

Laser-Scan Ltd.

Software Product Specification

MATRIX package

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1 DESCRIPTION

The Laser-Scan MATRIX package is the support package for all Laser-Scan DTM generation and manipulation software, and other Laser-Scan software using the DTI matrix file format.

There are 4 Laser-Scan DTM production and manipulation packages:

- o DTMPREPARE - prepares IFF format vector data for subsequent DTM construction using package DTMCREATE,
- o DTMCREATE - the DTM creation package,
- o TVES - **T**errain **V**isualisation and **E**xploitation **S**oftware,
- o DTMCONVERT - conversion of DTM data between DTI format and external formats.

Package MATRIX contains:

- o Laser-Scan DTI (**D**igital **T**errain **I**mage) format DTM utility programs, for DTM manipulation, joining and edit,
- o a basic DTM viewing program, and,
- o a DTI file interface subroutine library (DTILIB) for applications programmers.

1.1 Package MATRIX - program input/output

The DTM utility programs within the MATRIX package require grid based data to be held in Laser-Scan's DTI (**D**igital **T**errain **I**mage) format. Data output and data conversion is to other DTI format grid files, to Laser-Scan vector IFF (**I**nternal **F**eature **F**ormat) files, or to text files.

2 HARDWARE PREREQUISITES

The following computer hardware requirements are needed to run MATRIX.

- o Any DEC VAX, MicroVAX or VAXstation computer supported by the current version of VAX/VMS.
- o At least 10MB of available disc space for software, plus sufficient for data files.
- o At least a 4096 page working set per process, and a virtual page count of 30000 pages is needed for efficient operation of the larger utilities.

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- o Any DEC-compatible alphanumeric terminal.
- o Any LSL-supported graphics device, currently one of:
 - Sigmex 6000 series colour display.
 - Sigmex ARGS 7000 series colour display.
 - Tektronix 4010 or 4014 DVST with enhanced graphics and optional Laser-Scan TMU controller (provides only vector graphics capability).
 - A DEC VAX workstation running UIS or the DECwindows/Motif windowing systems.
- o Any DEC-compatible alphanumeric terminal (optional if graphics device has alphanumeric terminal capabilities).
- o Optionally, a Laser-Scan supported digitising table with 16 button cursor, for use with DTIVIEW matrix viewing utility for source document registration and command menu input.

3 SOFTWARE PREREQUISITES

MATRIX modules run under VAX VMS Version 5.4-3 (or later version, assuming continued upwards compatibility by DEC). MATRIX co-exists with other interactive and batch processes.

For the use of Motif on a VAXstation, the "DECwindows Motif" layered product from DEC is required. The "VMS DECwindows Developers Kit for Motif" is not adequate.

For the use of UIS on a VAXstation, VAX VMS Workstation Software (VWS) version 4.3 or later is required.

A minimum working set of 4000 pages is recommended. Larger working sets will help performance, particularly with large matrix files.

Laser-Scan's **IFF Map Processing** package (IMP) is a prerequisite. Laser-Scan's LITES2 interactive digitising and editing software is recommended for digitising and editing vector input data. LASERTRAK automated digitising is recommended for large numbers of input documents.

4 GROWTH CONSIDERATIONS

The minimum hardware and software requirements for any future version of this product may be different from the minimum hardware requirements for the current version.

5 SUPPORT LEVEL

MATRIX is a fully supported Laser-Scan standard software product.

NOTE

There is a facility (DTIPATCH) within the MATRIX package to edit the header of a DTI file to signal to any subsequent processes that the data within the file is not at the standard start corner and direction (SW and clockwise), particularly important for the correct display of the DTI file in LITES2.

Support for rotated DTI files is limited to DTILIB, DTIPATCH, DTIROTATE and LITES2. It is provided for the purpose of initial examination and registration of raw data. Such non-standard data should be rotated using DTIROTATE before further processing.

It is not recommended that any data transformation MATRIX utilities (except for DTIROTATE) be used on any of these non-standard DTI files as unexpected results will probably be encountered. DTIPATCH and DTITRANS/DESCRIPTOR may still be used safely to change any header parameters.

BIT datatype DTI files are only supported by a limited set of programs (DTICONVERT, DTITRANS/DESCRIPTOR, DTIPATCH and LITES2), and only for storage and display.

For any sort of processing of BIT datatype files, such as transformation or combination, the data should be converted to BYTE datatype using DTICONVERT. This restriction arises from the fact that a byte is the smallest data unit capable of independent manipulation by the VAX computer architecture.

6 COMPONENT LIBRARY

The MATRIX package contains DTILIB which provides a library of functions which enable an applications program to access DTI files, and perform basic I/O operations on both the header and data areas. The following groups of routines are provided within the library:

1. File Manipulation - eg. DTI file creation
2. DTI Utility - eg. print header details
3. Header Read - eg. read word from header

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4. Header Write - eg. write word to header
5. Data Read - eg. read word from data area
6. Data Write - eg. write word to data area
7. Header Copy - eg. copy array of byte values to header
8. Data Copy - eg. copy array of word values to the data area
9. Data Initialisation - eg. set all data values to 0

The library allows up to 9 DTI files to be opened simultaneously.

