawing pen following. It is only when a pulse is released by the foot switch that the point is joined with the preceding one by a straight line. It has proved expedient to plot curved lines of artificial origin (e.g. curves of streets) likewise in the "line" mode in such a way that the operator draws a polygon with very

short side lengths by repeatedly actuating the foot switch at short intervals. The foot switch is always actuated at the moment when the measuring mark does not deviate from the line to be mapped. When the left foot switch is actuated, the next point is approached with the drawing tool lifted.

The maximum drawing speed is 170 mm/s. It can be changed within certain limits. When drawing dashed lines the average drawing speed is still 45 mm/s.

Switching-over from tool 1 to tool 2 involves that tool 2 immediately moves to the previous position of tool 1. Thus the drawing can be made in two different colours or line thicknesses.

The marking of the points with different symbols is likewise released by the foot switch. Available symbol marks are square, cross, triangle, and square with cross.

The accuracy of the drawing table was checked by measuring grid mappings. The mean error was found to be $\pm$ 0.1 mm. The repetitive accuracy is claimed by the manufacturers to be $\pm$ 0.06 mm.

On-line connection of the interface renders it possible that by connecting a computer the instrument system is further extended to a computer-assisted stereoplotting machine.

3. Magnetic tape interface for Coordimeter and Digital Contrd Unit for Topocart-Orthophot D

3.1. General

Normally the necessity exists to input digital coordinate information obtained with photogrammetric stereoplotters into larger electronic computers, in order to calculate aero-triangulation nets or to process digital terrain models. Therefore, the data must be recorded on data carriers, which are capable of being read by any larger computers without further conversion. At the moment the periphery of most digital computers is best equipped with punched card and magnetic tape units. Punched cards are primarily used in the economic sector, where a host of data have manually to be handled. In photogrammetric data processing punched card input plays only a role, when available programs have to be modified by control cards or provided with constants. For data acquisition the 1/2 inch magnetic tape is better suited. The data flow between plotter and magnetic tape reaches only low transmission frequencies, so that it is necessary to buffer the information of sufficiently long information blocks (records). Therefore, magnetic tape units with built-in buffer stores are particularly suitable for the connection to stereoplotting machines. A unit of this type is Model 9832 of Messrs. Kennedy (Fig. 4). The Jena Works realized the connection of this magnetic tape unit to the instruments Coordimeter F, Coordimeter G, and the Digital Control Unit for Orthophot D.

3.2. Modes of operation

The Kennedy magnetic tape unit Model 9832 can be used in the "write" and "read" modes. When it is connected to the Coordimeter, the "write" mode is predominant. However, with Coordimeter G also the reading of the contents of the tape and the print-out with the daro 1154 serial printer is possible with appropriate coding. When the magnetic tape deck is connected to the Digital Control Unit for Orthophot D, the "read" mode is predominant. But also in the output mode with digital control it is possible to write a matrix of height numbers on the tape.

The two buffer stores of the magnetic tape unit have a capacity of 512 bytes. Therefore, the instrument automatically provides an EOR gap after 512 characters. Since it is to be avoided that this happens amidst a number to be recorded, records are formed by the Coordimeter and the Digital Control Unit, which are shorter than 512 characters. The output of the EOR to the magnetic tape unit is then automatically effected. With Coordimeter G the EOR can also be output to the tape unit by actuating a button on the keyboard console. The transfer of the buffer store contents after the last recording can be effected by the EOF button of the magnetic tape unit. In this way the data record is terminated by an end-of-file mark.

3.3. Off-line differential rectification

The application of the magnetic tape unit in connection with Coordimeter G and the Digital Control Unit for Orthophot D is to be described in more detail by referring to an off-line differential rectification system as an example. The off-line differential rectification gains increasing importance by the fact that its application on the basis of stored digital terrain height models is highly economic. The digital terrain height models are stored in data banks and are then available for the automatic control of differential rectification, the new aerial photo-material being obtained by repeated photo flights. With particular computer programs control data are gained from the terrain height information, which enable the cross slope of the terrain to be taken into account in the differential rectification process. Thus, with larger slit widths a considerable increase in working productivity can be achieved while simultaneously improving the image quality (correction of gaps, double images, and staircases in the orthophoto). Another feature of off-line differential rectification is the rectification of the entire photographs (double models) instead of single models being typical of on-line rectification.

