Class 3 – Image Registration

1Image Registration

Registration is a geometric transformation that relates the image coordinates (line and column) with the geographic coordinates (latitude and longitude) of a map. This transformation eliminates existing distortions in the image, caused by the image formation process, by the sensor system, and by errors in the platform position (airplane or satellite).

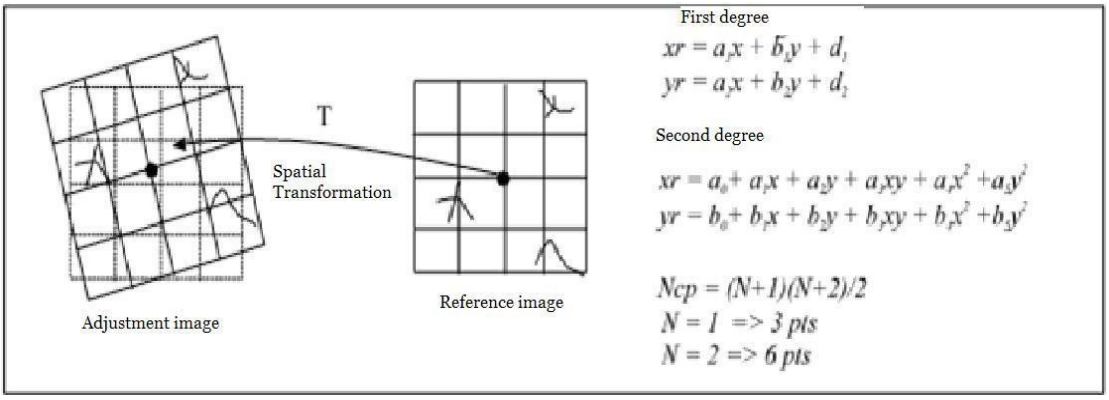
The registration is required for:

- The integration of images acquired by different sensors.
- Temporal analysis of images acquired at different times.
- The generation of 3-D information from images acquired from different positions.
- Generation of image mosaics.

Procedures

To perform image registration you will need:

1. **Choosing the Control Points** – these are features that are possible to be identified in a precise way in the image or on the map, like roads crossing.
2. **Define the mapping equation** – choosing which mathematical equation, usually of the first or second degree, will resample the pixels.
3. **Define the interpolation process** – Nearest Neighbor or Bilinear.



2Database Definition and Model

Following you will be presented the procedures to create a **Database** and an **Image** category in this database.

⇒ ***Creating a Database:***

Windows: #Start – Spring<version><Language><system> – Spring<version> <Language>

Linux: # Command to be typed on the Console (Shell) – # s_spring

MAC: #Dock – Launchpad – Spring <version> < language >

- [File] [Database…] or button 

Database

- (Directory…) *select the path C:\Tutor_10classes\springdb (windows*
  ~/Tutor_10classes/springdb - Linux
- {Name: Database1} – *or any other name (32 characters at most)*
- (DBMS ⇔ SQLite)
- (Create)
- (Apply) – *Answer **Yes** in case you have another Database/Project loaded.*

⇒ ***Creating a Category to work with images:***

SPRING

- [File] [Data Model…] or button 

Data Model

- {Categories - Name: TM_Image}
- (Model ⇔ Image)
- (Create)
- (Apply)
- (Close)

3Procedures to register the image – via keyboard

In SPRING the user can acquire the control points in three ways: using the map on the digitizing table (**Table** mode), through any information layer already georeferenced (**Screen** mode) or informing the coordinates directly from the keyboard (**Keyboard** mode).

Table: In the Table mode you will need only to have a map (topographic map of the same image area). This map must be calibrated in a digitizing table. It is not necessary to load a Project, in this case the system will ask you to inform the projection to be used in the registration.

Screen: In this mode you can use an Information Layer in a project loaded. This IL could be an image that was already georeferenced or a Thematic IL (for instance, river or road map) that has features that are recognizable in the image.

Keyboard: In the keyboard mode it is also not necessary to have a project loaded, being necessary in this mode to inform the projection of the points. The control points are informed in plane or geographic coordinates, being collected directly over a topographic map or with a GPS.

