

# Map Digitizing

## Objectives

This unit will teach the functionality of digitizing in order to capture the data in GIS. The general procedure is illustrated step by step through Animation.

At the end of the unit, the students will master how to capture the point, line and polygon features using digitizing capability of GIS.

## Introduction to digitizing

Digitizing is the process of converting geographic features on a paper map into digital format. The x, y coordinates of point, line and polygon features are recorded and stored as the spatial data. The feature attributes are also recorded during the digitizing process.

It is the most common and labour intensive method to create spatial database. The method is used especially when existing maps are available as the source of data. Coordinates of point features, line features and polygon features are recorded by manually pointing or tracing, using a digitizer table and cursor. The cursor position is accurately measured, by the device in order to generate the coordinate data in the digital form.

Although digitizing is substituted by scanning, digitizing tablets are still used to convert existing maps and drawings into GIS.

Digitizing tablets typically support E-Size and larger drawings, with 0.001-foot resolution, 0.001-foot repeatability and 0.005-foot accuracy. Remember that, digitizer contributes errors.

## Step-1 Setting up the digitizer

Go to the Step-by-Step Animation on the web. See the Step 1.

The setting up procedure is different to different models and brands of digitizers, digitizing software and operating system.

The digitizer driver software must be installed first. Normally, WinTab compliant digitizer software is necessary. Check the documentation of digitizer tablets or contact the manufacturer or its web site in order to find out the availability of WinTab compliant Driver Software for a particular digitizer.

The hardware guide of digitizer and hardware set up guide of digitizing or GIS software must be checked to find out and configure the following parameters for the compatibility to communicate between digitizer and digitizing or GIS software.

- digitizer name,
- communication port,
- mode of digitizing in point mode or stream mode,
- baud rate,
- parity and
- sending the data from digitizer to the digitizing software in ASCII or Binary mode.

The digitizer hardware must be configured according to the recommendation of digitizing software, using the dipswitch manually in older digitizer models or digital binary switch using digitizer tablet in newer models of digitizers. Some digitizers such as SummaSketch II Professional 1812, SummaSketch Plus 1201, do not provide the switches to configure. In that particular case, use the Digitizer Manager Program or WinTab Manager Program to configure it.

Some digitizers have 16 buttons and some have 4 buttons. Depending on the digitizing software design, the buttons on the digitizer puck must be configured.

After collecting the necessary information and configuring the digitizer hardware, communicate the digitizer and GIS or digitizing software using command provided by the software.

```
GITTA> ComDigitizer Cal9500 1 9600 none 8 1
```

In the above example, ComDigitizer is the command. Cal9500 is the digitizer name. 1 is the port number-1 where digitizer is connected to the computer. 9600 is the baud rate. None is none parity. 8 represent 8 data bits. 1 represents 1 Stop bit.

After communicating the digitizer and software, it should be tested by using commands provided by the digitizer software.

Go to the Step-by-Step Animation on the web. See the Step 1 again.

