Map Digitizer Program Version 2.1.0 - Help Topics

This software is freeware. Use it and pass it along.

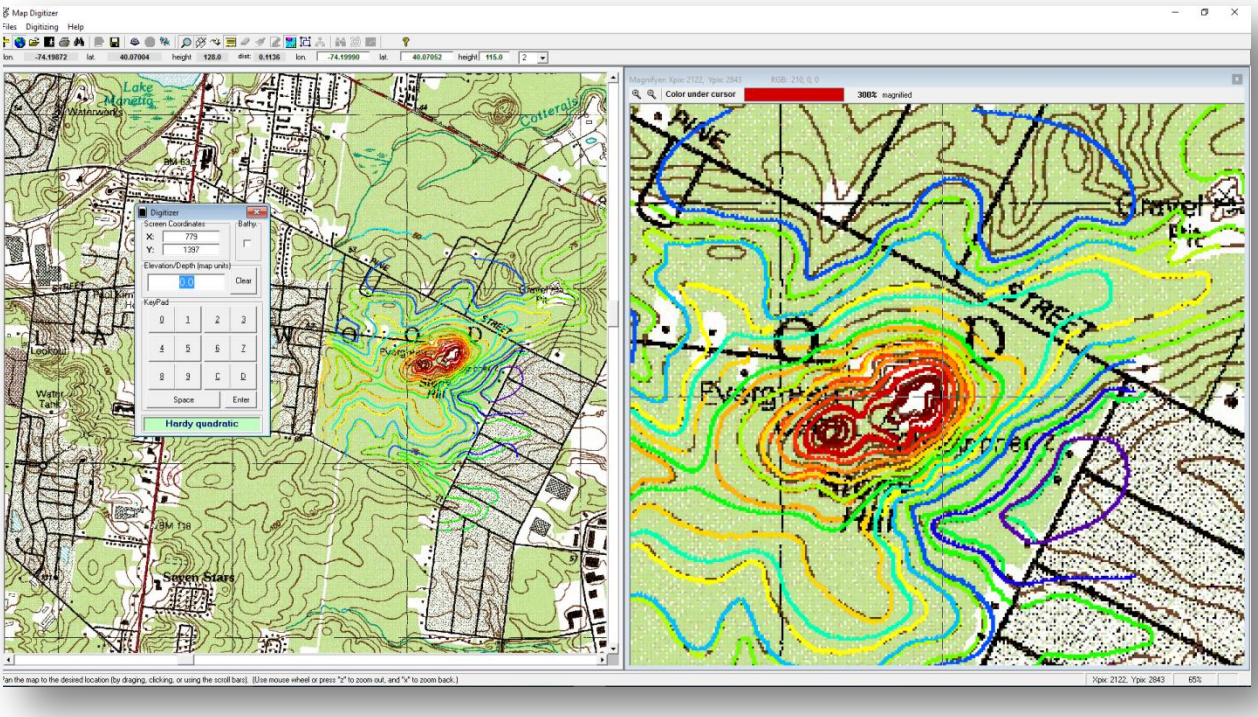
TableWorks is a licensed component of GTCO CalComp Corporation which allows it to be incorporated into the installation programs that use their table digitizers.

This program is still in its developmental stage. Please report any bugs to the author, Chaim Keller, at: chaimkeller@yahoo.com

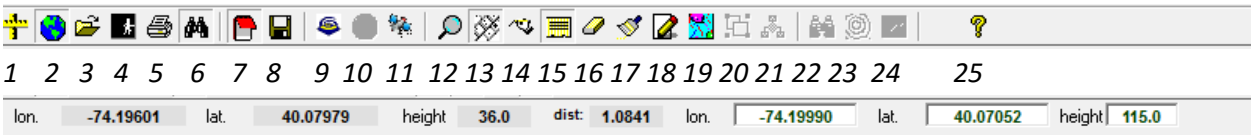
The latest version of this program will be maintained at the following address: http://www.chaitables.com/MapDigitizer_setup.exe

Introduction

This program was originally conceived as a replacement for a map digitizing program that was written many years ago by Dr. John K. Hall to run on DOS using Halo graphics and employing a GTCO digitizer with a 16 button mouse. That program was remarkable for its capability to digitize a great deal of points in a short amount of time. To bring the software up to date, Dr. John K. Hall (jkh1@012.net.il) kindly offered to support the writing of its replacement which can run equally well with or without a GTCO digitizer. However, during the course of the program development, I drifted from the original idea since it was my feeling that much more could be accomplished by writing a user-friendly Windows based interface that incorporated digitizing as well as other features of John Hall's original suite of DOS programs such as rubber sheeting (working on a grid of the graticule intersections so as to correct for imperfections in printing, scanning, etc.) and DTM creation using Hardy Quadratic Surfaces, all in one package.



Picture (above) shows program in the process of creating Hardy Quadratic Surfaces



Km. from cursor *Goto coordinate text boxes*

Toolbars and coordinate text boxes

Buttons (left to right):

1: Options** menu, 2: **Maps**, 3: **Open** stored contour file (topo_pixel.xyz), 4: **Goto** coordinates entered in the coordinate text boxes, 5: **Print** map, 6: **Search** for digitized points, 7: **Report** listing the digitized points, 8: **Backup** results as dxf file, 9: **Enable** GTCO CalComp Tablet Digitizter interface, 10: **Google** Earth interface (not supported in this version), 11: **GPS** interface, 12: **Magnifier** window (right panel in uppermost picture), 13: **Digitize**, 14: **Extend** grid lines, 15: **Rubber** Sheeting, 16: **Eraser**, 17: **Sweep** eraser, 18: **Edit** digitized points, 19: **Hardy** Quadratic Surfaces, 20: **Create** DTM, 21: **Smooth** merge areas, 22: **Search** for highest points, 23: **Contours**, 24: **Profiles**, 25: **Help

TOOLBAR (buttons, left to right, see picture above)

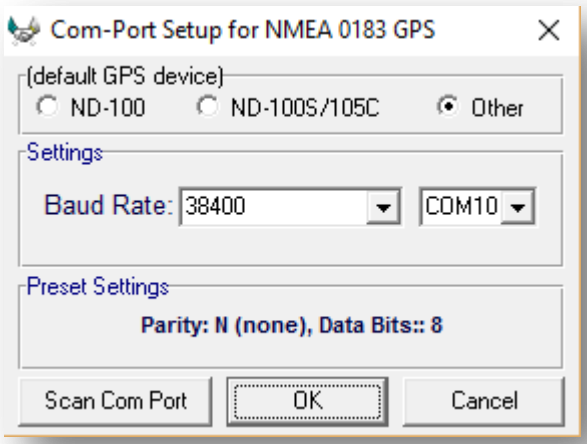
1. **Options**. Add maps, change opening map to one of those in a list, define boundaries, change settings for program features.
2. **Map**: Open the map defined in "Options" to be the default.
3. **Open**: Open saved topo_pixel.xyz format file for replotting as contours.
4. **Goto**: go to the coordinates entered in the coordinate text boxes
5. **Print**: Print a screen shot of the map
6. **Search**: Search for digitized points.
7. **Report**: Display search results.
8. **Save**: Save the digitized data.
9. **Tablet**: Enable GTCO CalComp Tablet interfacing.
10. **Google Earth**: Plot digitized points on Google Earth (not supported in this version).
11. **GPS**: Use a GPS device connected to a USB port on your computer to locate your position on the displayed map (requires a geographic latitude and longitude coordinate system).
12. **Magnify**: Open magnify window.
13. **Digitize**: Plot previously digitized points and open digitizer dialog
14. **Extend**: Extend partially missing or hidden grid lines.
15. **Rubber Sheeting**: Run the "Rubber Sheeting" Wizard.
16. **Eraser**: Click to erase errant contour points (continually press the left mouse button while erasing.)
17. **Sweep**: Define rectangular region to erase all the digitized points.
18. **Edit**: Edit digitized points, i.e., delete ("K"), or move ("R").
19. **Hardy**: Drag the mouse to define a rectangular region for calculating Hardy qudratic surfaces. You must have rubber sheeting activated, as well as having digitized the selected region.
20. **Merge**: Drag the mouse within a region whose elevations have been determined by the Hardy Quadratic Surfaces calculations. You can choose to create DTM patches from the Hardy quadratic surface results and merge them onto the base DTM. DTM spacing and units are set in the Options dialog "DTM" tag. You must also define the path to a folder where the created DTM's will be stored (use the "Path" tab in the Options dialog.) You can also use the Hardy Quadratic Surfaces to repair the elevation model that is being used. When finished merging the

desired regions, depress the button, and then continue calculating Hardy Quadratic Surfaces for other digitized regions (see above). Then repress the merge button. The merged regions already completed are outlined by boxes. Proceed to select a new region to merge, etc.

21. **Smooth DTM**: Drag the mouse over the borders between merged regions in order to smooth the transition between them using a spline fit. This button is only activated when merging (see above).
22. **Search for highest point**: Drag the mouse to select a region to search for the highest elevation. This button is already activated when an elevation model has been defined (use the "Paths" tab in the Options dialog) or has been created by merging Hardy Quadratic surfaces. Note that if you click on any point in the map, the distance from that point in kilometers will be displayed for geographic (e.g., WGS84) and ITM (Israel Transverse Mercator) DEMs or when using the base DTM as a height model.
23. **Contours**: Drag the mouse to select a region for plotting colored elevation contours. This button is only activated if a path to an elevation model has been defined (use the "Paths" tab in the Options dialog), or after creating a DTM elevation model by merging output from the Hardy Quadratic surface calculations. To use the latter, you must check the appropriate checkbox in the "DTM" tab of the Options dialog.
24. **Profiles**: Click on a point and then select which horizon to profile. After the calculation is completed, an interactive graph of view angle versus azimuth of either the eastern or western horizon for any clicked point is displayed. To use this option, the map must be defined has having either ITM or geographic (latitude, longitude) coordinates. You must also enable the saving of xyz coordinate files (i.e., 'topo_coord.xyz" files) (Use the "Settings" tab of the Options dialog).

This program has a GPS interface. Press the "GPS" button, and set the Baud rate and COM port of a NMEA 0183 v3 compatible USB dongle (see picture below). Once the settings are accepted, the map

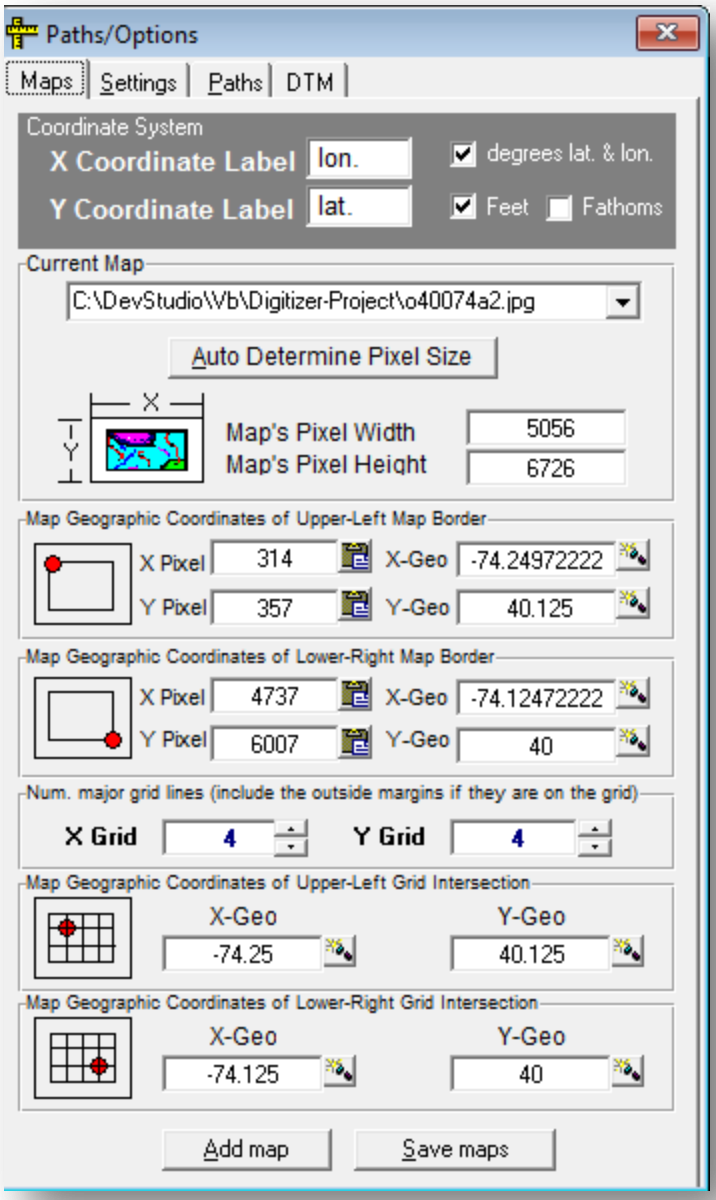
moves to the GPS location. This option requires that the map has been gridded to a geographic



latitude and longitude grid.