Cross slope correction permits an increase of the profile distance in differential rectification with continuously moved slit diaphragm. This is the reason, why with the preceding scanning of the model in profiles not sufficient height data are gained so as to draw the contour lines with great accuracy and minimum departure from the true shape. Fact is that digital terrain models represent the terrain

best on the basis of digitized contour lines. Another aspect to be considered is that the relief belongs to that part of a map which undergoes scarcely any changes, so that an exact relief retains its value over decades. An off-line differential rectification system for the production of maps with contour lines should, therefore, be based on digitized contour lines.

The off-line differential rectification system Topocart C - Orthophot D with Digital Control Unit and Cross Slope Corrector requires a matrix of control numbers for the control of the rectification process; these control numbers contain terrain height and cross slope information for a grid-like point array. For calculating this matrix the program package "OFF-DE 78" was elaborated, which processes coordinates of arbitrarily arranged terrain points and is therefore especially also suited for the calculation of the matrix of digitized contour lines. The matrix of the control numbers can be output by the program optionally on punched tape or magnetic tape.

If the digital terrain heights can not yet be called from a data bank, then this height information must be gained in the form of digitized contour lines with the Topocart stereoplotter and the connected Coordimeter with magnetic tape output. For the full utilization of the Topocart-Orthophot D differential rectification equipment at least two Topocarts are required. The recording of points along the contour lines is controlled by the Coordimeter optionally in time or distance intervals. So as to check completeness the operator simultaneously draws the contour lines. For this purpose the drawing table ZT 90 x 120 is used, which is connected to Topocart. The addition of contour lines to the orthophoto can then be made either by graphically smoothing the drawn contour lines or the processing and drawing of digitized contour lines with an automatic Coordinatograph in off-line operation. The entire data flow is shown in Fig. 5. For obtaining the contour lines 3 photographs are used, which form two adjoining models. For rectification only the middle photo is then employed, which can quickly be oriented in the Topocart of the differential rectification system according to the previously determined setting data.
The stored contour lines enable repetitive rectifications to be made, where the same control data can be used again in the case of renewed photographs corresponding to those existing already. However, the program "OFF-DE 78" also allows the calculation of new data from up to 20 data records, so that in the case of repeated photo flights exactly corresponding photographs may be dispensed with. For this case an orientation technique was developed, which permits a fast orientation of single photographs in the right image carrier of Topocart-Orthophot on the basis of a control point mapping. But each operator may go on orienting the images in the differential rectification system as stereomodel in the conventional way with great accuracy. Rectification is made through the mechanical analogue computer of the Topocart and a true-colour optical image transfer system of high resolution with up to 5 times magnification between photograph and map.

