Traster T10
Digital Imaging Stereoplotter Data Acquisition for GIS

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ABSTRACT

MATRA MS2i manufactures provides the Transfer T10 Digital Imaging Stereoplotter. The T10 is a state-of-the-art all-digital photogrammetric stereoplotter; see Fig. 1-1.

MS2i is a partly-owned subsidiary of the Matra Group, MS2i designed the T10 as a major technological improvement to the earlier analytical stereoplotters, the Traster T-1 through T-5.

The T10 is differentiated from traditional analytical stereoplotters by the fact that the stereo pair of images or photos are in the digital domain, rather than hardcopy. Source data such as digital imagery from the SPOT satellite or digital cameras can be input directly. Hardcopy source data such as aerial photographs is raster-scanned with a high resolution digital scanner, then input to the T10.

The T10 performs the following functions:
1) Photogrammetric data collection
2) Elevation modelling
3) Ortho-image creation

This data can feed a map production facility, a geographic information system, a command and control application, etc.

1. T10 CAPABILITIES

This section identifies the major capabilities of the T10.

1.1 Photogrammetric Data Collection

The T10 performs traditional photogrammetric data collection functions.
1) Aerial triangulation

2) Spatial triangulation for SPOT satellite imagery

3) Strereorestitution

4) Storage, retrieval, and display of photogrammetric data

1.2 Elevation Modelling

Elevation modelling is very effective with the T10, since automatic pixel correlation algorithms can be used to greatly accelerate process. Functions include:

1) Automatic creation of gridded elevation models from SPOT satellite imagery and small scale (1: 60.000) and smaller aerial photography

2) Creation of elevation model at random positions, and interpolation

3) Creation of contour lines

4) Verification and editing of elevation models (gridded)

5) Verification and editing of externally-produced elevation models

6) Verification and editing of elevation contours

1.3 Ortho-image creation

The T10 can create ortho-images from the source image and elevation model:

1) Creation of ortho-images (mono images can be used if elevation model already exists) in various projections

2) Georeferencing/geocoding using existing externally-created or T10 created elevation models

3) Creation of monoscopic and stereoscopic perspective views

1.4 GIS Operation

The T10 is designed to feed its output to Geographic Information System (GIS):

1) Support an on-line GIS

2) Export to an external GIS

1.5 Special Features

The T10 includes special features:

1) A particular strength of the T10 is its patented capability to pan in sub-pixel steps. This results in totally smooth panning and highly accurate positioning of the floating mark for measurement.

2. BENEFITS OF DIGITAL IMAGING STEREOPLOTTERS

The benefits of working entirely in the digital domain with digital imaging stereoplotters, compared to using analytical stereoplotters are:

1) Improved accuracy:

a. The image pairs are archived digitally; they are easier to retrieve and not subject to deterioration and geometric instability.
b. The stereo model can not be altered by film shrinkage or out- of-calibration of the stereo plotter. Each retrieval will bring back exactly the same model without any new orientation.
c. The human eye misses many details because of insufficient contrast. Image processing functions (such as equalization, edge- enhancement, contrast, etc.) improve the details in the viewing. This is particularly effective for SPOT imagery stereoplotting where the geometry is very accurate but many details are hard to see or are invisible.
d. There is no need to produce a hard copy if the image is already digital (SPOT and future digital cameras). For example, spatial triangulation of SPOT imagery is thus more accurate.

2) Reduced field survey - The image processing helps to plot more details, thereby reducing the reliance on fields surveys to supplement the photogrammetry. Again, this is particularly effective for exploiting SPOT imagery.

3) Improved production rate - functions are automated wherever practical

4) Automatic elevation models - The T10 computes a gridded elevation model at the same resolution as the digital image pair.

5) Reduced operator fatigue - The operator views the stereo pair via a 3-D shutter/polarized monitor with polarized glasses, instead of through binoculars. Head motion during viewing is possible

6) Graphic superimposition - 3-D vector, polygon, and point data are drawn in real-time as colored overlays on the digital image, without additional hardware. Registration is more accurate and perfectly stable during panning and zooming.

7) Stereoplotting across the boundaries of adjacent stereo models is possible because the next model can be retrievad in a few seconds.

8) Improved aerial triangulation. The T10 provides on-line creation of strips to allow reliable data collection for aerial triangulation. After the block adjustement (bundle, independent models, or polynomial adjustement of strips), each model is automatically updated to be ready for stereoplotting without reorientation

9) Increased functionality- The T10 provides new functions not available on analytical stereoplotters, or which require additional hardware:

- Automatic creation of elevation models
- Verification and editing of elevation models and contours
- Ortho image creation and control
- Stereoscopic superimposition
- Interactive automated feature extraction

10) Exploitation of digital technology - Digital technology, on which the entire T10 is based, is advancing very rapidly in terms of price/performance. For example, processing speed and data storage densities are dramatically improving. In contrast, there is very little advancement in mechanical/optical components used in analytical stereoplotters. The T10 is therefore poised to exploit future technology.