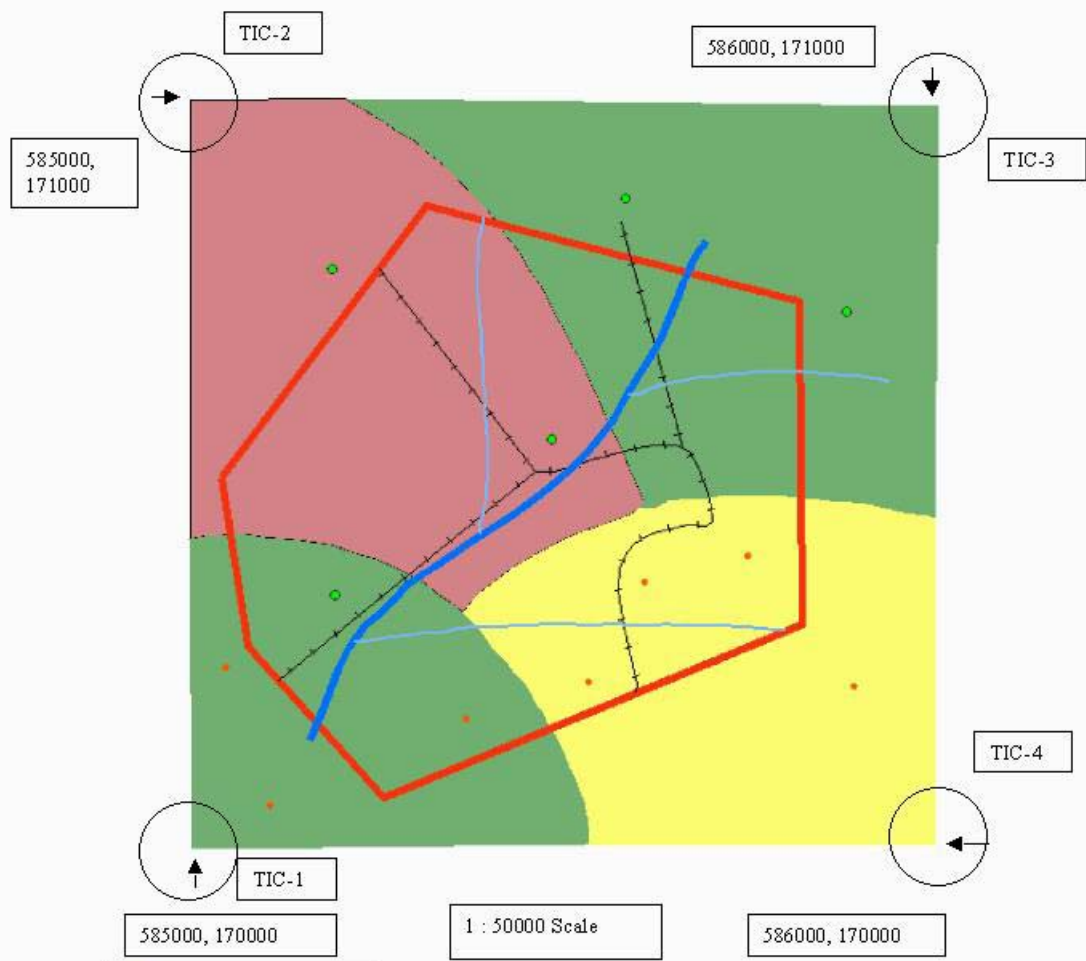
## **Step-2 Preparation of the Map for Digitizing**

Go to the Step-by-Step Animation on the web. See the Step 2.

The map should meet the data quality specification of the Project. Refer to the data quality and coverage section for detail information.

The paper map should ideally be reliable, up to date, not torn or folded. To minimize distortion in digitizing, copying paper maps to a more stable material such as Mylar is recommended. Moreover, the coordinate system and map projection of the paper map should be known and recorded.

The ground control points must be first established for later use to register the map to geographic space. The control points are also referred as the tic points.



- Layers**
- VillageTown
    - VILL54D
    - Town (ID-1)
    - Village(ID-2)
  - streams
    - TEST54D
    - Major stream (ID-1)
    - Minor stream(ID-2)
  - road
    - ROAD54D
    - Highway (ID 5)
    - Railway (ID 99)
  - landuse
    - LANDUSE54D
    - Agriculture (ID-1)
    - Forest (ID-2)
    - Industry (ID-3)

Projection

Oblique Mercator (Azimuth)  
 Spheroid: Bessel  
 Units: Meter  
 Scale factor at the Center of projection: 1  
 Longitude of center of projection: 7 26 22.5  
 Latitude of center of projection: 46 57 8.66  
 Azimuth at center of projection: 90  
 False Easting: -9419820.5907 m  
 False Northing: 0  
 Xshift: 0  
 Yshift: 0

The following would be marked and noted based on the paper map or drawing:

- At least 4 Control TIC points, which are circled. These are corner points of the map in the example, but can be any point with known coordinates.
- ID values for the TIC Points
- Coordinate values of each TIC point
- Projection and Coordinate Information
- Feature-ID values for different geographic features.