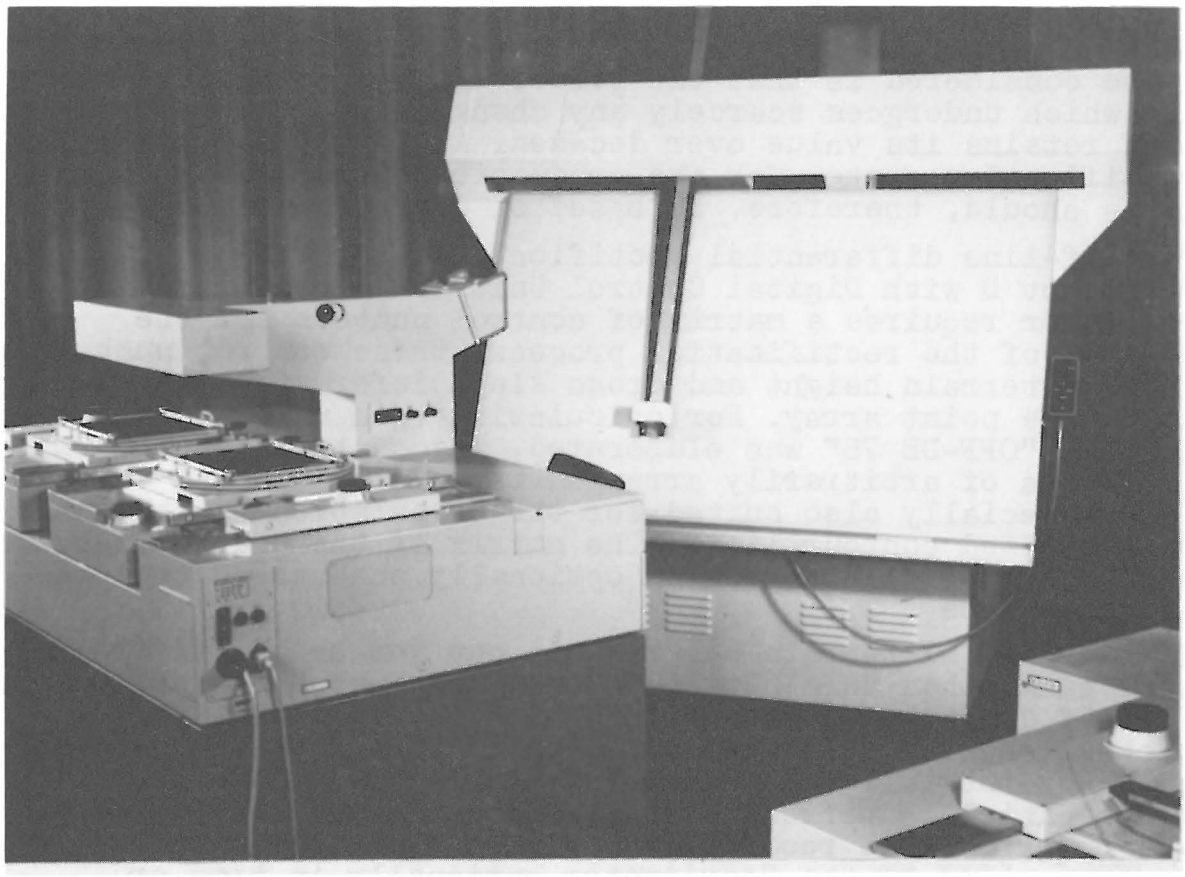

Fig. 1 Topocart with DT 3454 Drawing Table

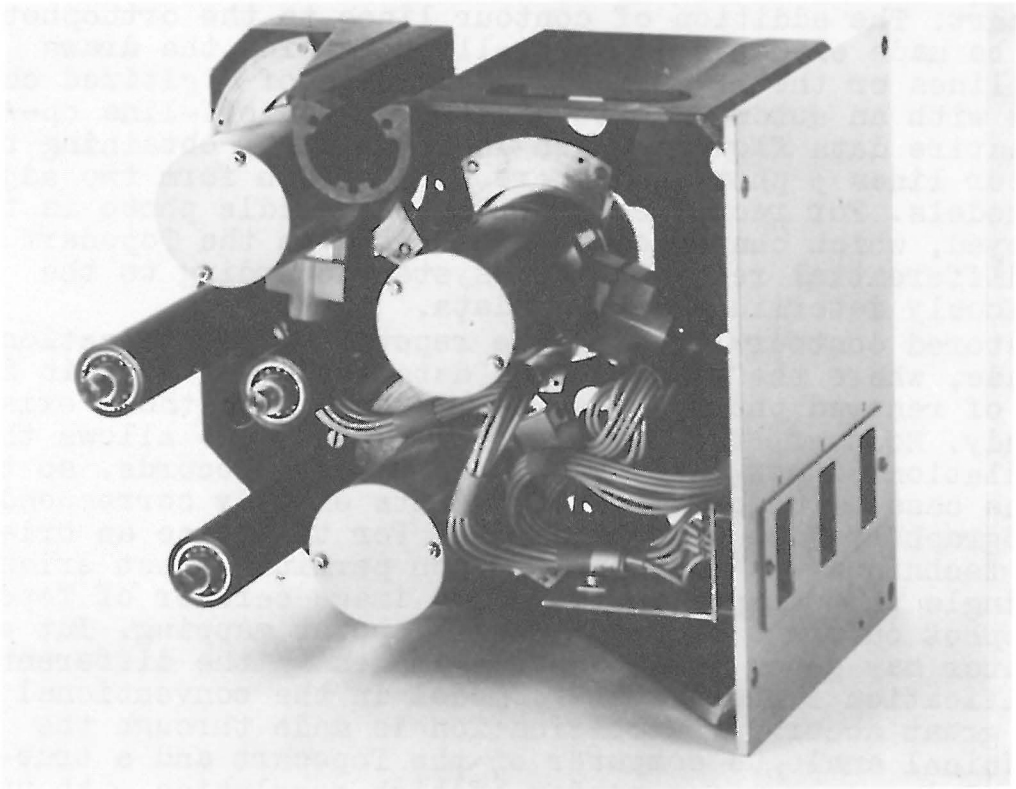

Fig. 2 IGR box

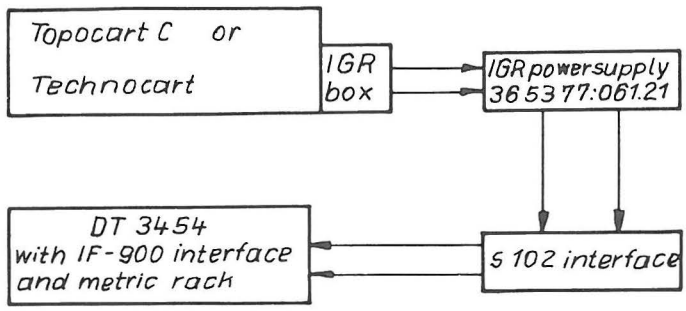

