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ANALPRET Computer Assisted and Controlled Plotter for Teaching and Interpretation

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Introduction

If the technical niveau of eastern and western photogrammetric laboratories at the Universities are compared the differences are sometimes shocking. Although the computer age knocked at the door of plotter rooms in eastern part of Europe in form of cheaper PC's as well, the analytical plotters remain unaccessible for most of them because of financials.

The way for them stayed the digitalisation of classical analog plotters but first of all mono and stereocomparators in order to demonstrate the advantages of on line data reduction with application of special measuring programs.

Our Institute has also followed this way. The good old Zeiss Steco 1818 Stereocomparator was attached with circular encoders in X, Y and PX axes having coordinate counter in a separate box. For the measurement and control of PY a stepping motor was attached to the comparator and the necessary control boards were built into the computer. This simple configuration makes it possible to enter the plotter coordinates into the measuring programs, realizing human friendly stereo vision at least for the observed homologous points.If the plotter is supplemented with usual graphical PC peripheries, the teacher can build up an expanded developing environment which is achievable within restricted budget.

Our Dept of Photogrammetry went through this way and at last won an application for a project to build a low cost system, sponsored by the Remote Sensing Program Office at the Ministry of Industry.

During this two years period the Analpret has been planned and the experimental type has been built which usually proceedes the prototype.
Although the experimental stage of this modest development has not been finished yet, we can summarize the concept of this plotter and the first measuring results.