Map parameters (Options dialog: "Maps" tab)

1. Load a map by using the "Options" button (first button on the toolbar).  This program supports most types of images with the notable exception of "tif" files (there is no native VB6 support). If you want to use a tif file, then you will need to convert it to another format.)



2. If you know your map boundaries, then add them into the appropriate text boxes. If not, after saving the new map, click on the "Map" button, , (the second button on the toolbar) and use the mouse (and the magnifier window -- activate it by clicking on the magnifier button) to determine the screen coordinates.

3. In order to use all features of this program, you must define the coordinate system of the map and input the appropriate the grid boundaries into the text boxes in the Option menu. The simplest coordinate scheme use the screen coordinates of the map's four corners and the

corresponding geographic coordinates. To use this method, enter the above coordinates and click on the "Rubber Sheeting Button",  , on the toolbar and choose "Simple method".

4. A much more accurate coordinate system can be defined by using the grid intersection coordinates through affine transformations and rubber sheeting based on the routines of Doythser and Hall [Computers & Geosciences, 23 (7), pp. 785-791, 1997]. To use this method, you will need to digitize the grid intersection by using the Rubber Sheeting Wizard (click on the "Rubber Sheeting" button on the toolbar, ). See below for further discussion of this topic.

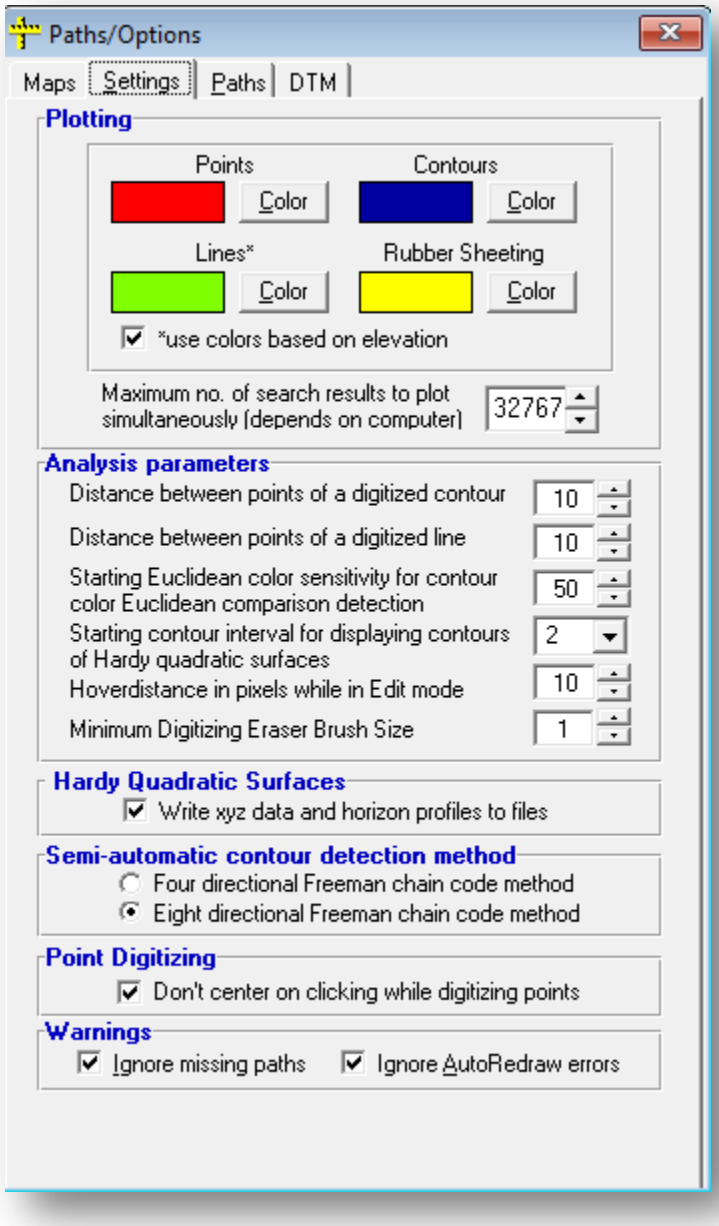
5. Map navigation and zooming can be accomplished by

- Using the scroll bars
- Clicking on the desired position to center.
- Dragging the map
- Zoom in and out with the wheel mouse, or use the quick keys "z" and "x".
- (This program fully supports a touch screen interface, so use the appropriate finger gestures to move and zoom).
- Arrow keys
- Home key (moves map to top left corner)
- End key (moves map to bottom right corner)
- PgUp key (moves map to top of map)
- PgDn key (moves map to bottom of map)

Program Settings Analysis parameters (Options dialog “Settings” tab)

1. Distance between points on a digitized contour: only generate points with this pixel interval when digitizing contours. (Larger for more points, smaller for less points.)
2. Distance between points on a digitized line: Ditto for digitizing lines.
3. Starting Euclidean color sensitivity: initial Euclidean threshold for a contour color. Decrease the sensitivity to increase the acceptance threshold and promote longer contouring without a break.
4. Starting contour interval: Steps in meters when drawing contours.
5. Hover distance in Pixels to search for digitized points: Used in “Edit” mode. The larger the number, the farther the program searches around the current mouse position for a digitized point. (Larger numbers require more CPU.)
6. Erasing mode brush size. Increases or decreases the area the eraser will erase in “Eraser” mode.
7. Write output of Hardy Quadratic Surfaces and contouring to xyz output files checkbox. This option must be checked in order to enable horizon profiles.
8. Contouring method: pick either 4 or 8 directional Freeman chain methods.

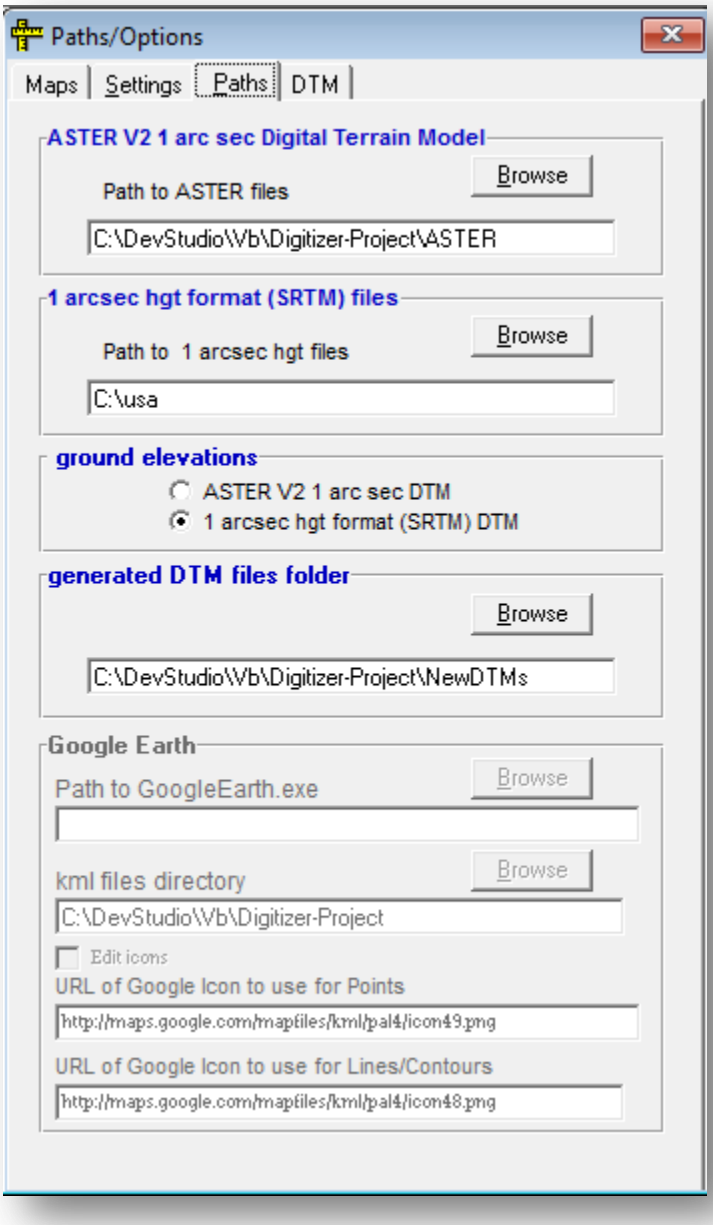
9. Centering screen while digitizing points checkbox: If checked, the program won't center the map on the left mouse click. This allows a region of the screen to remain fixed until the point digitizing is finished.
10. Warning checkboxes: If checked, program won't give messages about missing paths or auto redraw errors.



Program Paths (Options dialog: "Paths" tab)

1. Path to ASTER DEM tiles ("bil" format).
2. Path to 1 arc sec SRTM tiles ("hgt" format).

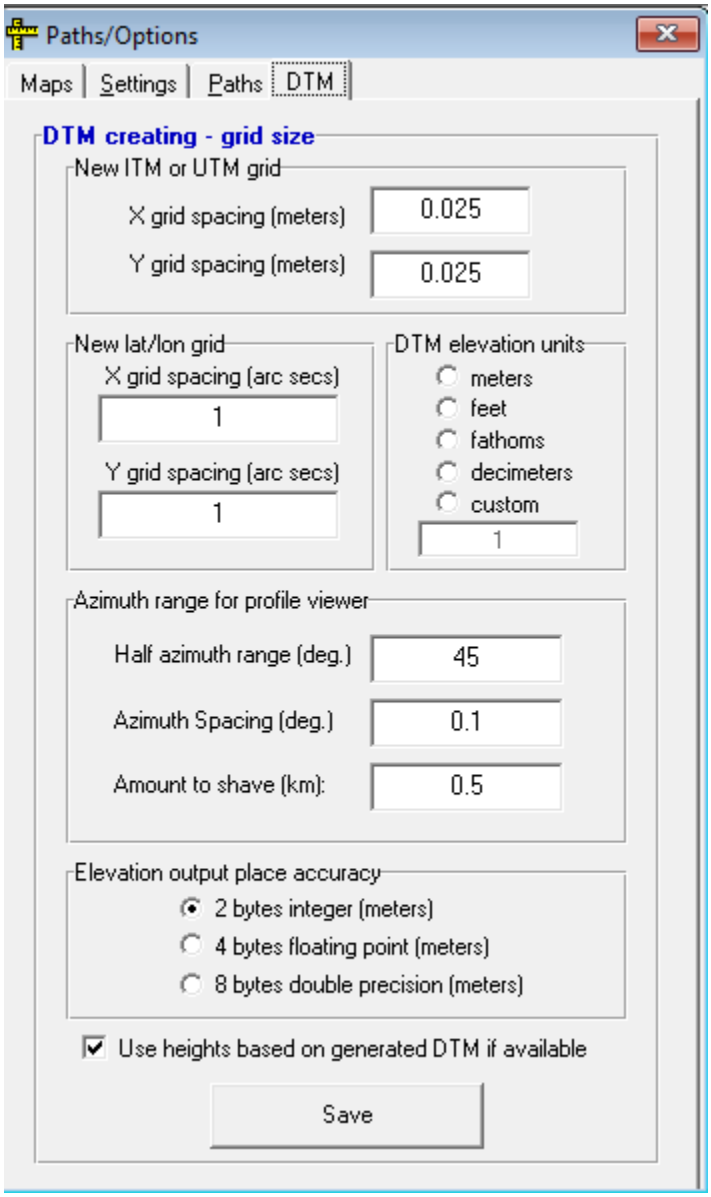
3. Radio buttons to choose the elevation model to be used for elevations in the program when s no created DTM is available.
4. Path to folder that will contain DTM models created by this program.
5. Path to Google Earth's exe file (not yet supported in this program version).
6. Path to directory to write "kml" files (not yet supported in this program version).
7. Path to Google Earth icon files (not yet supported in this program version).



DTM settings (Options dialog: "DTM" tab)

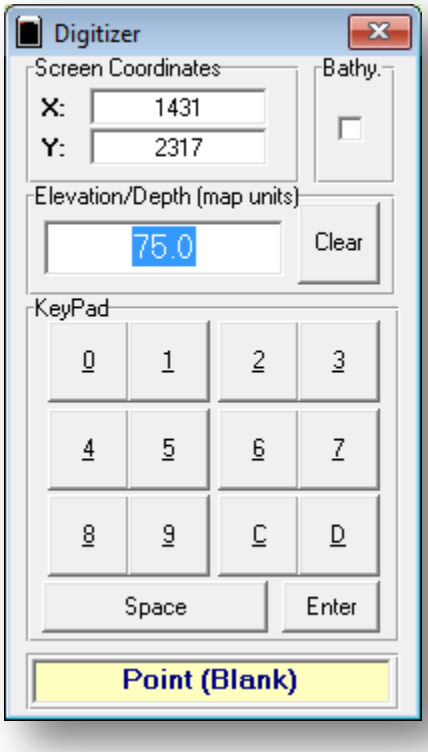
1. Grid size for creating DTM files in either ITM or UTM coordinates.
2. Grid size for creating DTM files in geographic latitude and longitude degrees.