Once identified these information, place the map on the digitizer board and fixed it with masking tape.

Go to the Step-by-Step Animation on the web. See the Step 2 again.

### **3. Create the Common TIC file**

Go to the Step-by-Step Animation on the web. See the Step 3.

It is a good approach to create control tic file to reference.

The control tic file should contain the ID, X, Y coordinate values of each control point and Maximum X, Maximum Y, Minimum X, Minimum Y value of map or drawing. Moreover, the coordinate and projection parameter information would be recorded in the master tic file. During the Animation of Step-3, the projection parameters shown are Swiss Map Projection parameters.

Other feature files such as Village, Road and Land use can be created by copying the control tic, coordinate and projection information.

### **4. Register the control points**

Go to the Step-by-Step Animation on the web. See the Step 4.

The digitizing or GIS software will illustrate similar kind of following Graphical User Interface in order to present the positional accuracy of registration. The Xmap and Ymap values are read from TIC file. The Xdigitizer and Ydigitizer values are read directly from the digitizer signal after registering each control point.

An RMS error is calculated in digitizer scale (inches) or in ground distance (map unit) as illustrated.

The acceptance of error depends on the accuracy standard that you practiced or followed in your project.

Detail method of RMS calculation is discussed in positional accuracy unit of data quality lesson.

Go to the Step-by-Step Animation on the web. See the Step 4 again.

TIC ID	Xdigitizer	Ydigitizer	Xmap	Ymap	Error
1	10194	15335	585000	170000	2.7380
2	10227	29862	585000	171000	2.7577
3	19850	29703	586000	171000	2.7809
4	19886	15297	586000	170000	2.7612

Buttons: Clear, Load X and Y Value of Map, Save the Control Registration

RMS Error: 2.7579, 0.0191  
Map Unit: Inches  
Digitizer Location: 22431, 18005  
Buttons: Accept, Reject

## 5. Digitizing Point Features

Go to the Step-by-Step Animation on the web. See the Step 5.

Digitizing Point Feature is simple. However, the unique FeatureID of each point feature would be determined before digitizing.

It is a good practice to set the Unique FeatureID using the software digitizing utility commands through keyboard or digitizer pad before digitizing each point.

Building the feature attribute table is necessary step to create a database table. Additional field can be added to the tables to store more descriptive information in text or numeric format.

Go to the Step-by-Step Animation on the web. See the Step 5 again.

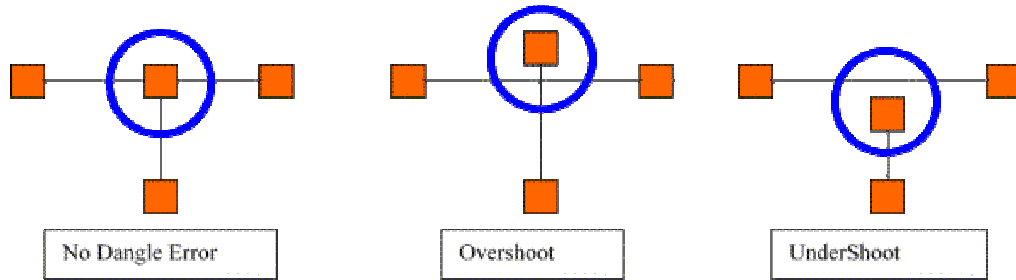
## 6. Digitizing Line Features

Go to the Step-by-Step Animation on the web. See the Step 6, 7 and 8.

