An Experience in Digital Orthophotos Production using LCRSSS Aerial Images

Samira Sultan Dhafer

Libyan Center for Remote Sensing and Space Science, Tripoli, Libya,
Email: samira_sultan@yahoo.com

Abstract

Photogrammetry plays a major role in the Geographical Information System (GIS). More than one of its products are used as sources of information for the GIS databases. One of them is the digital orthophotos. In this work we describe the needed processes to product digital orthophotos from high resolution aerial images acquired in 2008 with Ultra Cam D digital camera using ERDAS Imagine Leica Photogrammetry Suite Project Manager (LPS PM) software.

Keywords: Digital Photogrammetry, aerial Image, digital orthophoto, Erdas LPS.

1. Introduction

Photogrammetry has been described as the "art, science and technology of obtaining information and of making measurements from imagery."[1] Photogrammetry plays a very important role in the collection of information for most Geographic Information System (GIS) database. [2] A common use of photogrammetric products is to populate or update GIS database. [1] Photogrammetric products frequently used as sources of information for GIS databases are of three types: images, maps, and digital data files. Orthophotos belongs to the first type. They are extremely convenient for use as background reference frameworks for GIS applications.[2]

A digital orthophoto is a digital photograph that has been modified so that each pixel within the image possesses geometric fidelity, removing errors due to a camera tilt, systematic errors and relief displacement. An orthophoto is a product which has the image qualities of photograph and the planimetric correctness of a map.

Orthophotos are produced through process called the differential rectification. This method uses a digital surface model (DSM), an aerial image with the parameters of its acquisition from interior and exterior orientation, or with other

words a DSM and an oriented image to eliminate image displacement due to photographic tilt and terrain relief.

In this work we generated digital Orthophotos (Orthoimages) from high resolution aerial images for a small area test that was selected near Zwara-Airport in Libya. Their ground resolution is approximately 10 cm. The images used here are owned by the Libyan Center for Remote Sensing and Space Science which were acquired using the digital camera Ultra Cam D in summer 2008.

The rest of this paper goes as following; in section 2, we refer to which photogrammetric software was used in this experience. Next in section 3, we describe the input data. Then in section 4, we begin to discuss the needed processes to produce a digital orthophoto and finally, concluding remarks are given in section 5.

2. Utilised Photogrammetric Software

IMAGINE Photogrammetry, PHOTOMOD, Geomatica, LISA are some examples for photogrammetric software. We used for the entire production processes to our small project only Erdas Leica Photogrammetry Suite 2014 (LPS 2014) which is commercial software package within ERDAS IMAGINE.

3. Input Data

The used data consists of 3 strips (images sequences) of aerial images, each containing 12 images with an overlap between 54% and 60%, IMU (Inertial Measurement Unit) which include the airborne GPS\INS (Global Positioning System\ Inertial Navigation System) information, known too as the exterior orientation data which defines the characteristics associated with an image at the time of exposure, the camera information (interior orientation data) which define the internal geometry of the camera as it existed at the time of image capture, and ground control points (GCPs) taken by ground GPS (See figure 1).
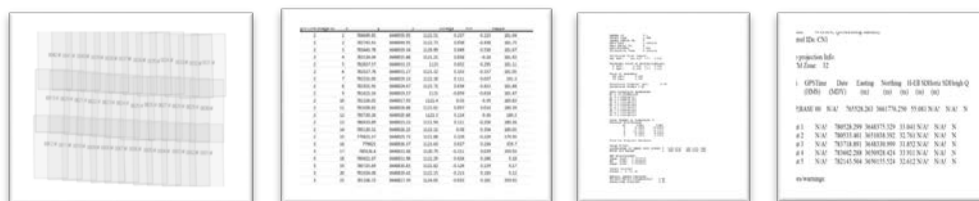

Figure 1: The Input Data

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4. The photogrammetric software workflow

LPS-PM has linear workflow. In this section we go through the needed processes to achieve our target.