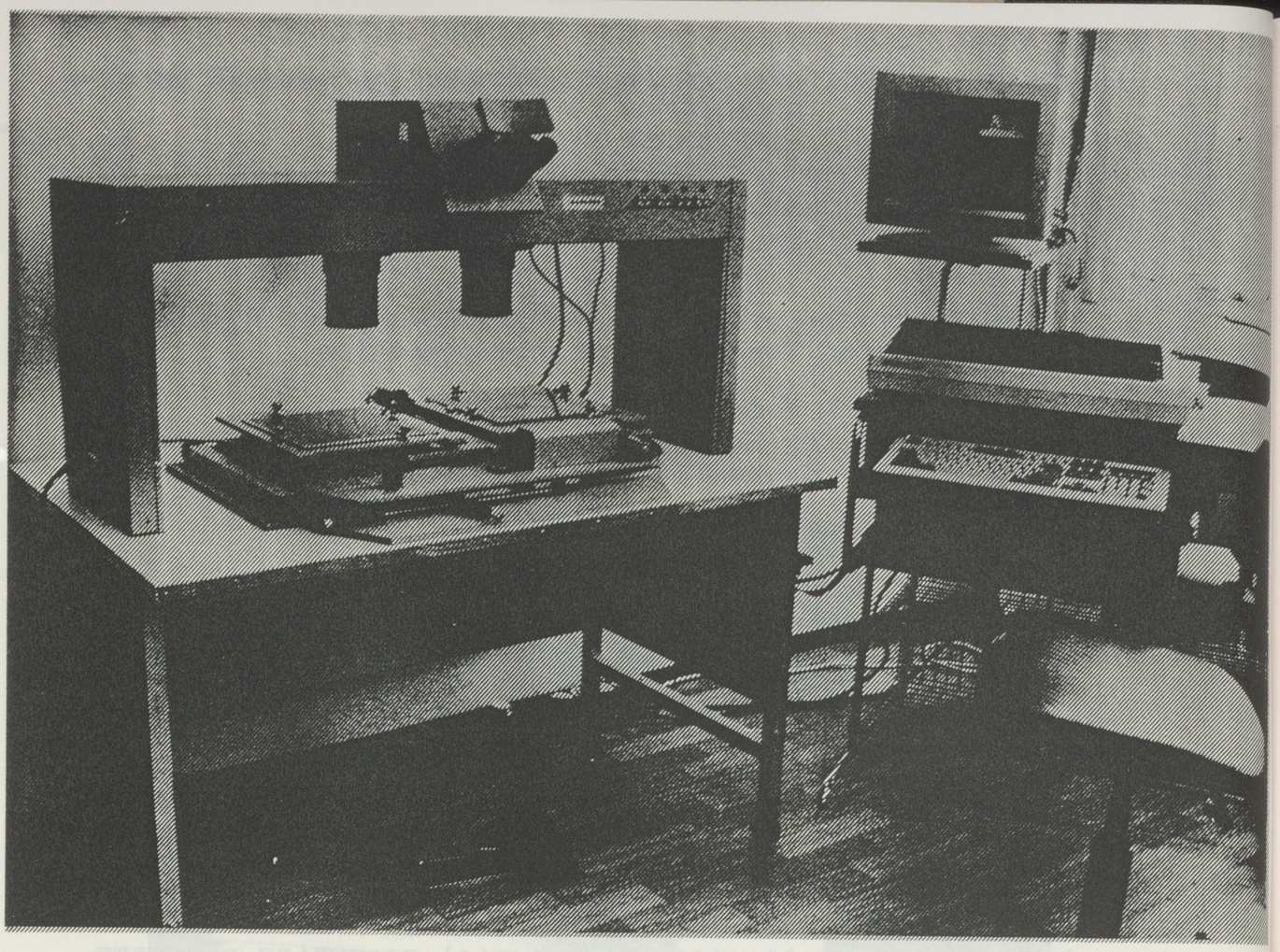


Fig.1. Analpret plotter (experimental type).

The Concept and Realisation

The plotter imagined was considered as representative of low cost instruments for teaching and analytical interpretation. It uses the PC attached as slave, communicating with the host controlling a work station by standard serial lines.

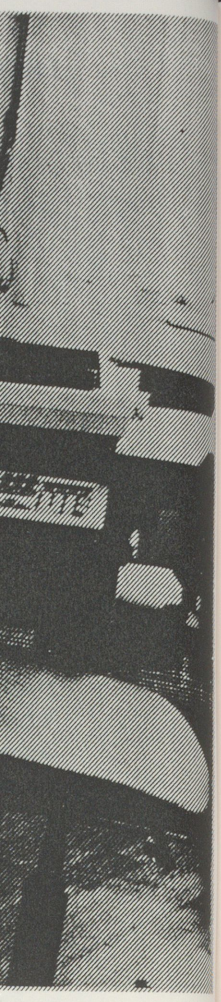
The measuring system follows the classical Pulfrich stereocomparator idea with line encoders for X and Y axes with 5 micrometer incremental resolution. The image carriers are moved by freehand, but fine movement may be made with pointing screws, if necessary.

The Px movement of the right image is controlled by screw and the impulses are given with circular encoder with 0.01 mm increments. The ranges of X, Y are 300 mm and 250 mm respectively. The measuring range of Px and Py is 50 mm.

A stepper motor has been applied for Py movement of the right image carrier with 5 micrometer distance increments related to the picture.

The digital counter for X,Y and PX and the circuits serve to adress the two pedals has been built into the plotter.

Further two PCB were put into the PC and machine code software serves for calling plotter coordinates and controlling stepper motor for movement and counting.



This program contols the different function of stepper, as measuring mode, stepped by hand or automatically and so on.

The optical structure of this plotter followes the idea of magnifying glass with telescope, when the magnifying glass has to be a well corrected (photographic type) lens system in order to achieve acceptable optical resolutions. The optical enlargement may be changed by the focus of frontal lens system. In our case the enlargements are 7x, 10x and 12x.

A light measuring mark illuminated with special bulb has been built into the optical system, the illumination may be controlled.

The software of the Analpret are written in Borland Turbo Basic, which produces compiled machine code EXE files.

The GRIDCOR serves to produce a correction array and software key for refining parallelity and perpendicularity within and between the plotter coordinate systems. The array and correction equations are used in the applied measuring programs.

INTOR using the GRIDCOR constants produces the affine transformation parameters for calculating image coordinates from plotter coordinates and back. The program evaluates the measuring result by T test. The residuals are between 0.01-0.03 mm.

RELABS uses the GRIDCOR and INTOR arrays and geodetic coordinates of control points for on line relative and absolute orientation. The program uses statistical test and gross error investigation for judging the quality of the whole measuring process. Using signalised control points 0.02-0.04 mm RMS may be achieved related to the image plane.

The coordinates of new points may be determined within the RELABS when the PY control automatically eliminates the Y parallax. The transformation parameters of RELABS are saved automatically. They serve for driving NEWPOINTS which is planned for further application, for huge quantity of new points for a file . The Py control seems to be faster in NEWPOINTS as the program itself smaller than the RELABS.

The automatic Py parallax removal may be considered "quasi" on line if the model is pointed continually.

The idea of Py removal is demonstrated in Fig.2. As it is known, there is no Y parallax in the normal case of orientation. The transformation of points with the relative orientation elements gives the key for this correction as it is explained in the figure.

We have also dealt with the parallax removal in case of space intersection by collinearity. It is observed that residuals in adjustment are loaded with gross errors caused by the y parallax. It may be logically accepted, that the residuals of observation equations, which keep to the 0 if the Py correction is also 0, will content the spread gross error of Py must be corrected automatically. If we introduce the sum of absolute value of the residuals as Py correction the Py parallax may be eliminated.
A more exact solution introduces the Py correction as unknown into the observation equations.