3. Elevation units for created DTMs. Default is meters (doesn't need to be chosen). If a custom unit is chosen, the custom conversion factor from meters needs to be entered into the text box. For example, if creating a DTM in centimeters, enter "100".
4. Azimuth range for view angle versus azimuth profiles. For example, if "45" is entered, the profiles will be calculated from -45 degrees to +45 degrees around due East or due West.
5. Spacing in azimuth to calculate in the profile. E.g., "0.1" mean steps of 0.1 degrees.
6. Distance in kilometers east or west of the chosen point to start using elevation points for calculating the profile. This parameter removes close obstructions from the view.
7. Choose the elevation model precision. Lower precision saves memory.
8. Check box: use the created DTM elevations for the program elevation display, etc.



DIGITIZING WITH A MOUSE

To begin actual digitizing with a mouse, right click on the map with the mouse or press the "Digitizer" button,  , on the toolbar. A digitizer dialog appears (see picture below). Different options can be scrolled by using the SPACE key, or reached more directly by using the shortcut keys (see below). Press ENTER to activate the currently chosen digitizing method (displayed on the bottom on the Digitizer Dialog). Press ENTER again to deactivate that method. Press SPACE to scroll to a different option, etc., or move to an option directly by using the shortcut keys listed below. **When digitizing below sea level areas in a map,** instead of entering minus signs just click on the "Bathy" check box. You can then enter the depths without the negative sign, and all the elevations will be recorded as depths below sea level.



SHORTCUT KEYS:

- **B**: backup to dxf file
- **C**: contour digitizing.
- **D**: (D once) delete last point
- **DD**: (D twice) delete last line
- **DDD**: (D three times) Erasing errant parts of digitized contours.
- **DDDD**: (D four times) Sweep erasing, i.e., erase all digitized points within a rectangular region.
- **H**: Pick rectangular region to draw contours of the already digitized points using the method of Hardy, R., "Multiquadric Equations of Topography and Other Irregular Surfaces, J. Geophysical Research", 76 (8), pp. 1905-1915, 1971.
- **L**: Line digitizing
- **P**: (P once) Point digitizing starting with blank elevation.
- **PP**: (P twice) Point digitizing starting with the last inputted elevation.
- **S**: (S once) Sweep erasing, i.e., erase all digitized points within a rectangular region.
- **E**: Edit mode (used for point editing of contours, points, and lines that were already digitized. This mode highlights the digitized points and vertices of lines and contours when hovering over them with the mouse.
- **R**: Replace mode (first need to press "E", see above). Replace last highlighted point or vertex with a new one at the current position of the cursor.
- **K**: Kill mode (first need to press "E", see above). Deletes the last highlighted point or vertex.

USING THE DIALOG'S NUMBER PAD

They mean what they are except C changes sign, D adds a decimal point. Buttons designed large enough for touch screen. Note, the map can be moved and zoomed with standard touch screen motions.

DIGITIZING WITH THE 16 button DrawingBoard VI mouse

(N.B.: You can also use the regular mouse and any of the shortcut keys above at any time.) Added options are moving in X, Y, Z (zooming). To navigate the map using the digitizer mouse, select one of the above, and then move (zoom) in one direction by pressing the "1" button. Move (zoom) in the opposite direction by pressing the "2" button.

The 16 buttons are mapped to do the following:

Button

- **0** - Use it as a left mouse key for the Digitizer Dialog or anywhere on the map (However, it won't work on any program message dialog box. You will have to the regular mouse to acknowledge your answer in those cases.)
- **1** - activates the currently chosen digitizing method
- **2** - deactivates the currently chosen digitizing method
- **3** - scrolls through all the navigation and digitizing options. To activate an option press the "1" key. To deactivate, press the "2" key.
- **4** - enters the numeral "0" to the elevation text box
- **5** - enters the numeral "1" to the elevation text box
- **6** - enters the numeral "2" to the elevation text box
- **7** - enters the numeral "3" to the elevation text box
- **8** - enters the numeral "4" to the elevation text box
- **9** - enters the numeral "5" to the elevation text box
- **A** - enters the numeral "6" to the elevation text box
- **B** - enters the numeral "7" to the elevation text box
- **C** - enters the numeral "8" to the elevation text box
- **D** - enters the numeral "9" to the elevation text box
- **E** - changes sign of entered elevation
- **F** - adds decimal point to end of entered elevation

DIGITIZING TOOLS EXPLANATION

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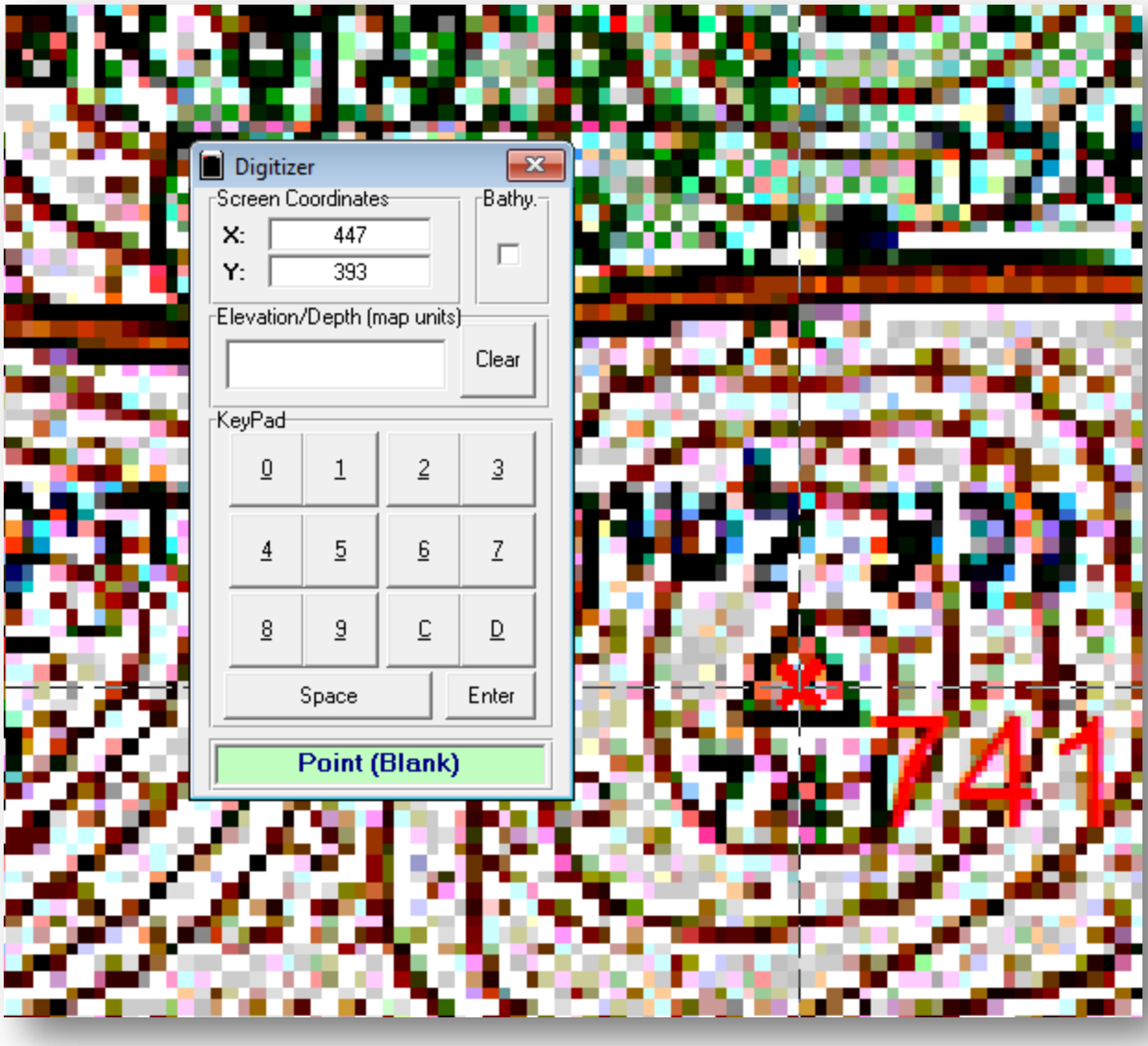
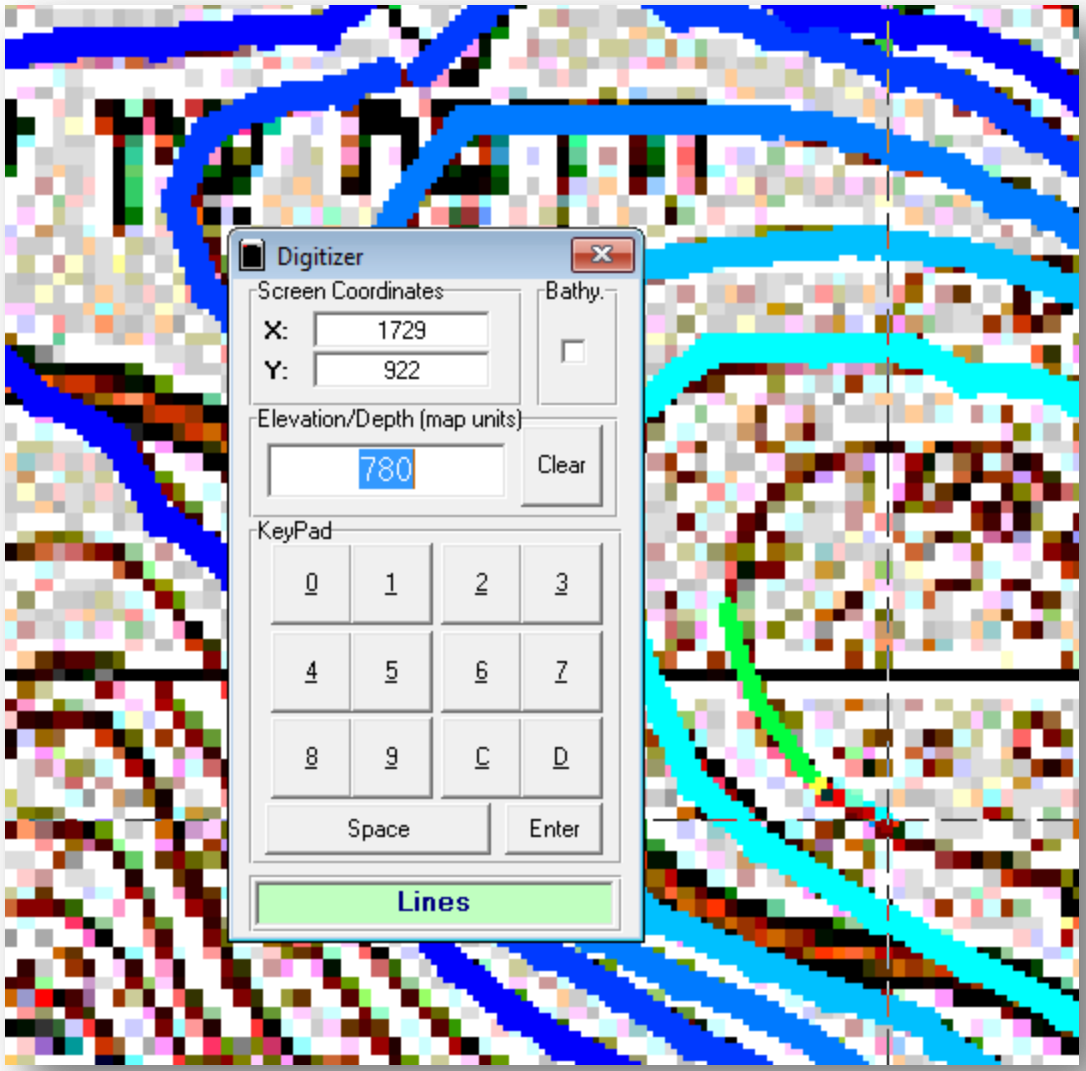
1. **Point digitizing**: Used for digitizing trig points and bathymetry depth marks. Enter the elevation/depth and left click on the mouse. To center the mouse on the point, it is advisable to use the magnification window. Click on the magnification button,  , magnify the map as desired using the toolbar buttons, and center on the point using the cross hairs.