4.1. Creating a block file

The first step to generate digital Orthophotos is creating a block file. Block is a term used to describe and characterize all of the information associated with a photogrammetric mapping project, including: defining the geometry of the used model which is a digital camera, choosing to work in this project with the UTM projection for the spheroid WGS84 and the Datum WGS84, setting the rotation system to omega, phi, kappa and the photo direction to the Z axis and entering the average of flying height. With this we defined our new project block file. Now we attach the images in the block, load the interior orientation parameters and import the exterior orientation parameters for each image. And to optimize the image display and the automatic tie point collection we compute pyramid layers for the images in the block. See figure 2.
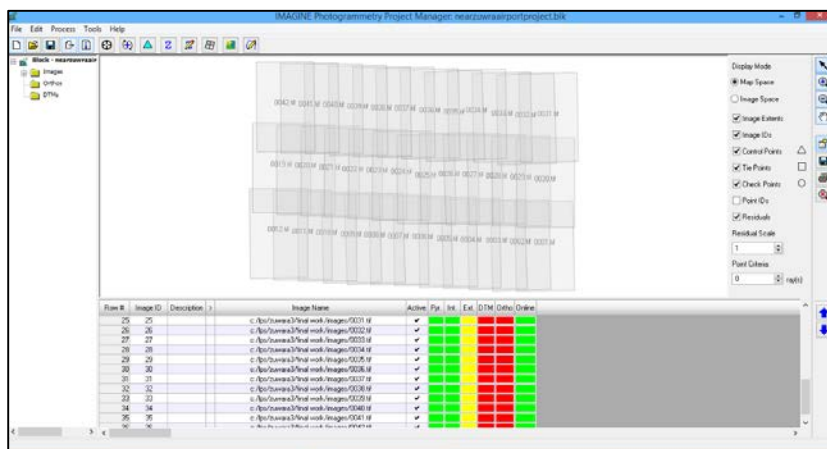

Figure 2: Near- Zwara-Airport Project Block file

4.2. Adding GCPs and Performing Automatic Tie Points collection

 At this point we are ready to measure the position of the ground control points, tie points and run the automatic tie point's extraction using the point measurement tool.

The theoretical minimum number of GCPs is two full GCPs (having X, Y, and Z coordinates) and one vertical GCP (having Z coordinate). In our test area we have found three GCPs that was collected using ground GPS. First we have measured the positions of these GCPs in the images, and then we selected random four tie points manually. After that we used all available images to generate 75 tie points per image automatically using the following parameters which suite the nature of our test area: search size = 21, correlation size = 15, least square size =30, feature point density =150%, coefficient limit = 0.80 and initial accuracy = 25%. With average Point Success rate of 100%, we have collected 1644 unique points. At last we reviewed the auto tie summery (see figure 3), and have checked some of them to ensure their accuracy.

Figure 3: Summary of the Automatic Tie Point measurement

4.3 Performing aerial Triangulation

Aerial triangulation is the process to establish the mathematical relationship between the images that make up the block file, the camera model, and the ground. Once the relationship has been established, accurate information concerning the earths' surface can be extracted. The aerial triangulation determines the ground coordinate of the tie points, adjust the exterior orientation parameters of each image and the interior orientation parameters, minimize and distribute the errors throughout the block using the bundle block adjustment technique.

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We had specified the parameters associated with performing the aerial triangulation to suite our project. In the triangulation summary dialog we had viewed the summary statistics to check whether the solution is satisfactory or not. For more details we opened the report and analyzed the results, written down the inaccurate points label and used the point measurement tool to adjust or delete them, and then we redid the aerial triangulation till the wishful accuracy reached. A total RMSE of 0.1464 pixels is good enough for our project. See figure 4.
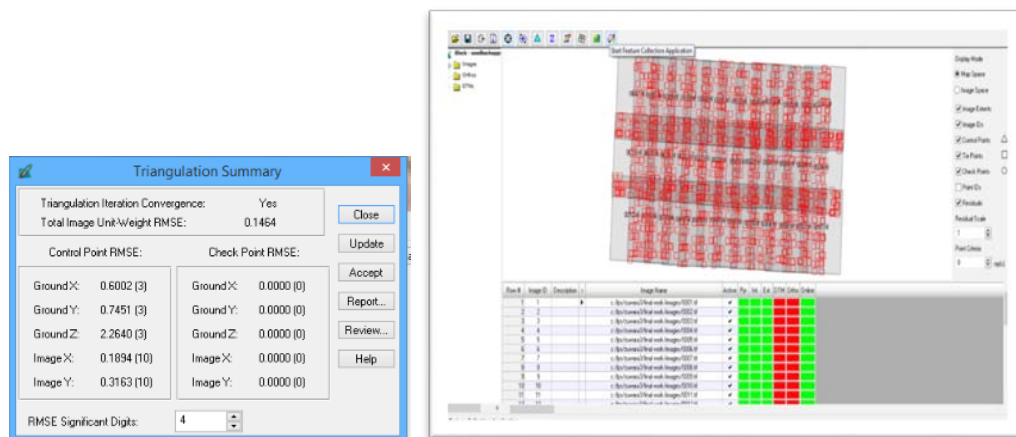