3.1Selecting the image to be registered

⇒ ***Selecting and enhancing the image to be registered:***

- [File] [Image Registration…]

Two windows are presented. In case you need to open again the **Image Selection click on the button below the window **Image Registration**. Click OK on the message that asks Auxiliary Display to open the image that was saved on the last lesson.*

Image Registration

- (Image…)

Image Selection

- (Directory…) *select the path C:\Tutor_10classes\Images – Windows or*
~/Tutor_10classes/Images – Linux or
~/Tutor_10classes/Images – MAC and press OK
- (Files | Brasilia.spg)
- (Select)
- (Bands | S255B3-*) – *or any other band*
- (M)

Auxiliary Display

- [Execute][Draw] or button  - the image is presented in the Auxiliary Display.

**To enhance the image contrast facilitating the acquisition of points.*

Image Selection

- (Contrast…)

Contrast

-drag and release the mouse over channel (M)

- (Apply)
- (Close)

Image Selection

- (Close)

Important: Do not close the **Image Registration** window, otherwise you will have to select the image again.

3.2Control points acquisition

⇒ ***Selecting the projection for the points:***

Image Registration

**It will be necessary to inform the projection system that refers to the points to be typed in.*

- (Projection…)

Projection

- (Systems | UTM)
- (Earth Models | SAD69)
- {Origin – Long: w 45 0 0} or {Zone: 23}, (Enter)
- (Apply)

⇒ ***Acquiring the control points through the keyboard:***

Image Registration

- (Acquisition ⇔ Keyboard)
- (Operation ⇔ Create)
- {Name: cp1} – *or use the name from the table below*
- (Enter)
- (OK) – *on the message "Type the reference coordinates!"*
- (Reference coordinates ⇔ Planes), - (Hemisphere ⇔ S)
- {X: 189127.2}, {Y: 8260695.1}
- (Enter)

**Since you are at the beginning of the registration process, the software still does not know the precise coordinates in the image. Therefore you should drag and drop each control point, right after it appears in the image, to its*

exact spot, according to the figure below. You may use the zoom tool to position the control points more precisely in the image. Remember that you cannot grab the control point while the zoom tool  *is selected, you must deselect it first.*

- (Save)

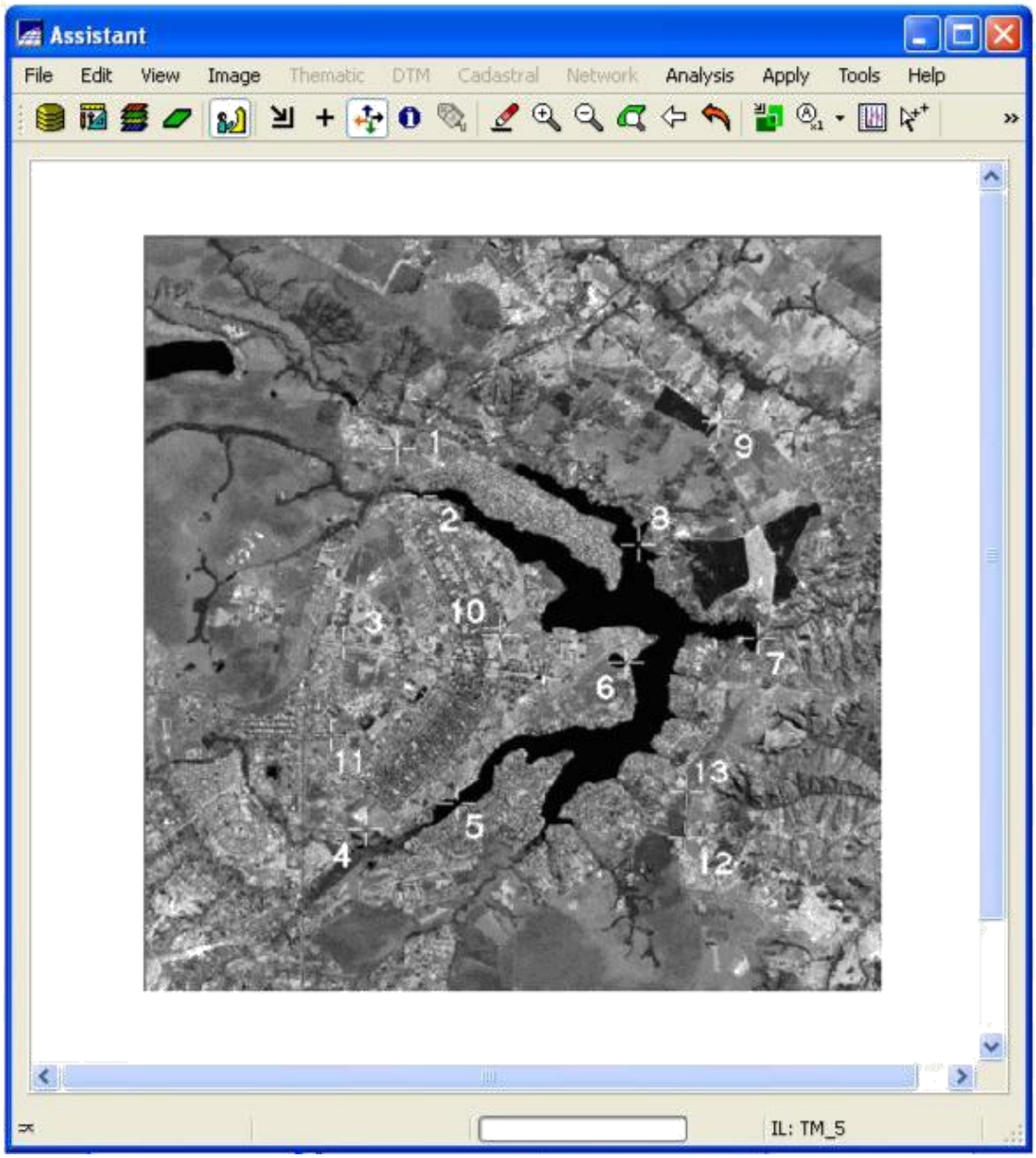
Note: press the save button after the acquisition of each control point, even if it is not sufficient for the registration.