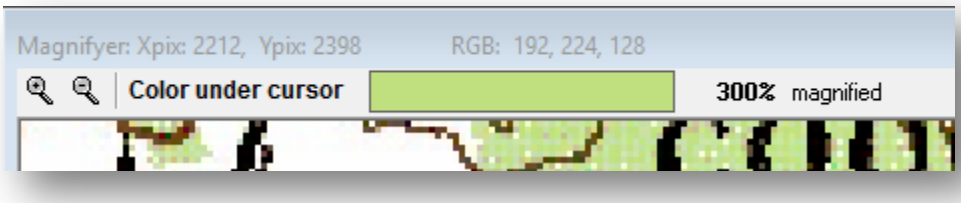


2. **Line digitizing**: Used for digitizing contours. Left click on the starting point. Enter the contour elevation. Move the mouse to the end point; left click to complete the line. Contours are stored in memory as separate points separated by a certain number of pixels as defined in the Options dialog "Setting" tab.

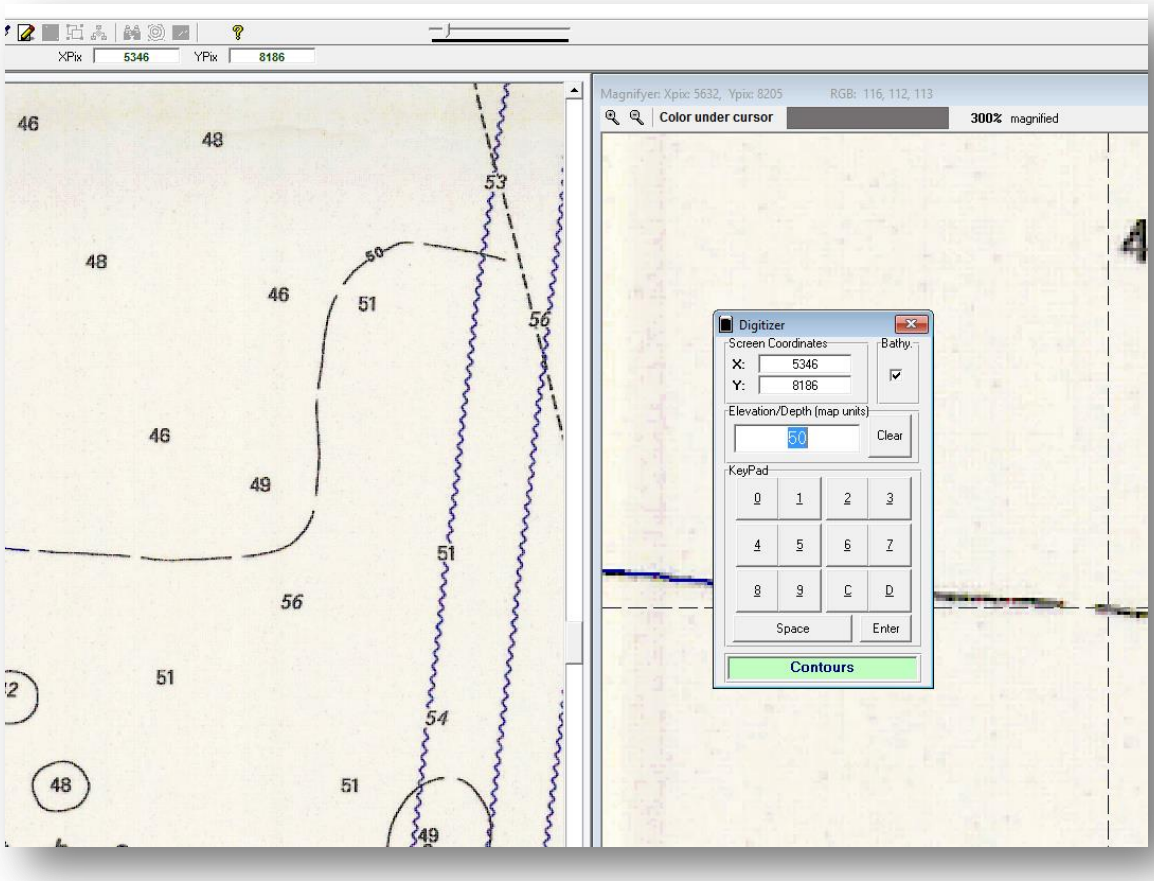


3. **Contour digitizing**: Uses semi-automatic contour boundary detection known as the Freeman chain method (4 directional or 8 directional. See for example Dziech, A., "Contour Extraction and Compression-Selected Topics", [Mobile Robots: Perception & Navigation, Sascah Kolski (Ed.), ISBN: 3-86611-283-1, InTech.] Enter the contour's elevation. Use the magnification window to determine a detection starting point by watching the "Color under cursor" color. Click on the darkest color, and the detection will commence. The color is followed by using RGB Euclidean color comparison criteria. Change the threshold of the comparison by moving the

slider on the main program's toolbar. 0 means accept Euclidean RGB differences up to 140. Higher slider values are more selective. End contour detection by pressing the ESC button. If the contour reaches an impassible point, or turns onto itself, you will be prompted to either pick a new starting point or to finish detecting the current contour. The contours are stored in memory as points separated by a certain number of pixels defined in the Options "Setting" tab. You can change the detection method from 8 directional (default) to 4 directional in the Option dialog "Setting" tab.

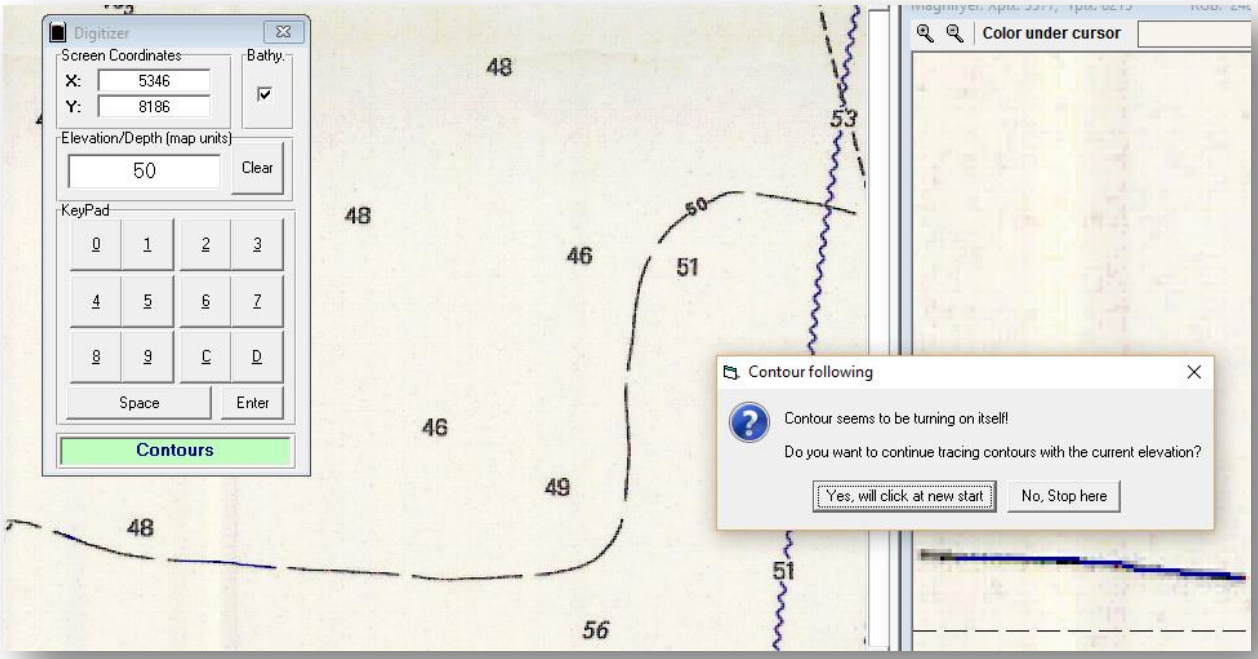


Picture: contour color display and RGB number to be consulted when determining contour start

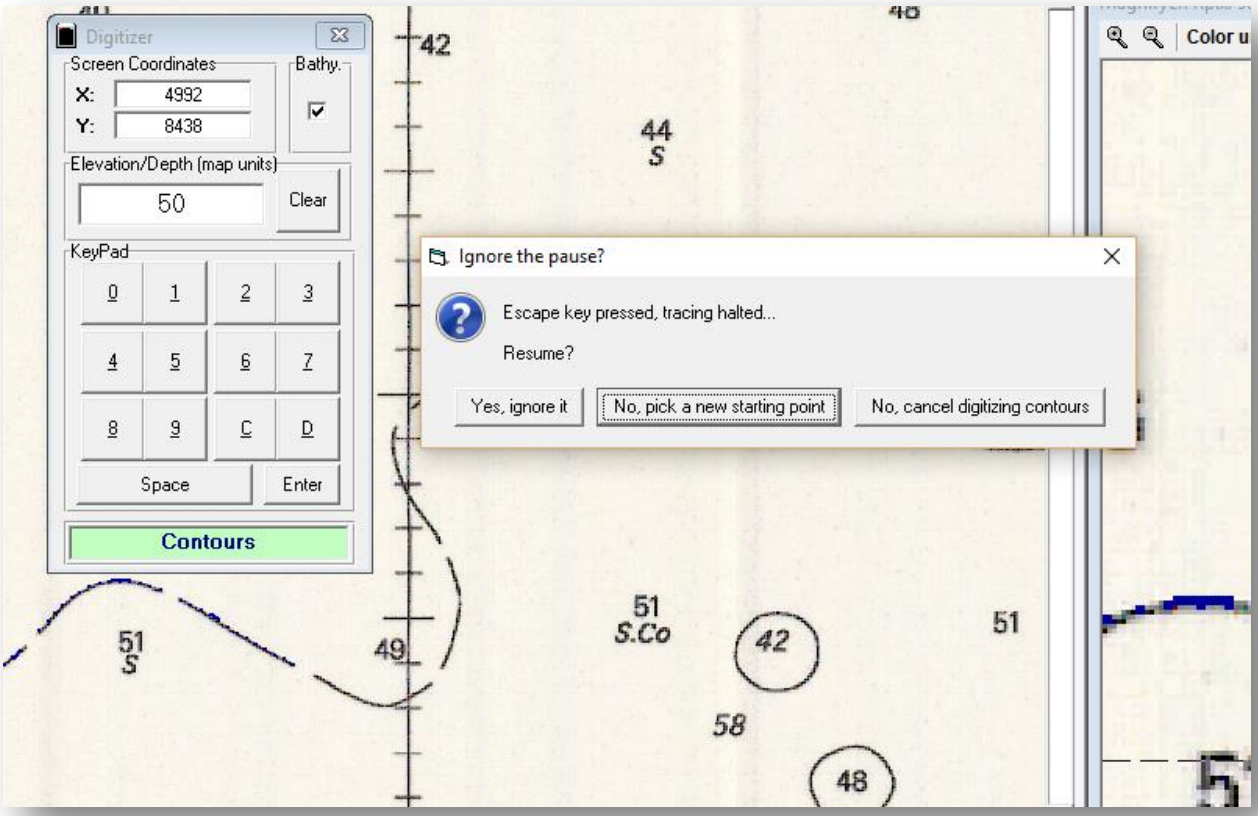


Picture: Contour Digitizing interface. Notice slider bar on toolbar that is used for setting the sensitivity of the color comparison between the starting color (the color clicked on at the

beginning of contouring) with colors encountered during the contouring process (the Euclidean difference is used to determine how close the colors match).