It should be noted that the DTILIB functions utilise the memory mapping routines (eg. VIO\$OPEN_SEC) within the Laser-Scan library LSLLIB, along with other LSLLIB I/O functions. An applications program that utilises DTILIB must therefore be linked with LSLLIB. A shared image of LSLLIB routines is provided as part of the Laser-Scan kernel LSLSYSTEM package.

7 COMPONENT MODULES

The MATRIX package consists of DTILIB and the following component modules:

MODULE DTIVIEW

The module DTIVIEW allows elevation data held in a grid DTM to be viewed as a 3-dimensional image. The module has facilities to generate a 3-D terrain image using either a parallel (isometric) or perspective projection. The terrain image may be output to a range of vector graphic devices, or to an IFF vector file.

The main features of DTIVIEW are:

- o Use of the whole or part of a digital terrain matrix
- o DTM sub-sampling
- o Registration of the DTM to a source document positioned on a digitising table
- o Isometric or perspective view generation
- o Production of a fishnet representation
- o User control over the direction, height and distance of viewing position
- o User control over the vertical and horizontal rotation of the model, and vertical exaggeration
- o Generation of a terrain profile between 2 points
- o Output to a colour graphics device with:
 - Full or split screen display
 - User positioning and scaling of image, or autoscaling and positioning within the plotting area
 - User control over colour representation
 - User definable colour lookup table
 - Annotation with user text and legend
 - Independent manipulation of the terrain view and any vector overlay or user annotation
- o Output to an IFF vector file for subsequent plotting on a pen or photo-plotting device
- o Command menu input

The facility to overlay data describing surface features (eg. rivers and woodland) upon a 3-D terrain image is available with the TVES module DTIVIEWEXTRA.

MODULE DTIEDIT

The module DTIEDIT enables the interactive display and editing of a Laser-Scan Digital Terrain Image (DTI) file, using a VT100 compatible display. In addition a number of non-interactive editing commands are provided, and an option to output the matrix display to a line printer or file.

The program will handle all types of digital terrain image headers, and currently supported data formats (ie. byte, word, longword, real and bit).

The matrix is displayed as an image of up to 26 classes, with each class (ie. band of values) being represented by an alphabetic character (lowest A, highest Z). The class interval, range of values displayed, and the area of the matrix displayed and available for editing may be set by the user.

Interaction with the display is via the keypad keys.

The main features of DTIEDIT are:

- o Display and editing of all Laser-Scan DTI raster format files
- o Full interaction with the displayed data including
 - Use of the keypad keys to move a screen cursor around the matrix
 - Continually updated display of cursor position and associated matrix value
 - Editing of individual matrix points
 - Editing of line or rectangular area of matrix points
 - Scrolling of the display in y
- o User control over the class interval and display range
- o Output of the matrix representation to a line-printer
- o On-line help

MODULE DTIBLEND

DTIBLEND is the MATRIX Digital Terrain Image (DTI) file edge blend utility. It takes as input two DTI files, usually containing terrain elevation models, and edge matches them to avoid value discontinuities at the matrix adjoining edge. Options are provided to hold one matrix unchanged while smoothing the other to match it, or to smooth both matrices to a common mean along the edge. An option is provided to read in IFF vector data for use as control to the smoothing process.

The data in all the input DTI files should be at the same grid resolution (no grid interpolation is performed).

Changes of DTI file grid resolution should be performed first using the DTITRANS utility.

DTIBLEND offers the following features:

- o holds one matrix unchanged while smoothing the other to match it, or
- o smooths both matrices to a common mean along the edge.
- o reads in IFF vector data for use as control to the smoothing process.
- o processes in_situ, i.e. open both input files for read and write access. This option is useful when edge blending large DTI files when the user's virtual address quota is inadequate for opening additional DTI files for output.
- o override of default blend border width (3 posts).
- o reports changes that exceed a user specified threshold value and
- o outputs editing directives to ROVER guidance files, and
- o generates a listing file.
- o is command driven.
- o on-line help and full user documentation.

MODULE DTITLE

DTITLE will either merge up to 8 DTI (**D**igital **T**errain **I**mage) files into a larger DTI output file, or will extract an area of interest from an input DTI file and write this to a separate DTI output file. In addition DTITLE may be used to create void areas in a DTI file.

The data in all the input DTI files should be at the same grid resolution (no grid interpolation is performed).

The output DTI file will be produced at the same grid resolution as the first input DTI file

Changes of DTI file grid resolution should be performed first using the DTITRANS utility.

DTITLE offers the following features:

- o joins DTM grids generated by the DTMCREATE package or other systems which use DTI files.
- o creates void areas or areas of constant value in the DTI file.
- o very efficient amalgamation algorithm.
- o is command driven.
- o on-line help and full user documentation.