Fig. 3 Connection of DT 3454 to Topocart/Technocart with encoders from Jena

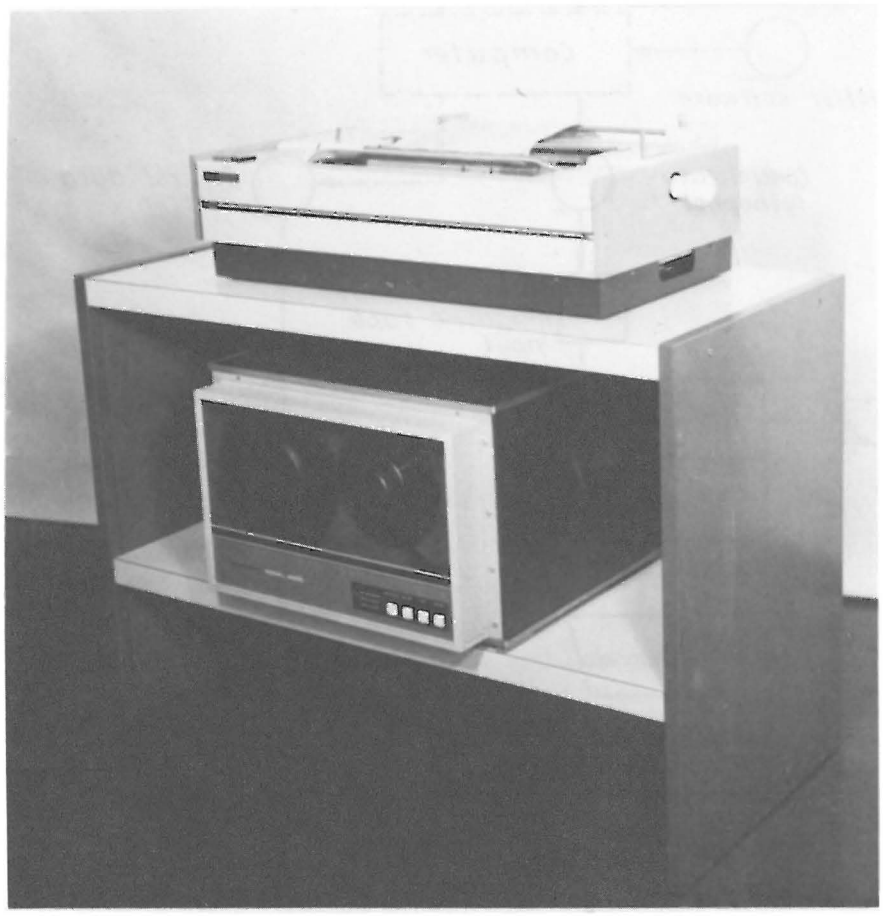

Fig. 4 Buffered magnetic tape unit Model 9832 of Messrs. Kennedy and the daro 1154 aerial printer for connection to Coordimeter G