Picture: Contour reaches impasse and program prompts for response

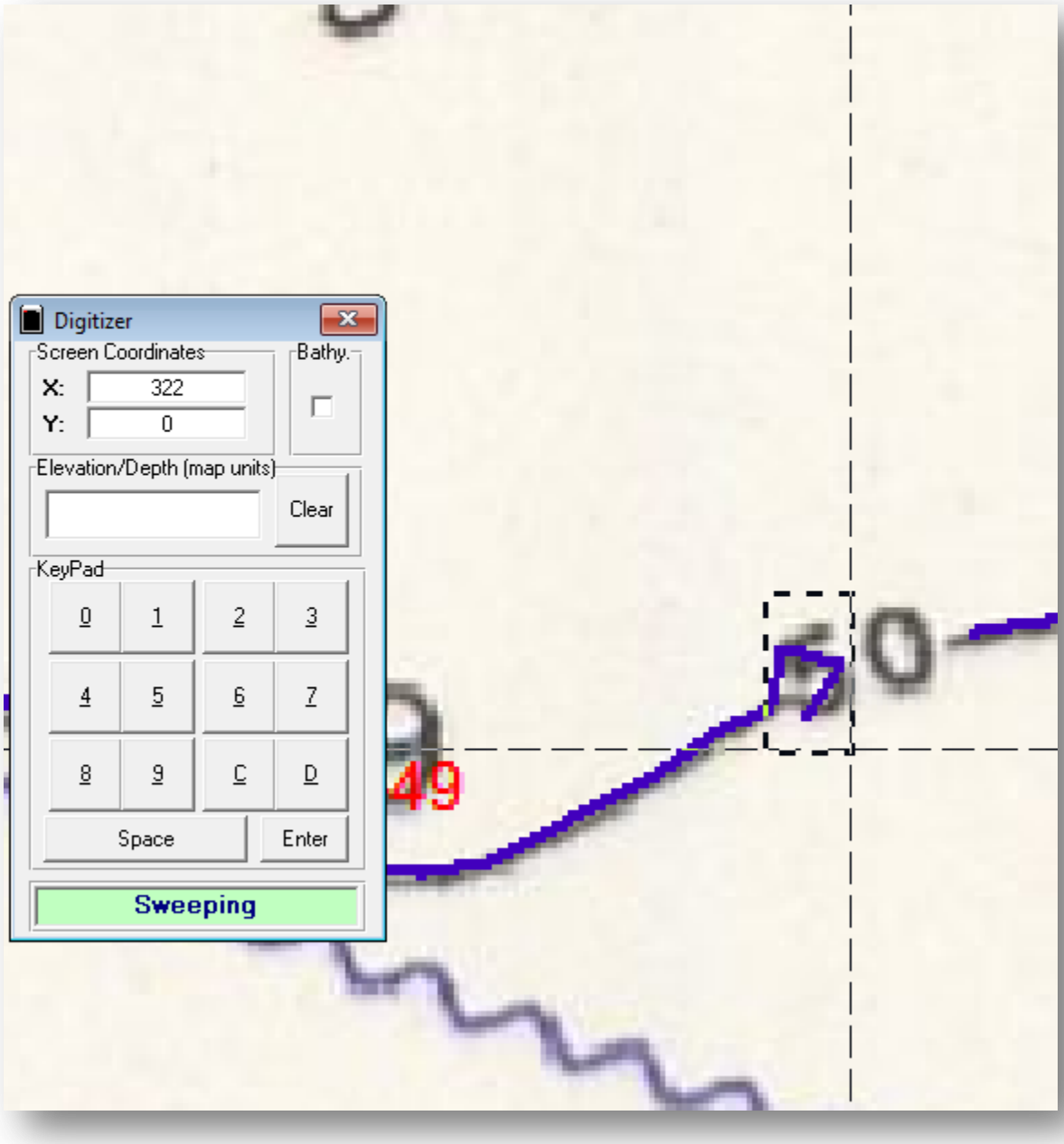


Picture: Contouring was interrupted with the "ESC" button, so program asks for clarification.

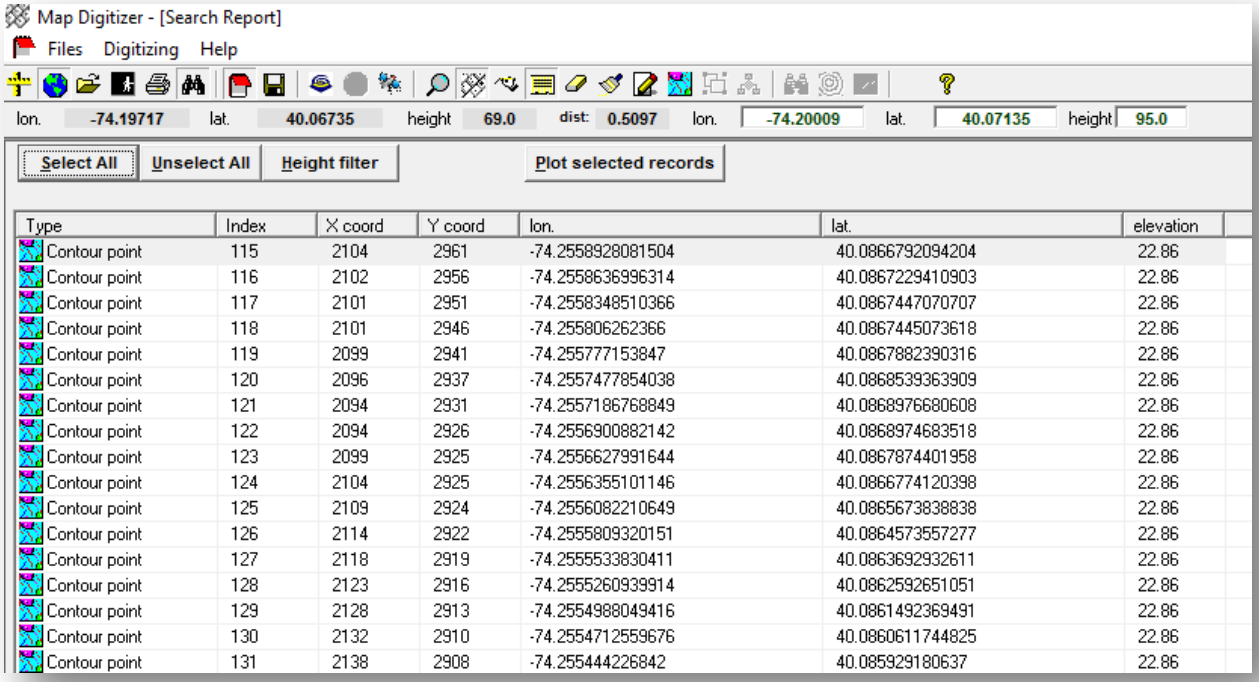
4. **Eraser**: Erases errant contour points while holding down the left mouse button and passing over those points with the mouse. Does not permanently affect digitized points and lines. Can be activated by entering the short cut keys (see above) when digitizing, or by directly pressing the "Eraser" button on the toolbar,  .

5. **Hardy quadratic surfaces**:  . Use it for checking on the quality of the digitizing as well as for calculating the elevations for a DTM elevation model after completing the digitizing of a section of the map. Choose a contour interval in the combo box that appears on the coordinate bar. Drag to define a rectangular region for analysis. Contours are plotted after completion of the calculation. Three temporary files are written during the initial processing. The "topo-out.GSC" file contains a listing of the digitized points within the selected rectangular region (pixel coordinates and height). The ".dxf" file contains the same points with the geographic coordinates. After completion of the analysis, a "topo-out.xyz" file is generated in the typical DEM xyz file format (if this option is checked in the "Settings" tab of the Options menu). A pixel xyz file, topo_pixel.xyz is also generated. Both xyz files can be plotted with such programs like "Global Mapper", or "DTMEditing".

6. **Sweep erase**: Access it from the Digitizer dialog, or directly from the toolbar,  . Define a rectangular region by dragging over the map (see picture below). All digitized points in this region will be deleted whether they were digitized points, lines, or contours. Best tool to be used for fixing errant digitizing as revealed by running a Hardy quadratic surface analysis.



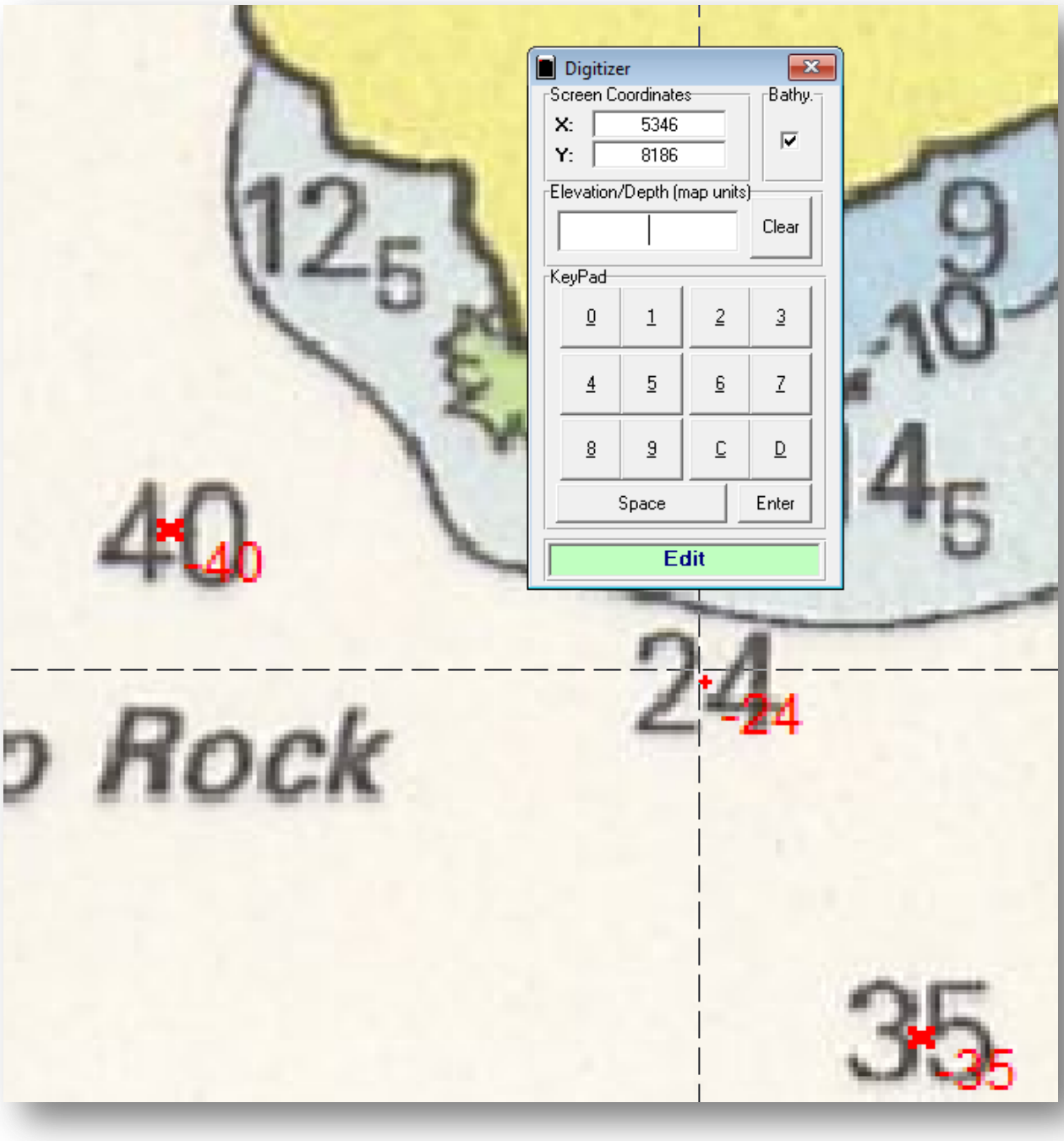
7. **Search**:  . (Can also be accessed from the Digitizer Dialog – see “Short Keys” above). Define rectangular region by dragging over the map to search for any digitized points from point, line, and contour digitizing, as well as contour points that were erased by the Eraser tool. The search results are displayed in the "Report" form. The report form can be used for sorting the points, selecting points according to their elevation, and plotting individual points (right click on the point's listing in the Report form) or plot a group of selected points (use the "Plot" button).