- Repeat for at least 6 control points. Always prefer points that are evenly distributed on the image.

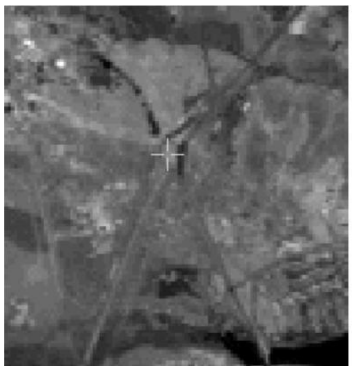
CP	Name	X (meters)	Y (meters)
1	Trevo_torto	189127.2	8260695.1
2	Ponte_asanorte	189773.2	8258734.3
3	Trevo_cpdex	186106.4	8253422.9
4	Trv_zoologico	185944.6	8246038.4
5	Pte_gsalomao	189544.2	8246578.1
6	Lago_jaburu	196520.2	8251208.2
7	Barragem	201670.7	8251500.6
8	Ilha	197639.3	8255736.0
9	Trv_nordeste	201244.2	8260185.0
10	Trv_unb	192014.9	8252928.3
11	Trv_cemiterio	185134.9	8249891.9
12	Trv_esfazenda	197860.9	8244118.9
13	Trv_esfazenda2	198175.0	8245925.3

The figures below show the position of the control points on the image, together with a zoom of each point.

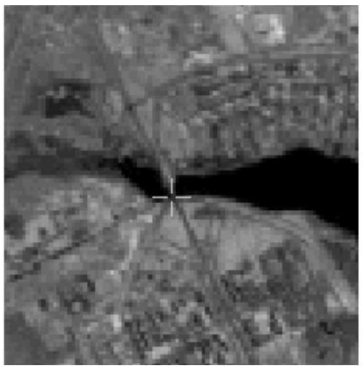
Control Points on the Image



CP1



CP2



CP3

CP4

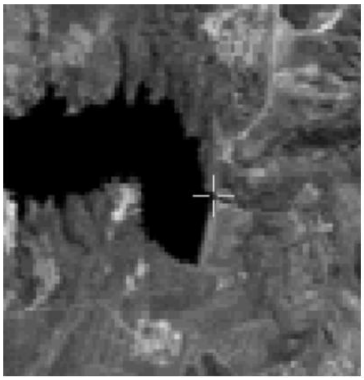
CP5

CP6

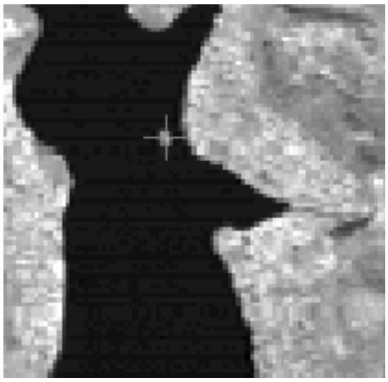
CP7

CP8

CP9



CP10



CP11

CP12

CP13

3.3Selecting points for the registration

The following procedures are common for any control point input mode (**Digitizer**, **Keyboard**, or **Display**)