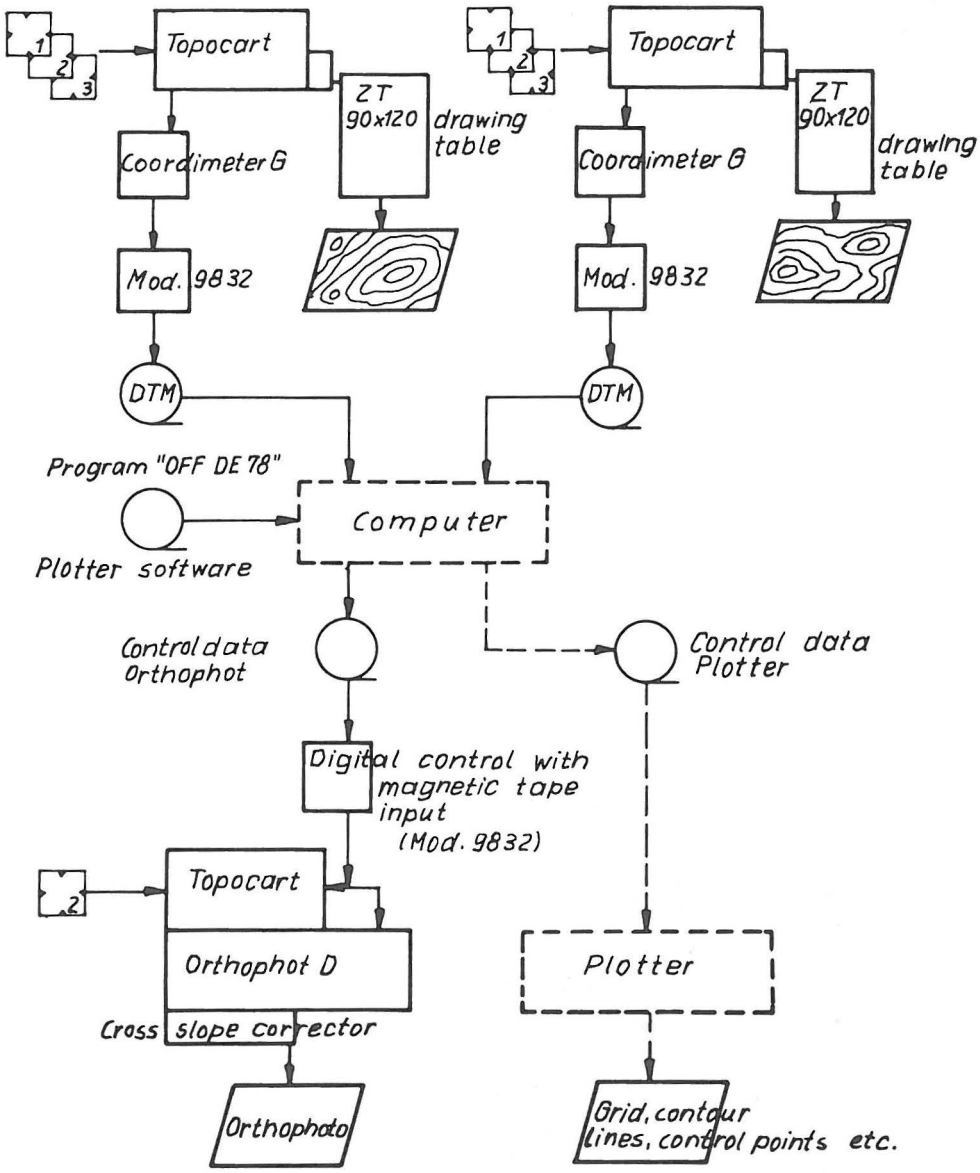

Fig. 5 Off-line differential rectification with Topocart C and Orthophot D with magnetic tape input and output