11) Upgrade - system performance and functional improvements are made by software upgrades and, less

frequently, replacement of standard off-the-shelf computer boards and peripherals.

12) Maintenance - there are no mechanical/optical moving parts, thereby eliminating calibration and reducing maintenance difficulty.

3. END USER'S VIEW OF THE SYSTEM

The T10 is an ergonomically-design single-user workstation. The console contains all electronic equipment and provides ample workspace for the operator.

At the center of console is the primary display device, a high resolution 3-D color monitor. It displays a 3.D view of the image being analyzed, user created graphical overlays, and floating cursor. The operator wears polarized glasses. The display creates alterning left and right views at 120 Hz through a polarizing screen with a liquid crystal shutter. This fast rate provides flicker-free viewing. Polarized glasses are worn by the operator. The operator's head position is quite free, in contrast to traditional stereoplotters with binoculars for viewing. The stereo scene can be smoothly is controlled with a hand-operated cylinder. Designation is controlled by two foot switches. Selection of viewing options is accomplished from a touch- sensitive screen which presents menu buttons.

At the right of the console is a color monitor, keyboard, and mouse used to control all the basic operations and file management functions of the workstation.

4. SYSTEM ARCHITECTURE: BASIC CONFIGUTRATION

Two subsystems comprise the T10:

1) Image Processor

2) Host Computer

In addition, the T10 includes an ergonometric console.

4.1 Image Processor

The Image Processor consists of the following hardware and software items:

1) Controls and displays

a. 3-D display with
   - Color monitor, 1280x1024 pixels, RGB
   - Polarizing liquid crystal shutter

b. Operator controls:
   - Trackball (right hand)
   - Cylinder (left hand)
   - Two foot switches

c. Touch sensitive black-and-white display (for menu buttons)

2) VME backplane chassis, with

a. 68020 processor with floating point co-processor
b. 8 MB RAM
c. two 600 MB hard disk drives (for image data)
d. SCSI interface (for hard disks)
e. Pericolor PRR image processor
f. Pericolor image memory, 18 MB
g. High speed Pericolor bus
i. Controls interface
j. Ethernet interface (for connection to Host Computer)

3) T10/Image Processor Software

The Image Processor performs the following functions:

1) Loads left and right images tiles from disk for initial display and during panning.
2) Controls the liquid crystal shutter for creating alterning left and right views
3) Displays the stereo image
4) Maintains and pans the stereo image under trackball control (the floating mark remains fixed in the center of the screen)
5) Move the floating cursor in the Z-direction under cylinder control.
6) Refreshs the floating mark
7) Zooms the stereo images during loading form disk, if requested.
8) Privides a graphical and text touch-sensitive display for menu selection of various image processing functions by the operator (e.g., cursor color, zoom value, start/stop, change/contrast, etc.)
9) provides footswitches for X, Y, Z point and tentative point designation
10) Record X, Y, Z points
11) Plots the color graphic superimposition
12) Moves the graphics superimposition with the panning of the stereo image
13) Performs pixel correlation for automatic digital elevation models computation

14) Resamples images for sub-pixel pan
15) Resamples images for rotation, anomorphism, ortho-images, perspective views.

4.2 Host Computer

The Host Computer consists of the following hardware and software items:
1) Sun SPARC station IPC, with
a. RISC processor and floating-point co-processor
b. 12 MB RAM
c. Two 207 MB internal hard disk drives
d. Floppy disk drive, 3.5"
e. Color display, 115x900 pixels
f. Keyboard
g. Mouse
h. Ethernet interface
i. RS-232 interface

2) Sun OS UNIX operating system

3) T10/host Computer software

The Host Computer performs the following functions:
1) Provides operator control over the major Image processor functions
2) Receives photogrammetric coordinates from the Image Processor, and provide storage, retrieval capability
3) Computer stereo model
4) Supports an optional on-line GIS
5) Displays Graphic or raster maps
6) Computes aerial triangulation or spatio-triangulation block adjustements
7) Manages files and data
8) Displays contours, profiles, map, perspectives
9) Displays colored isometric views of elevation models

5. OPTIONS

The following optional items are available:
1) Digital raster scanner subsystem for photographs
2) Nine-track magnetic tape drive to load digital images
3) Demeter GIS software
4) Plotters, including electrostatic
5) Additional memory for the SPARC station, to support more applications
6) Additional on-line storage, including hard disk and optical disk
7) Standard SCSI peripherals, such as CD-ROM drive, 8mm tape drivers
8) Ethernet networks to interface multiple T10s
9) File servers to support multiple Y10s.