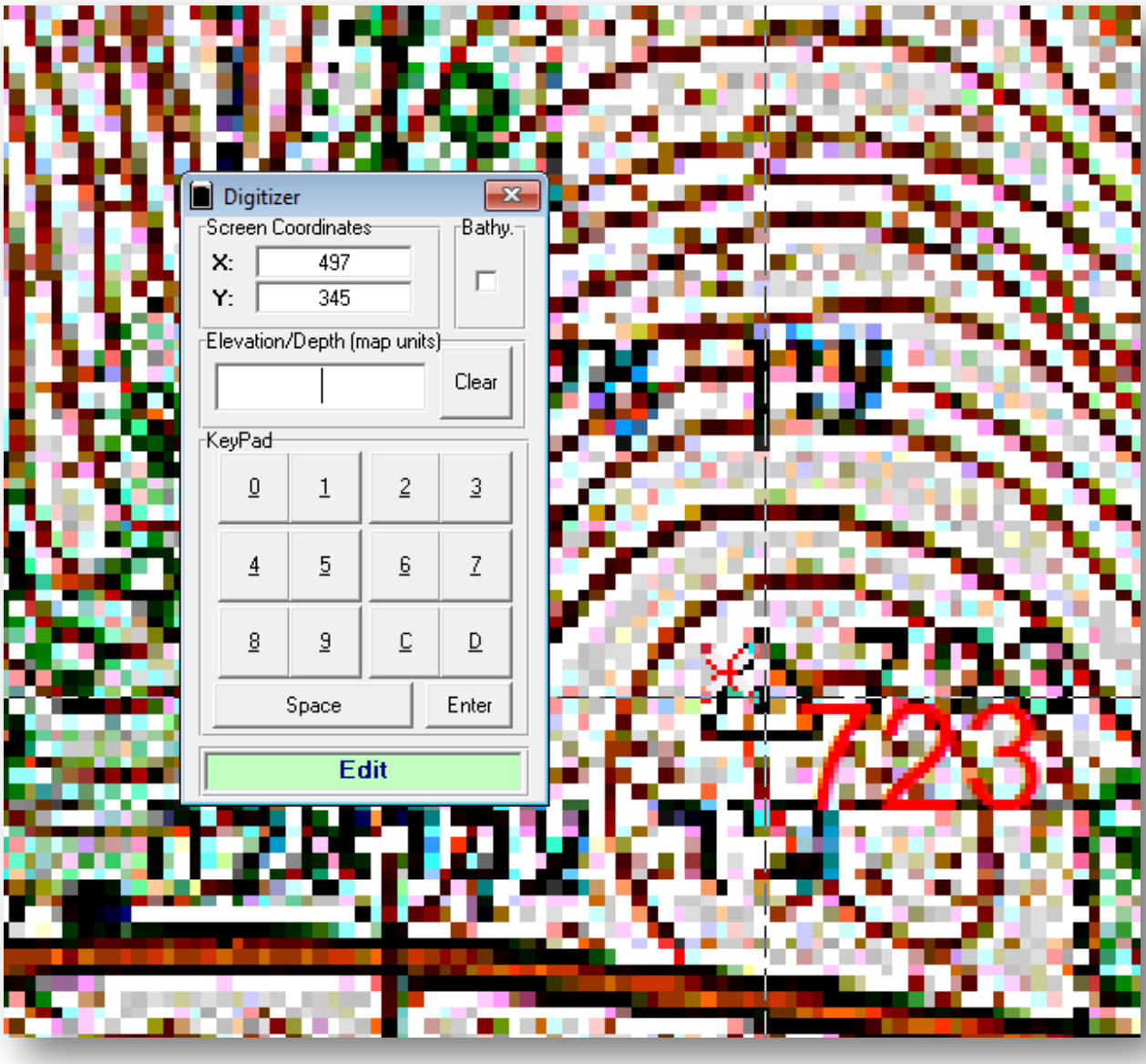
Type	Index	X coord	Y coord	lon.	lat.	elevation
Contour point	115	2104	2961	-74.2558928081504	40.0866792094204	22.86
Contour point	116	2102	2956	-74.2558636996314	40.0867229410903	22.86
Contour point	117	2101	2951	-74.2558348510366	40.0867447070707	22.86
Contour point	118	2101	2946	-74.255806262366	40.0867445073618	22.86
Contour point	119	2099	2941	-74.255777153847	40.0867882390316	22.86
Contour point	120	2096	2937	-74.2557477854038	40.0868539363909	22.86
Contour point	121	2094	2931	-74.2557186768849	40.0868976680608	22.86
Contour point	122	2094	2926	-74.2556900882142	40.0868974683518	22.86
Contour point	123	2099	2925	-74.2556627991644	40.0867874401958	22.86
Contour point	124	2104	2925	-74.2556355101146	40.0866774120398	22.86
Contour point	125	2109	2924	-74.2556082210649	40.0865673838838	22.86
Contour point	126	2114	2922	-74.2555809320151	40.0864573557277	22.86
Contour point	127	2118	2919	-74.2555533830411	40.0863692932611	22.86
Contour point	128	2123	2916	-74.2555260939914	40.0862592651051	22.86
Contour point	129	2128	2913	-74.2554988049416	40.0861492369491	22.86
Contour point	130	2132	2910	-74.2554712559676	40.0860611744825	22.86
Contour point	131	2138	2908	-74.255444226842	40.085929180637	22.86

8. **Backup (Save)**:  Backups all the digitized points in the entire map to a "dxf" file format

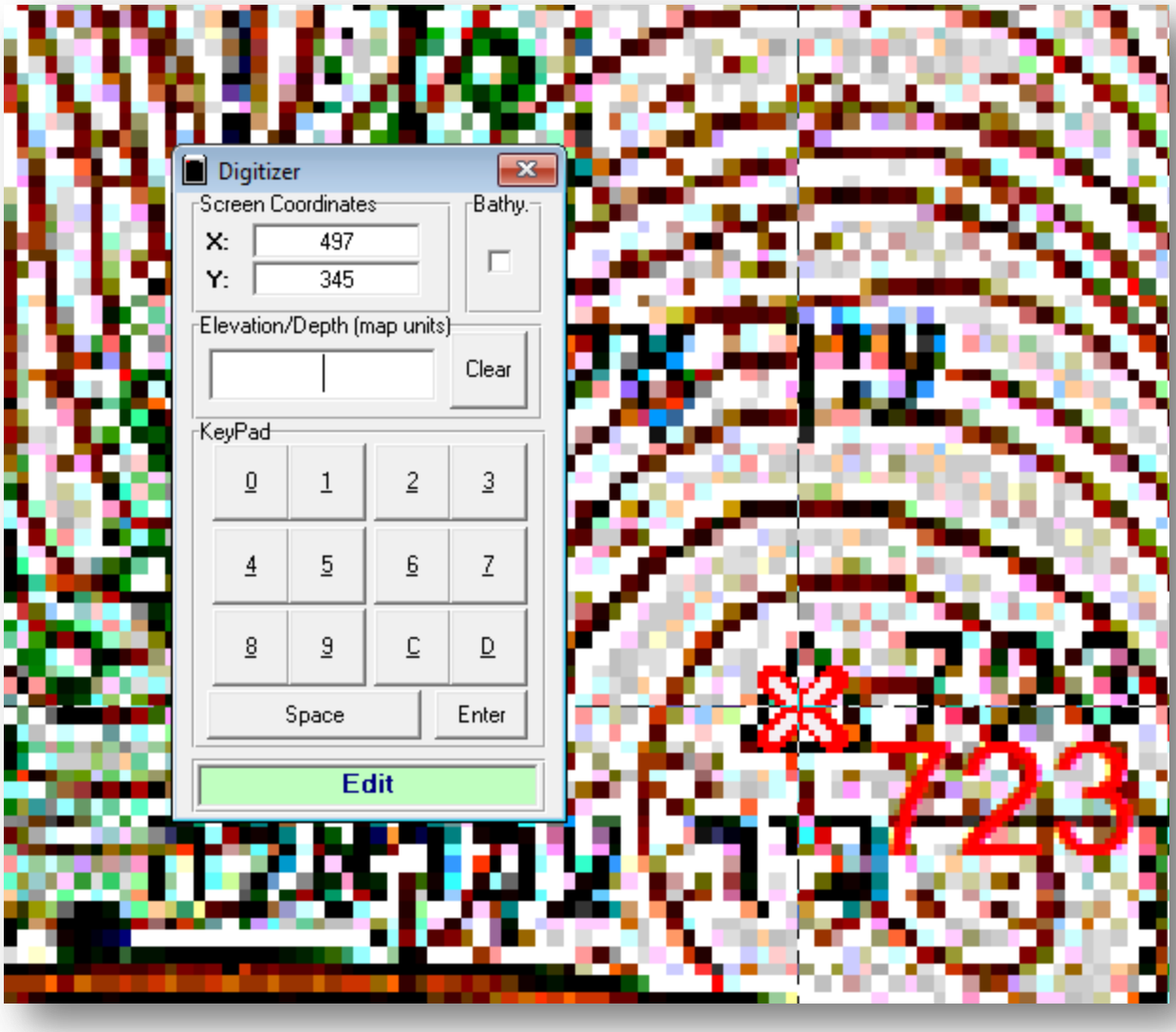
9. **Edit Mode**:  (Can also be activated by the shortcut key while digitizing -- see “Shortcut keys” above). Use this mode for quick editing of digitized points, contours, and lines. When this mode is activated (pressing the “Edit” button, or pressing “E”), the digitized points, etc., are highlighted when hovering over them with the mouse. To move a point to a new position close to the last one, press the “R” keyboard button while the mouse is in the desired new position. To delete a point, press the “K” keyboard button and the highlighted point is deleted. See pictures below. The hover distance can be changed by changing it in the “Settings” tab of the Options dialog (see discussion and picture below).



Picture: Editing a digitized point. Notice that the point is highlighted when the cursor is nearby



Picture: Point is misplaced (should be in center of trig mark). Cursor is set at correct position and "R" key is pressed to move it to the correct position (see picture below)



Picture: Digitized point has been successfully edited to be at the center of the trig point.

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Brief Tutorial on how to use this program to create a DTM model from a topographic map

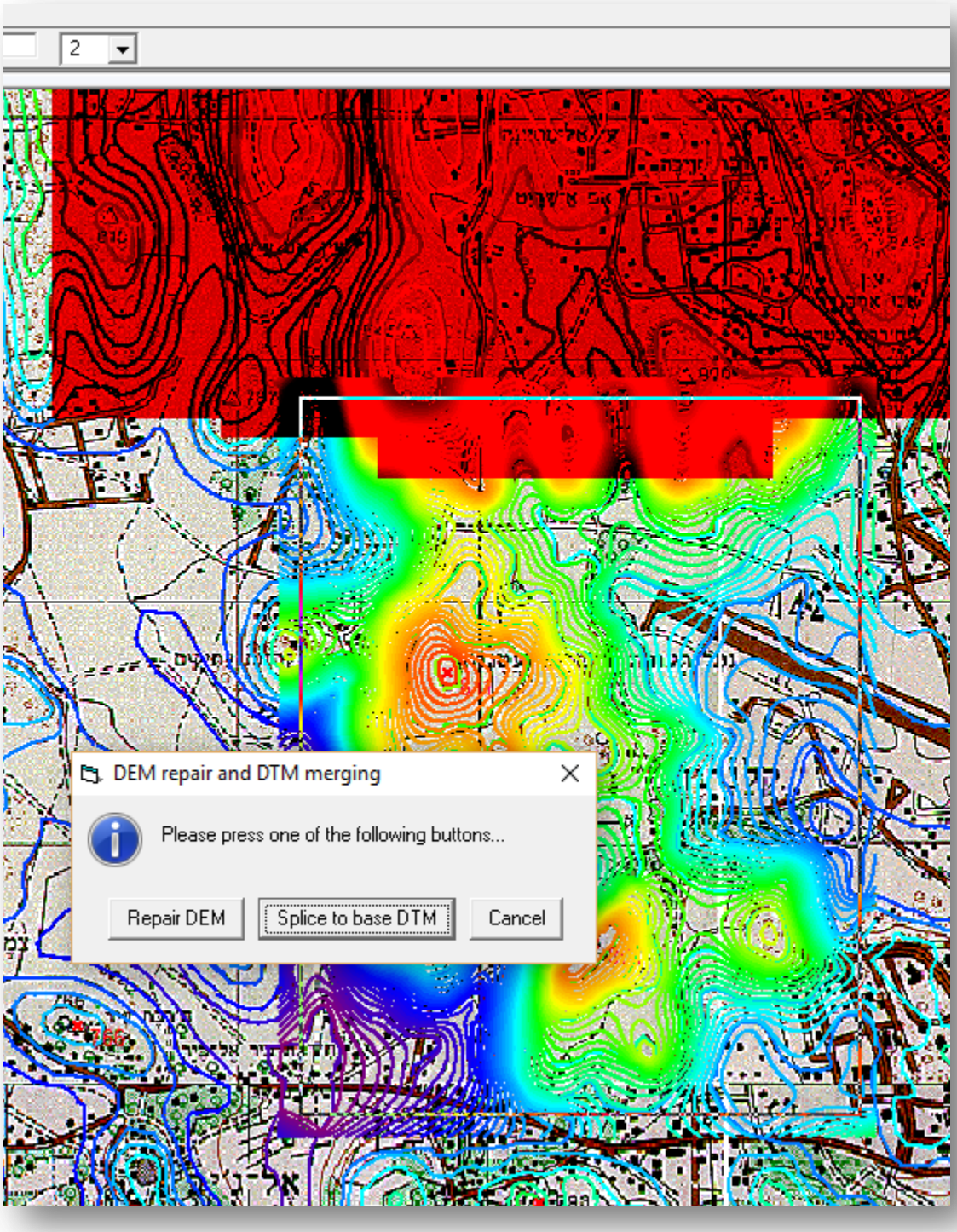
1. Open the Options dialog by clicking on the first toolbar button . Browse for your topographic map (Note: "tif" files are not supported, so convert them to a supported format). The program determines the pixel size of the map. You are then required to define a grid. Click on the relevant check boxes concerning whether the grid is in latitude and longitude degrees, and whether the elevations on the map are in feet or fathoms. If you will be using the map corners for the coordinate grid without further rubber sheeting (e.g., the map image is not contorted and the corner coordinates are known) then enter the pixel coordinates of the map's corner

(i.e., where the actual map starts and finishes, and not the corners of the map's borders). You can use the buttons in the dialog for pasting the clicked pixel coordinates. For maps using geographic grids of degrees latitude and longitude, you can enter either decimal degrees, or enter degrees, minutes, and seconds using a "-" to separate them, e.g., "-32-42-52" is interpreted by the program to mean -32 degrees, 42 minutes, 52 seconds. Use the buttons next to the relevant text boxes to convert from the "-" format to decimal degrees and vice versa. If you will be using rubber sheeting, which is necessary for rotated grids or for contorted map images, enter the number of horizontal and vertical grid intersections and the value of grid coordinates (in whatever unit that is being used by the map) in the relevant boxes.