MODULE DTICOMBINE

The module DTICOMBINE allows data values in one or more (up to 8) DTI files to be combined according to user specified arithmetic operations. The module creates an output DTI file containing the resulting data values.

Optionally only data values that lie within a user specified rectangular window may be processed.

DTICOMBINE is used to perform overlay operations and determine differences between DTI files.

DTICOMBINE may use the following operators and functions in the expression:

Operators are chosen from the set:

Arithmetic operators:

unary minus	-	e.g.	- A
addition	+	e.g.	A + B
subtraction	-	e.g.	A - 3
division	/	e.g.	A / 2
multiplication	*	e.g.	A * 3
exponentiation	**	e.g.	A **1.2

Bitwise operators:

bitwise AND	&	e.g.	A & 127
bitwise OR		e.g.	A B
bitwise NOT	~	e.g.	~ A
bitwise XOR	^	e.g.	A ^ B

Logical operators:

logical AND	&&	e.g.	(A > 1) && B
logical OR		e.g.	(A<3) (B>20)
logical NOT	~~	e.g.	~~(A = 4)
logical XOR	^^	e.g.	(A = 3) ^^ (B < 3)

Relational operators:

less than	<	e.g.	A < 3
greater than	>	e.g.	D > 4
equal to	=	e.g.	A = B
not equal to	<>	e.g.	A <> 6.7
less than or equal to	<=	e.g.	C <= A
greater or equal to	>=	e.g.	B >= (10*A)

Functions available are:

absolute	ABS	e.g.	ABS(A)
nearest integer	NINT	e.g.	NINT(3.1415927)
arc cosine	ACOS	e.g.	ACOS(.32)
arc sine	ASIN	e.g.	ASIN(A)
arc tangent	ATAN	e.g.	ATAN(B/A)
cosine	COS	e.g.	COS(90)
sine	SIN	e.g.	SIN(D)
tangent	TAN	e.g.	TAN(A/B)
maximum	MAX	e.g.	MAX(A,B,C,D,E,F)
minimum	MIN	e.g.	MIN(2,D,B)
conditional	IF	e.g.	IF(A>3,A,B)

MODULE DTIROTATE

DTIROTATE is a matrix manipulation module to permit reordering of DTI format DTM rows and columns to suit customer requirements.

DTIROTATE offers the following features:

- o takes a DTI format DTM grid generated by DTMCREATE or another system and reorders (flips) its rows and columns to suit customer requirements.
- o changes the 'origin' of the output file to be any of the four corners of the input DTM if required.
- o enables the data to be ordered by row or by column with respect to the original model.
- o creates a DTI format DTM file.
- o provides "most often required" default settings for all options.
- o is command driven.
- o offers command file operation to reduce operator error rate and use of "guidance files" for training, demonstrations, and semi/fully-automated operation.
- o on-line help and full user documentation.

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MODULE DTI2TEXT

The module DTI2TEXT converts a DTI file into a formatted text file. The record format of the text file may be user defined at run-time. Integer and floating point format output may be specified.

DTI2TEXT provides a data window facility to enable the user to select sub-areas of the DTI file for text conversion.

MODULE DTICONVERT

The module DTICONVERT enables a user to convert between the header and data type formats supported within Laser-Scan's Digital Terrain Image (DTI) raster files. This conversion may be carried out to reduce the size of raster images stored on disk, or to prepare data for display using TVES modules such as ROVER.

The module allows conversion:

- o from MIKE, TED4, UHL1, ALVY and LSLA header formats to UHL1, TED4 and LSLA formats
- o between BYTE, WORD, LONGWORD, REAL and BIT data formats

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MODULE DTIPATCH

The module DTIPATCH enables the contents of a DTI header to be modified. Currently DTIPATCH operates only on the record fields that are common to all DTI header types (ie. matrix extent values, grid interval values, minimum and maximum range values and data corner and orientation).

DTIPATCH is an interactive prompt driven program.

MODULE DTITRANS

The module DTITRANS performs the following sets of operations on grid data held in a DTI format:

- o transforms data held in one map projection system into another projection system
- o transforms data held in a map projection system into Geographicals (latitude and longitude), or from Geographicals (latitude and longitude) to a map projection system
- o transforms data using affine transformation parameters determined by the IMAGEPROCESS (was SATMAP) image orientation module, to create an image map
- o resamples data to new x and y sample intervals and coordinate space, using control point files for alignment, without any projection change.
- o allows a DTI projection record to be created and modified

The module is applicable to all types of raster data, but is primarily used to transform satellite or digital terrain data.

MODULE DTIFROMTEXT

The module DTIFROMTEXT converts a text file into a DTI file. The program supports a range of text file input formats, controlled by the qualifiers, including the reading of z height data only, or x,y,z data, and a limited range of customised translations.

NOTE

See the warning in section 5 about non-standard orientation DTI files.