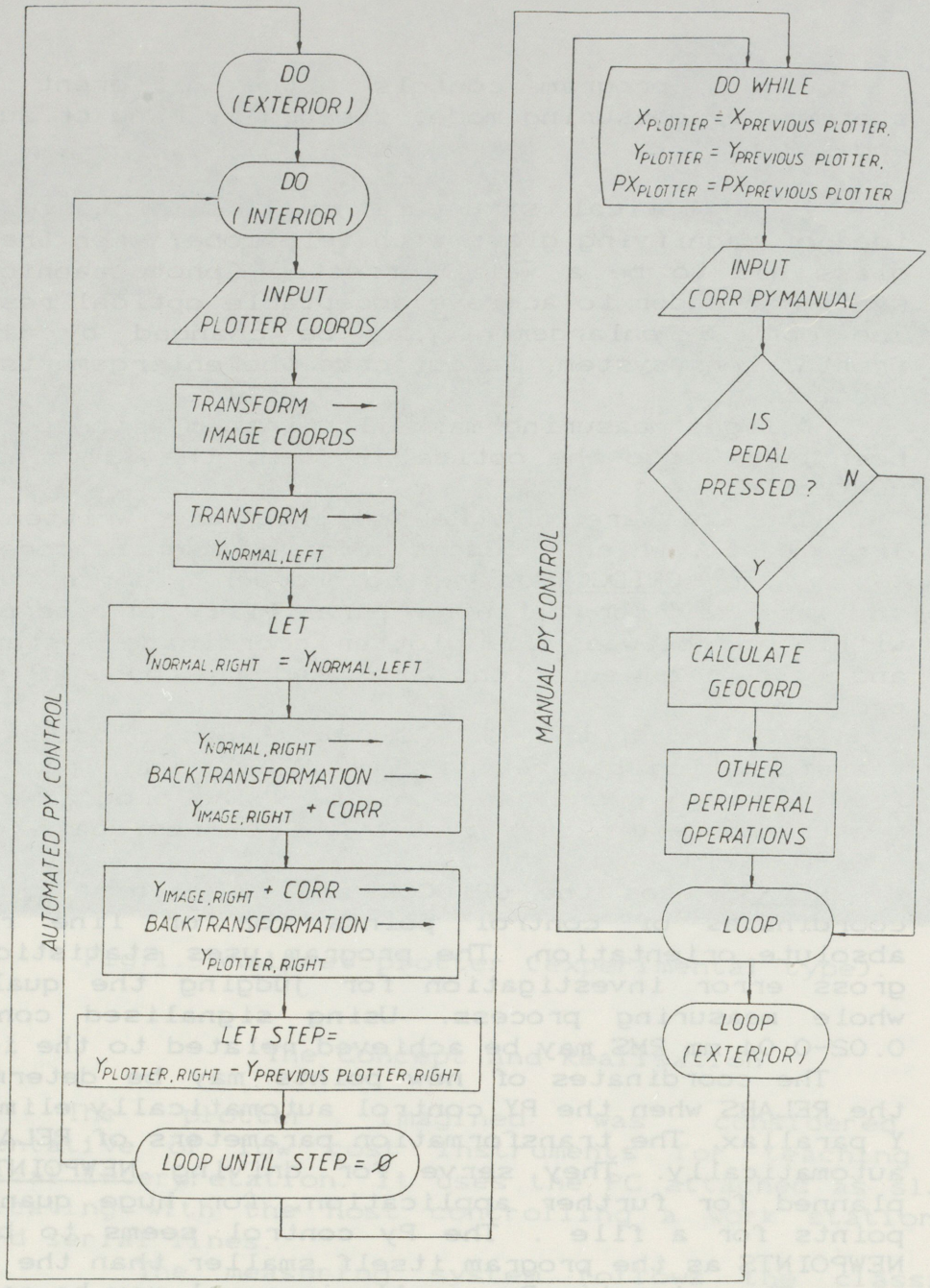


FIG 2 PY CONTROL AT THE ANALPRET

Summary

A computer assisted PC compatible low cost plotter has been developed with automatic parallax removal. Although it is only in experimental stadium yet,it seems to be suitable for teaching and pointlike digitizing purposes so that it may be fitted to the graphical working station. The PC serves as slave.

The solution for Py parallax removal was discussed and experienced practically as well.

The first measuring results show 0.02 -0.04 mm RMS errorsincoordinate measurements which are sufficient for some purposes. The plotter gives further possibility for writing measuring programs under PC control and gives way for teaching of user friendly man-machine cooperation.