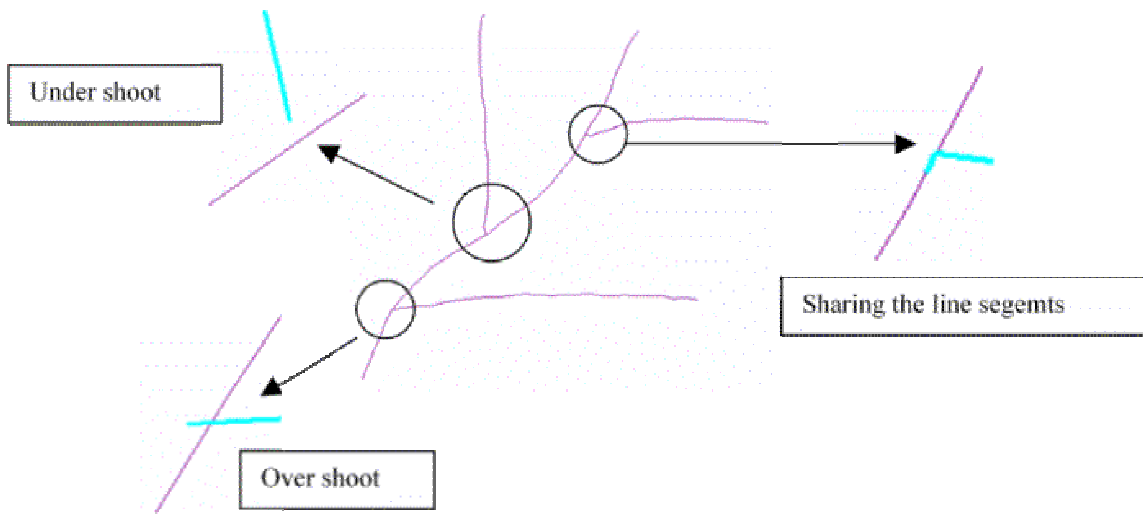
The FeatureID of line features would be clearly defined before digitizing and the quality of data source for the line feature should be acceptable according to the data quality standard of project.

The snap distance, grain tolerance and dangle length of line feature should be set in order to minimize the geometry errors such as overshooting and under shooting which are refer as dangle errors. This option allows to automatically trap dangle errors as they may not be observable at digitizing scale.

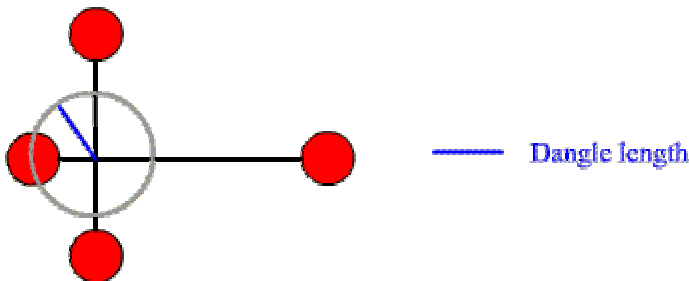
An arc having the same polygon on both its left and right sides and having at least one node that does not connect to any other arc. It often occurs where a polygon does not close properly (undershoot), where arcs don't connect properly, or where an arc was digitized past its intersection with another arc (overshoot). A dangling arc is not always an error. For example, dangling arcs can represent cul-de-sacs in street centerline maps. (ESRI)



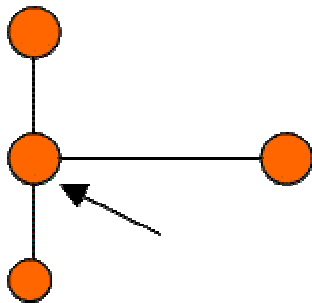
The following errors are commonly occurred in digitizing line features especially at the intersection points



According to the learning process in Animation, the overshoot dangle error can be corrected using the dangle tolerance or length. The dangle tolerance or length is the minimum length allowed for dangling arcs.

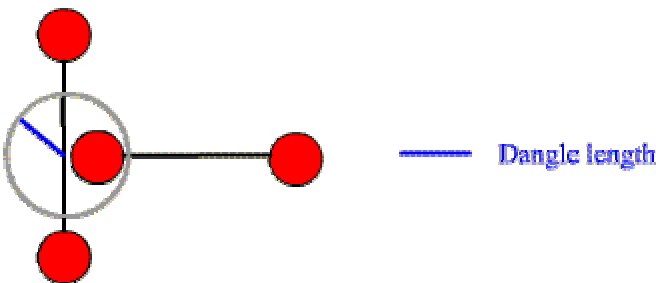


In the above figure, assuming that overshooting is approximately 2 Meter in Map Unit. If dangle length is set a value greater than the overshoot distance, the overshoot will be corrected.