2. Click the "Paths" tab and define a path to the folder where the new DTM's will be written to. You only have to define paths to ASTER or SRTM tiles if you want the program to display those elevations when moving the mouse and clicking on the map in the process of creating a DTM. This is extremely useful when attempting to read contour values, etc.
3. Click the "DTM" tab and define the grid spacing of the DTM that will be created. For ITM or UTM grids in units of meters, enter the X, Y spacing in meters in the relevant text boxes. For a geographic latitude and longitude grid in degrees, enter the X, Y spacing in units of arc seconds.
4. Press the "Save" button" In the "Maps" tab of the Options dialog to save the map and its associated parameters. The map is added to a list of previously entered maps. Any of the stored maps can be opened and viewed and worked on by selecting it from the list.
5. Open the map by pressing the "Map" button  (the second button in the toolbar). The first time the map is loaded, the program creates a binary file containing the colors of each pixel. The toolbar is grayed out until the end of this operation. This color map is used for editing the digitized points and contours, i.e., restoring the original map when erasing, or when replacing or removing digitized points.
6. You can now proceed with digitizing the map using the Digitizer dialog (click on the Digitizer button,  , on the toolbar). The Digitizer dialog and the map interface were designed for maximum user friendliness for mouse, touch screen, and keyboard operations. The map can be easily panned and magnified by any of the above methods. See above for the brief description of special keys or the interfaces. It is especially useful to activate the magnification screen (click on the "magnifier" button on the toolbar) when digitizing the map. The Digitizer dialog offers a wealth of methods for digitizing including points, lines and contours. Editing can be done easily using erasing, sweeping, and deleting. Note that the Digitizer dialog was specifically designed for touch screens in order to facilitate the entering of elevations using the digit buttons. When contouring, it is essential to use the magnifier screen. When you move the mouse over a contour, the color at the cursor is shown. It is essential to pick the darkest color before clicking to start contouring. Adjust the sensitivity of the color threshold to include or exclude similar colors to be accepted/rejected when determining where the contour goes.
7. The next step is to define the grid used for outputting the created DTM. This is done by clicking on the "Rubber Sheeting" button,  . The Rubber Sheeting dialog opens. You can choose several options. If the map is not contorted and the coordinates of the map coordinates are

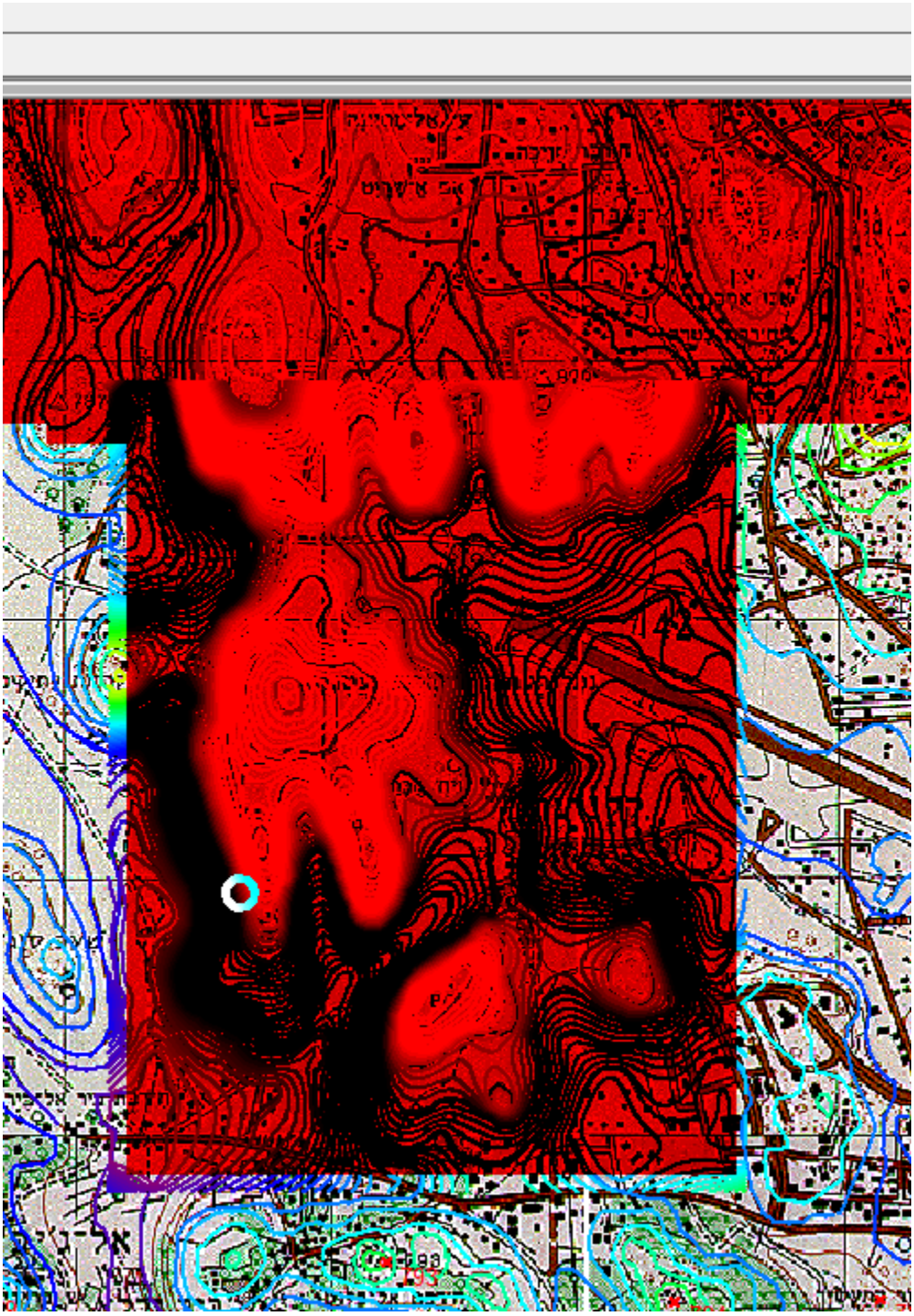
known and have been entered in the Maps tab of the Options dialog, then check “Use corner coordinates”. Other check “Rubber Sheeting”. The idea of the rubber sheeting process is to digitize the intersections of the map’s graticule. If an intersection is missing, it can be extended by grids to form intersections. To do this, press the “Extend” grid button and click on the lines beginning and then once again at its end. Repeat this process to extend more grid lines. Pan to the most Northwesterly grid intersection. Left click on that point. If its position is satisfactory, then click on the “Next” button. Iterate this procedure from North West to North East, then one grid row down from East to West, continuing across the row, then one row down from West to East. The wizard will show the geographic coordinates of the next intersection. Continue in this manner until the last grid intersection on the most Southerneastern corner is clicked. Afterwards, click on the “Activate calculation method” button. (Digitizing of the grid can also be down along columns by checking the bottom check box in the “Geo Coord. Step Size” frame.) Once the rubber sheeting digitizing is finished, it doesn’t need to be repeated. Each time you press the Rubber Sheeting buttons, the stored intersections are marked and you are notified that all of them have been already digitized and you are prompted to just press the “Activate” button.

8. Once rubber sheeting is defined, elevation values are shown as the mouse moves along the map if the path to an elevation model has been defined in the “Paths” tab of the Options dialog, or if a DTM has been already created for this map.
9. Actual calculation of DTM elevation points can proceed at this point. Click on the “Hardy” button,  , and all the digitized points, lines, and contours are shown. Select a rectangular area to calculate the heights by dragging with the mouse. The number of digitized points you can select is limited by the memory of the computer and by the patience you have to wait for the calculation to finish.
10. After the Hardy Quadratic Surface calculation is complete, contours of the calculated heights are drawn on the map. To merge these points into a new DTM, click on the “Create DTM” button,  . A prerequisite for this operation is defining the map’s corner coordinates. To do this, open the Options menu and paste in the corner pixel and geographic coordinates as displayed in the text boxes (picture shown above).
11. The program first generates a basis DTM file which at this point is all blank. After completion of the writing of the basis DTM, define a region within the drawn contours for merging into the base DTM. Do so by dragging within the contoured regions. It is often best to avoid the edges since the Hardy calculation can be inaccurate in those places if nothing has been digitized beyond the borders chosen.
12. The program will then calculate the heights of this region on a grid size defined in the “DTM” tab of the Options menu and will merge it onto the base DTM. After completion of this process, a box will be drawn around the boundaries of the merged regions. Continue to merge regions until you have exhausted the contoured area. Depress the “Create DTM” button and select a new region of the map that has been digitized for undergoing the Hardy calculation. Continue this process into the entire region of interest has been converted into a DTM.



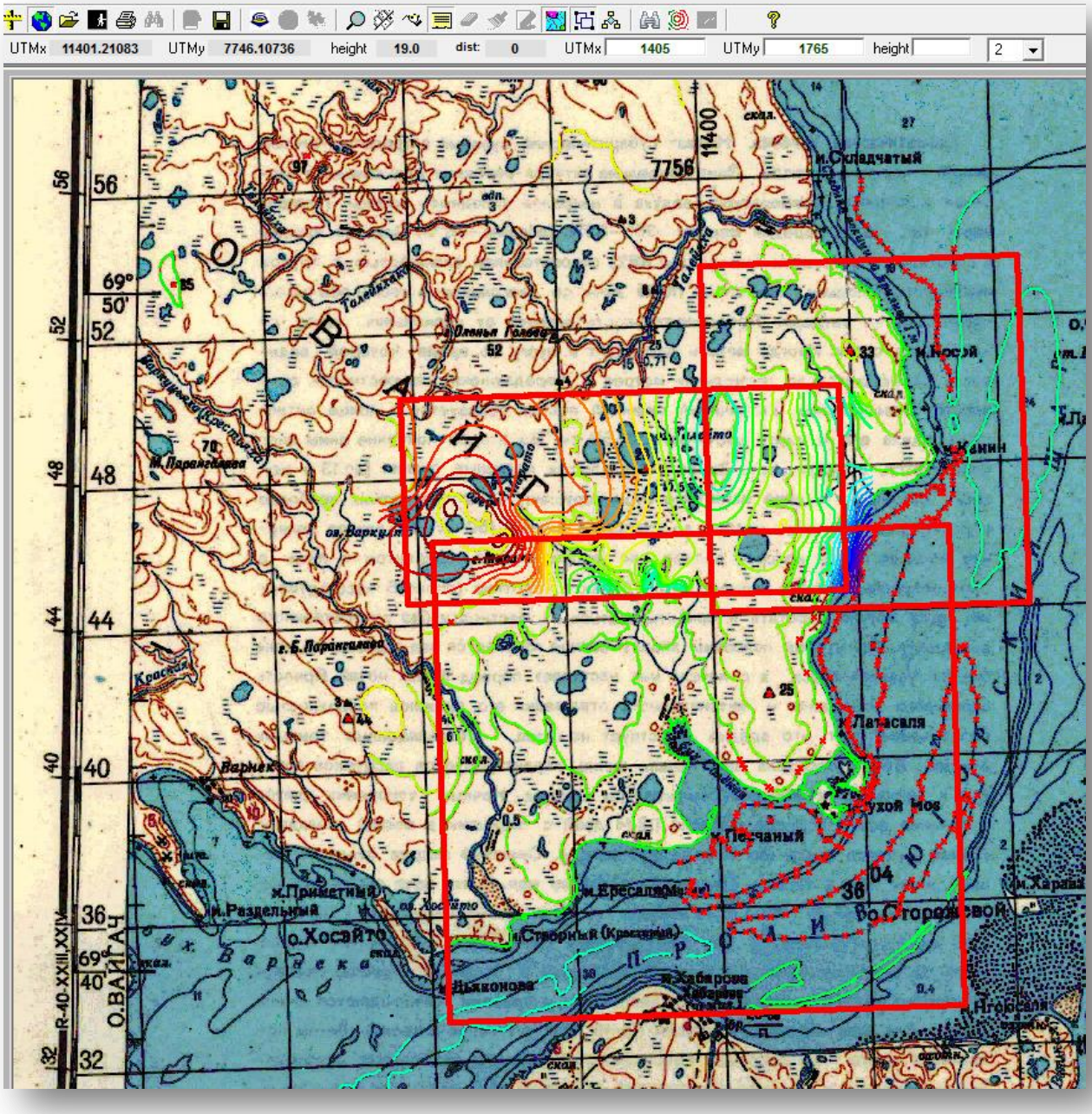
Picture: Colored areas are regions already merged into the base DTM. The rectangle demarks a new region to be merged that has already undergone the Hardy Quadratic Surface calculation (results are drawn as contours). Note that the region must be interior to the region calculated by

the Hardy Quadratic Surfaces. It is useful to pick only the region where the surfaces fit the contours, i.e., far from boundaries which haven't yet been digitized.