⇒ ***Defining the mapping:***

Image Registration

- (Operation ⇔ Select)
- (Polynomial degree ⇔ 1)

**Select all the control points and evaluate the errors in the Test and Control Points.*

- *Edit the points (move, suppress and create as needed by your evaluation of the Test an Control errors)*

**As a starting point look for a combination of Control Points that will lead to an Error of the Control Points that is less than 1 pixel, and an Error of the Test Points that is less than 1.5 pixels (see the Notes below). In case you cannot reach those figures revise you control points in order to check if they are not misplaced or if you have mistyped their coordinates.*

- (Save) *save the set of points of minimum error (the points are saved in the SPG image file itself)*
- (Close)

NOTES:

- As the points are being selected, which turns them into **Control Points**, the error calculation (in number of pixels) is automatically presented next to their names. The calculations are also performed for the points that were not selected (these are the **Test Points**).
- The ideal is to work with as many control points as possible, for the more points the better for the registration, provided they are evenly distributed and precise.

- The user should observe the value presented as **Error of the Control Points**, because he will have to use it to keep control over the desired precision. For example: in an urban area, we can consider a 0.5 pixel error, for a 30 meter resolution. In forest area, we can accept a 3 pixels error, for that same resolution, due to the difficulty in

finding good control points. That will depend on the user's application.

- Another parameter used for the analysis is a function of the error of the scale you are working. For example: for a mapping in the scale 1:50.000, the acceptable error in the registration is half of the scale (25 meters). Thus a 2 pixels error, for a 10 meter resolution, that is, 20 meters, would be acceptable for this scale.

- If necessary, repeat the operation of control point selection and test until you achieve a satisfactory result. You can test with other points, other polynomial, or even correct the position of some point that you don't want to discard.

3.4Registering an image

Now it will be necessary to define a Project that includes the image to be registered.

⇒ ***Defining a Project:***

SPRING

- [File] [Project…] or button 

Project

- {Name: DFederal} *or any other name (32 characters at most)*
- (Projection…)

Projections

- (System | UTM)
- (Earth Model | SAD69)
- {Origin – Long: o 45 0 0} or {Zone: 23}, (CR)
- (Apply)

Note: *Most of the secondary windows are closed after* (Apply), *however, other windows where you can perform more than one operation will require* (Close).

Projects

- (Coordinates ⇔ Geographic)
- {Long1: o 47 57 30}, {Long2: o 47 47 00}
- {Lat1: s 15 52 30}, {Lat2: s 15 41 55}

**It is necessary to define first the lower left corner and then the upper right corner (diagonally opposite)*

- (Create)
- (Load)

Note: Observe that in the **Control Panel** there are no Categories nor any corresponding IL's, despite there is a category in the Image model that was previously defined, which is only presented in the **Control Panel** after importing the SPG image to it, that is, after creating an IL.

⇒ ***Importing the image to the Project:***

SPRING

- [File] [Import][Registrated Images…]

Import Registrated Images

- (Directory: C:\Tutor_10classes\Images) – Windows
  ~/Tutor_10classes/Images – Linux
  ~/Tutor_10classes/Images - MAC
- (Files | Brasilia.spg)
- (Images | S255B1-*)
- (Category…)

  Categories List

  - (Categories | TM_Image)
  - (Apply)
- {Infolayer: **TM3**}
- (Interpolator: ⇔ Nearest Neighbor)
- (Apply)

Notes:

- At the end of the registration observe that the imported information layer now is part of the list presented in the **Control Panel**.
- When the available image is not sufficient to cover the whole project area, you should acquire the adjacent image and repeat the whole image reading and registration procedure again for the new image thus creating a **mosaic**.

Tip: In case you do not acquire the control points, you could import the **Brasilia_po.spg** file to the project, for it contains all the control points. You will be able to see the control points if you import the image through the Image Registration option in the File menu.