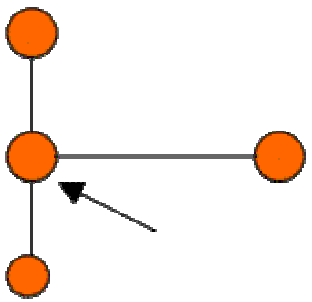


**If Dangle Length > over shoot**

The under shoot dangle error can be corrected using the fuzzy tolerance. Fuzzy tolerance is an extremely small distance used to resolve inexact intersection locations due to the limited arithmetic precision of computers.



The above figure illustrates the under shoot dangle error. Assume that undershooting or gap is approximately 2 Meter in Map Unit. If Fuzzy Tolerance is set a value greater than the under shoot distance, the under shoot will be corrected.



**If Fuzzy Tolerance > Under shoot**

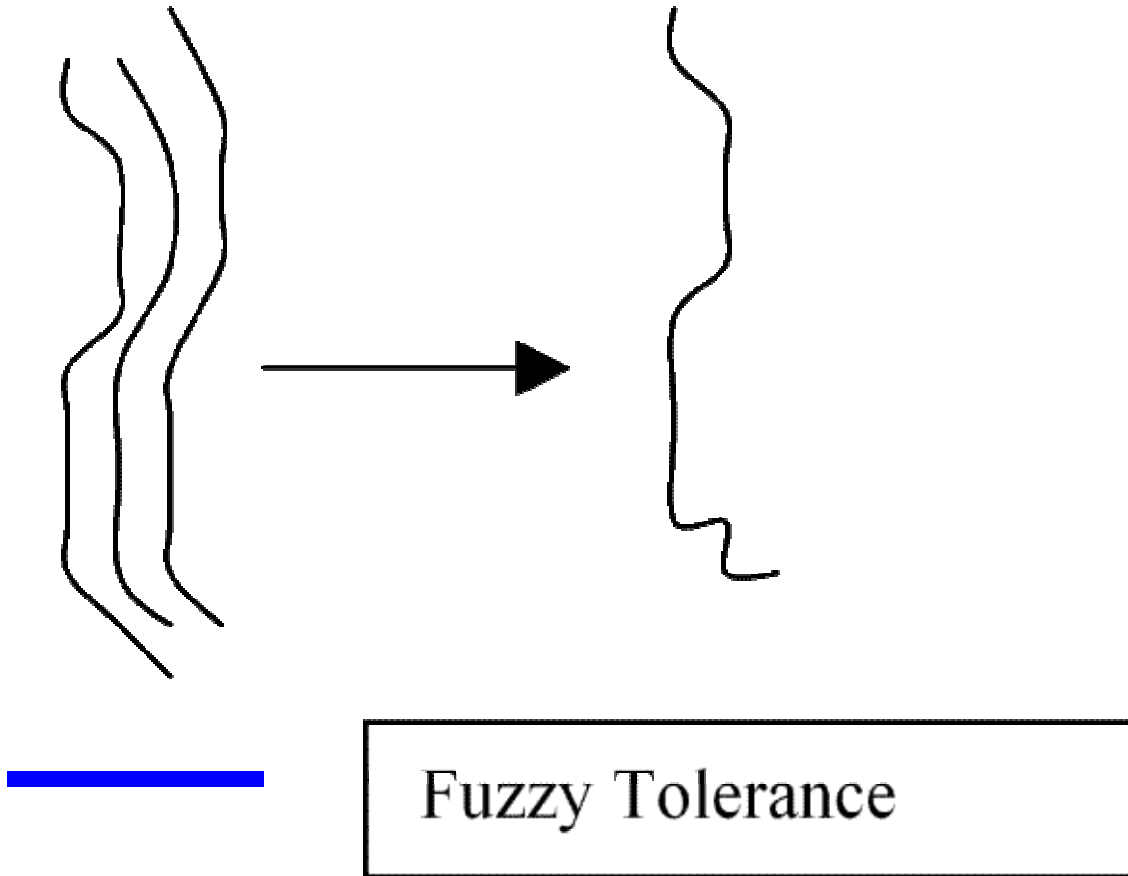
Fuzzy tolerance and snap distance is conceptually similar. However, fuzzy tolerance is applied after digitizing process as the batch processing in order to correct the undershoot dangle. Snap distance is applied during the digitizing process in order to correct each undershoot node error.