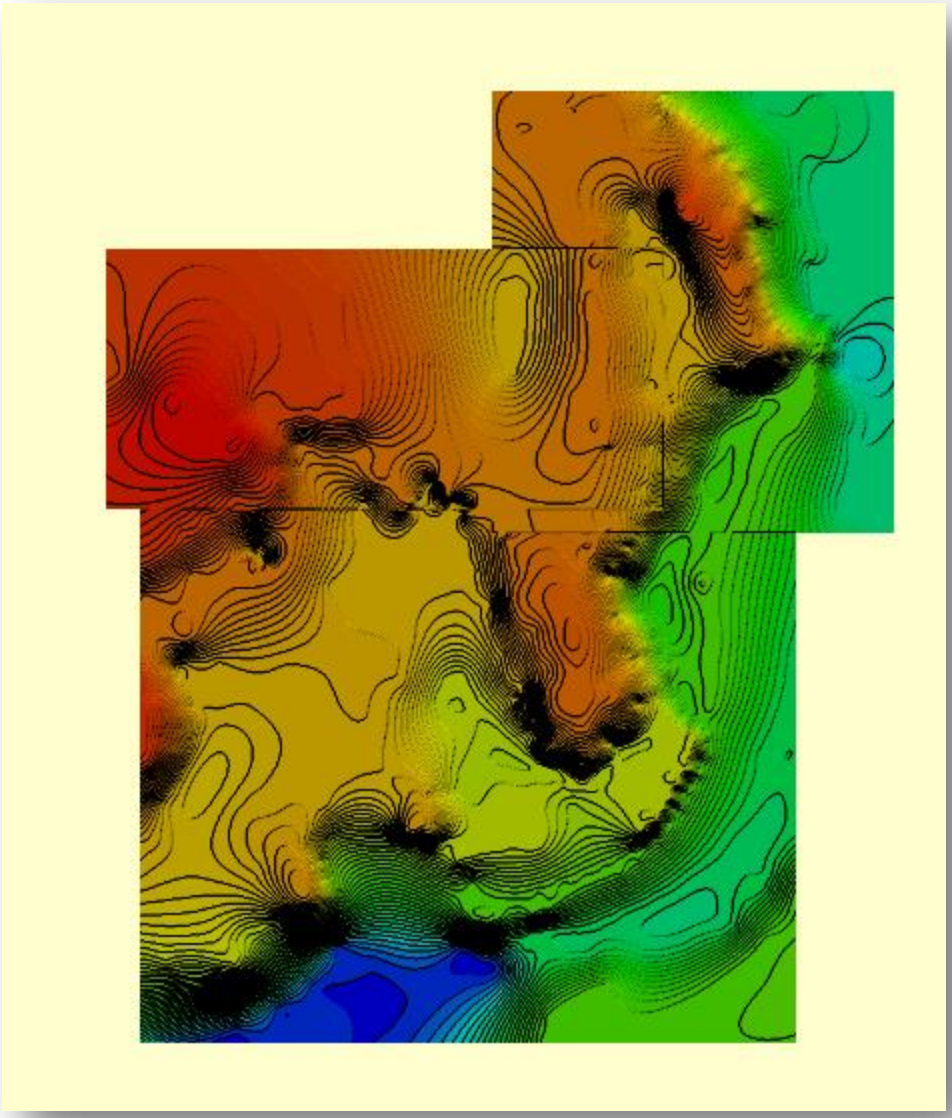


Picture: New region has been marked as merged onto the DTM

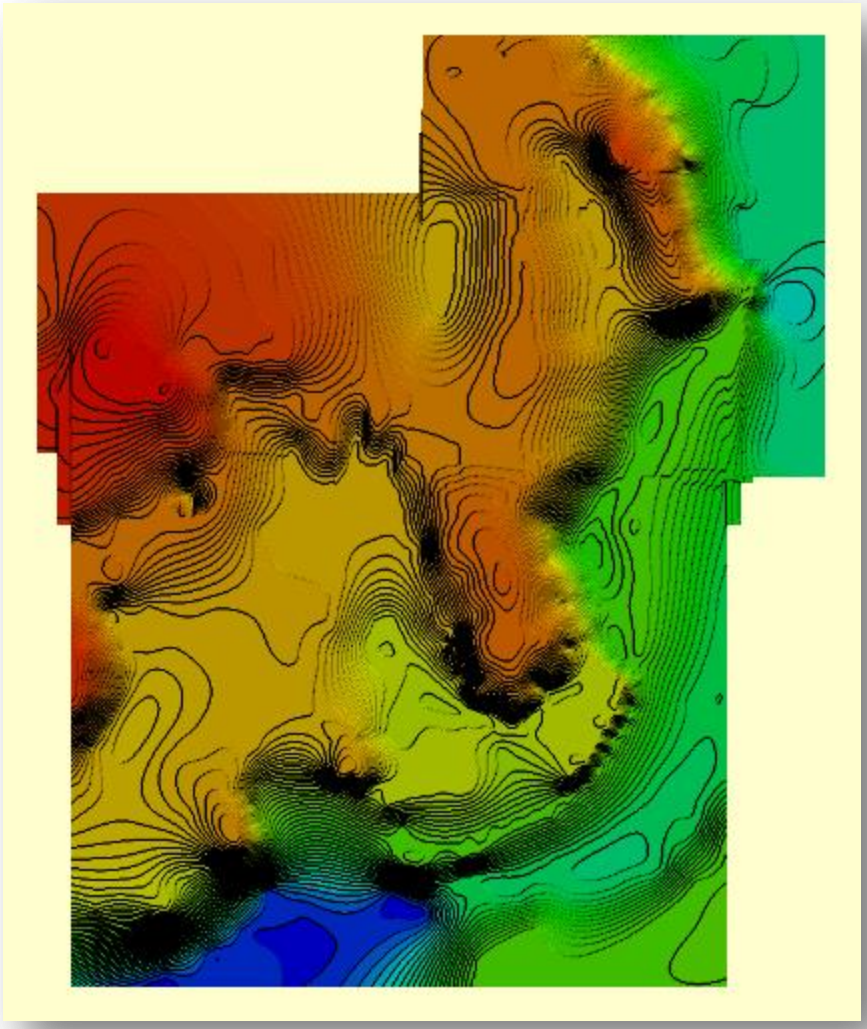
13. In general, borders between different Hardy calculations will not be smooth (the picture below shows several such regions defined by the intersection of merge regions). Notice that the program can handle highly rotated grids to a very high accuracy with the rubber sheeting.



1. To smooth the borders, click the "Smoothing" button, after merging a section. Drag the mouse to define a rectangular area that you wish to be smoothed. The two pictures below show the resulting DTM Surfer grd file from the map above before and after smoothing (plotted using "Glober Mapper").



Picture: DTM before smoothing between merged regions (notice that abrupt borders). Steps in elevation are an artifact of calculating the heights to the nearest integer (this setting can be changed in the Options Menu "DTM" tab).



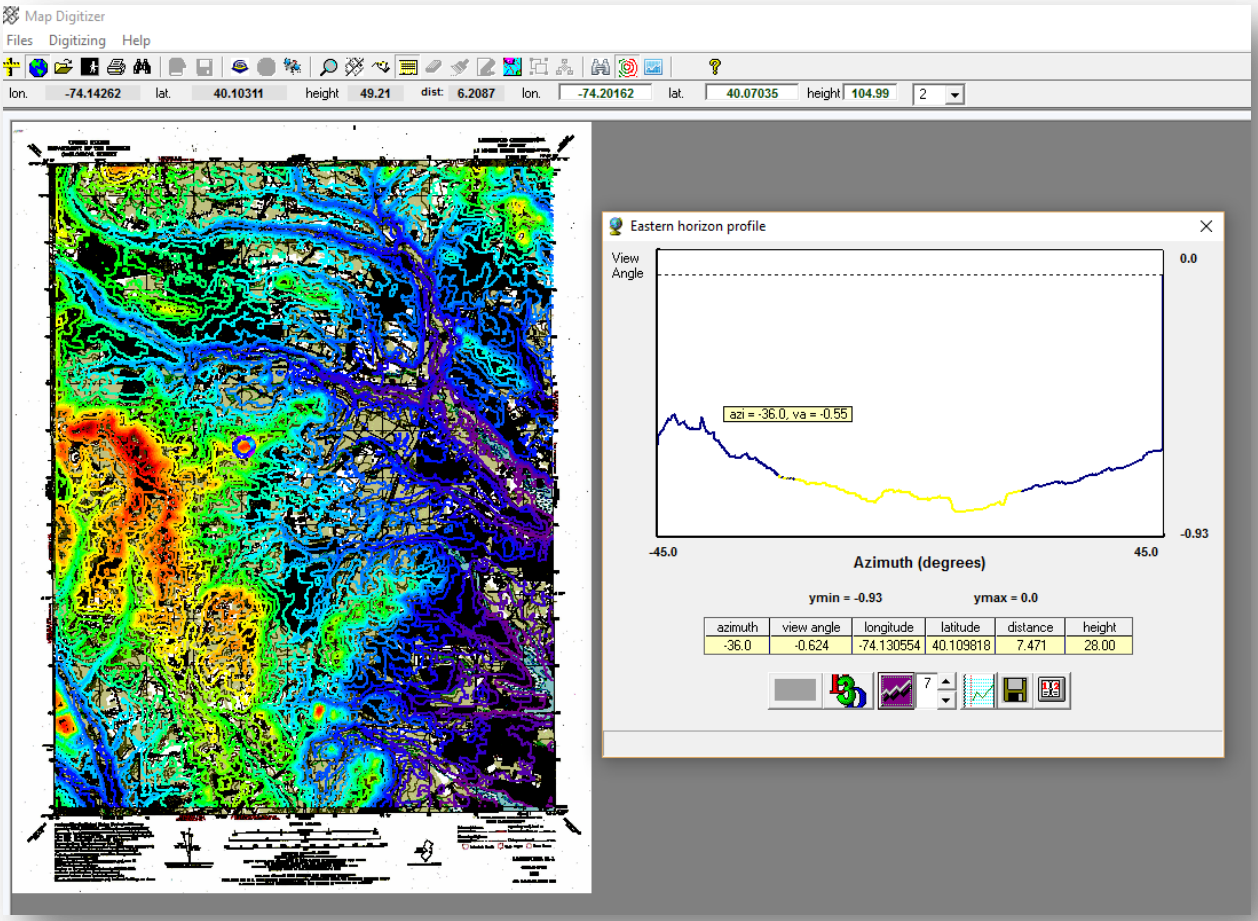
Picture: finished DTM after smoothing.

2. Once the DTM of a portion of the map has been completed, the program will display those heights when the mouse moves to that region (check the "Use heights based on generated DTM" in the "DTM" tab of the Options menu).
3. The created DTM is written as a standard Surfer version 7 binary "grd" binary file which can be plotted with Surfer or with Global Mapper, etc.

Contouring and Horizon Profiles

1. Contouring can be done over the map by pressing the "Contour" button (requires that a source is defined for the elevations). (see picture below). Define a rectangular region to calculate the contours by dragging over that region using the mouse.

2. To view the horizon profile from any point in a contoured region, click on any point. (Rubber sheeting must have been activated so that the point has a geographic latitude and longitude grid in degrees or is an ITM grid; this option doesn't support UTM grids. You must also have set the option to write xyz coordinate files in the "Setting" tab of the Options menu) . Then press the profile button  . The calculation's result is plotted on an interactive graph which shows the distance to the horizon and the elevation at any azimuth. The amount of the horizon that is less than a certain distance from the chosen point can be shown by setting a distance and clicking on the purple button. A portion of the graph can be zoomed by dragging over that area. Restore the original axis by pressing the "plot" button.



Picture: Map with 2 meter contours (the contour interval can be changed by setting it in the Options dialog "Settings" tag, or by setting it in the drop down list under the toolbar as shown in the picture). The chosen center point is marked on the map. The Eastern horizon from that point has been calculated in the graph. The graph is of view angle (the angle a surveyor measures with a theodolite) versus azimuth around due East. The yellow portion of the line marks a region in the horizon which is within 7 kilometers of the point. This option is activated by pressing the

purple button after setting a distance in kilometers. Notice that there is a display of azimuth (degrees plus or minus from due East or West), view angle, longitude, latitude, distance, and height at any point of the graph as the mouse moves along the x direction (azimuth).

3. Searching for the highest point in a region: Click on the "Search" button  and drag over the map to define a rectangular region for searching. The program will move the blinking cursor to the highest elevation in the chosen region.