However, there are pitfalls to consider setting the values of Dangle length and Fuzzy Tolerance.

The large dangle length value may cut out segments, which are essential part of the feature geometry such as small overshoot water pipeline which actually exist on the ground and part of the water pipeline feature.

The small dangle length value may not correct the overshoot dangles, which are longer length than dangle length.

The large fuzzy tolerance value will snap the vertices of features unnecessarily and produced more errors.



In the above example figure, contours are digitized at a steep area. Therefore, the widths between contours are narrow.

If the fuzzy tolerance value is larger than the width of contour, all the vertices of contours will snap together and only one error contour will remain in the above figures after applying the fuzzy tolerance.

The recommended values of fuzzy tolerance and dangle length is 0.002 inch equivalent of ground distance or map unit for a particular map scale.

Share line segments are corrected by splitting and deleting it.

Geometry error corrections are software specific. However, these general rules can be applied. Check with your software to correct overshoot and undershoot dangles.



Building the feature attribute table for line is necessary step to create a database table. Additional field can be added to the tables to store more descriptive information in text or numeric format.

Go to the Step-by-Step Animation on the web. See the Step 6, 7 and 8 again.

## **7. Digitizing Polygon Features**

Go to the Step-by-Step Animation on the web. See the Step 9, 10 and 11.

The snap distance, grain tolerance and dangle length of line feature should be set in order to minimize the geometry errors such as overshooting and under shooting which are refer as Dangle errors.

The FeatureID of polygon features would be clearly defined and the quality of data source for the polygon feature should be acceptable according to the data quality standard of project.

The shared boundary of polygons would be digitized only once, as features are organized as chains in topological structure.

The dangle errors can be corrected in similar way as discussed in digitizing line feature.

After correcting the geometry error, the polygon feature ID or polygon label errors would be corrected. Two kinds of polygon label error could be occurred. These are (1) missing polygon label (2) many labels in the polygon.

(1) Missing polygon label can be corrected by adding the appropriate polygon feature ID.

(2) Many labels error can be corrected by deleting extra labels.

Go to the Step-by-Step Animation on the web. See the Step 9, 10 and 11 again.

## **Digitizing Exercise**

1. Set up the digitizer with digitizing software or GIS software available at your Geoinformatics Lab.
2. Print out the map on page-3.
3. Digitize the point features. The file name would be given as Settlements. Build the Attribute table of settlements.
4. Digitize the line features that represent roads. The file name would be given as Road. Correct all the dangle errors. Build the Attribute table of Roads.

5. Digitize the line features that represent streams. The file name would be given as Stream. Correct all the dangle errors. Build the Attribute table of Streams.

6. Digitize the polygon features that represent different land uses. The file name would be given as Landuse. Correct all the dangle errors and label errors. Build the Attribute Table of Landuse.

## **Questions**

1. List the three most common methods of data capture.
2. List the steps for digitizing based on your experience of digitizing at your Geoinformatics Lab.
3. Before digitizing the map, what information should be obtained or gathered about the map?
4. Why tic controls are necessary and explicitly marked before digitizing?
5. After registration the 1:25000 scale map with the TIC control points, the RMS error is 0.5 inch at the digitizer scale. The project document standardizes the accuracy requirement according to the US National Map Accuracy Standard. Should we accept this RMS value or should we register the map again? Why? See the Positional Accuracy unit of Metadata Quality Lesson for more information on US National map Accuracy Standard.
6. What is User ID of features? Explain with examples.
7. What is dangle errors? Explain with examples.

## **Share The Result**

1. Submit your result of digitizing to the discussion group.
2. Submit your answer to question 1 to 7 to the instructor by Email.