Figure 4: left: Triangulation Summary, Right: the triangulated Block

4.4 DTM Extraction

In this step we had created a DEM image file from the image pairs with an overlap of 50% or greater in the block. The DEM extraction process is done using LPS ATE (Automatic Terrain Extraction).

The digital surface model (DSM) contains Z values at the top of objects situated on the terrain. Such a model is needed when orthophotos should be created [3]; hence we extracted this model for our test area with the same projection as the projection for the block with the default cell size 1 meter resolution and the default value for the background, the DTM border was trimmed by 5%, the DTM correlation area was reduced too by 5% and to visually represent the accuracy report we had enabled the create DTM point status option. The result was successful with a General Mass Point Quality Excellent of 90.5849%, Good of

9.1758% and Fair of 0.2393 %. The DTM and its point status are shown in figure 5 below.
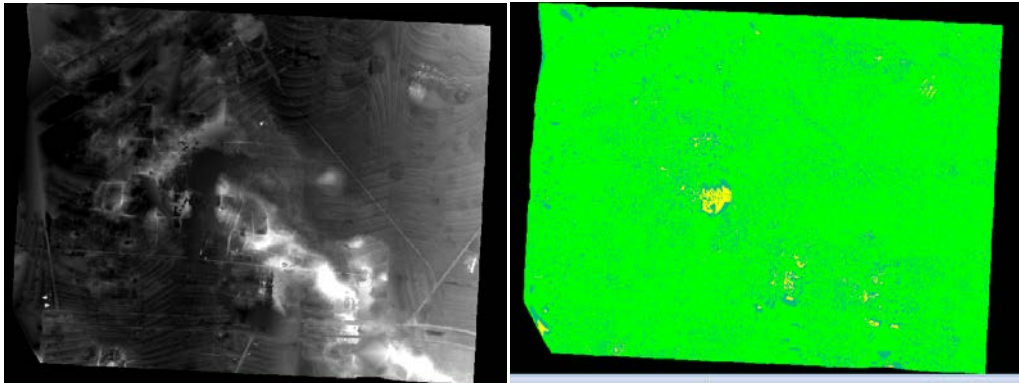

Figure 4: left: 1-meter DEM, Right: Mass Point Status Quality

4.5 Digital Orthophotos Generation

The next step creates orthorectified images of our block file images using process called orthorectification. Orthorectification is the process of reducing geometric errors inherent within photograph and imagery. The variables contributing to geometric errors include, but are not limited to camera and sensor orientation, systematic error associated with the camera or sensor, topographic relief displacement and Earth curvature.

The orthorectification process takes the raw digital images and applies a DEM and triangulation results to create an orthorectified image. An image with an orthographic projection one for which every point looks as if an observer were looking straight down at it, along a line of sight that is orthogonal to the Earth. [4]

We used the bilinear interpolation as the resampling method to create Orthoimages with cell size of 9.635 centimeter, choosing our DSM product as source for the elevation information.

4.6 Orthophotos Mosaic

In rural areas, the main quality aspect will come from the correct mosaicking (particularly the problem of 'hot spot'), nobody will notice the way the trees or

the fences are represented. [5], so we used this aspect as one of the methods to check the quality of our product.

And when the radiometry is very precise (the case of the digital cameras acquisitions), it is necessary to make the join-up line visible in the mosaic to remind one that the orthography is not originating from only one unique photo [5]. With this a statement from Didier Moisset we used the MosaicPro tool in LPS PM to balance the colour of our product and then join them and form a large image. See figure 5.
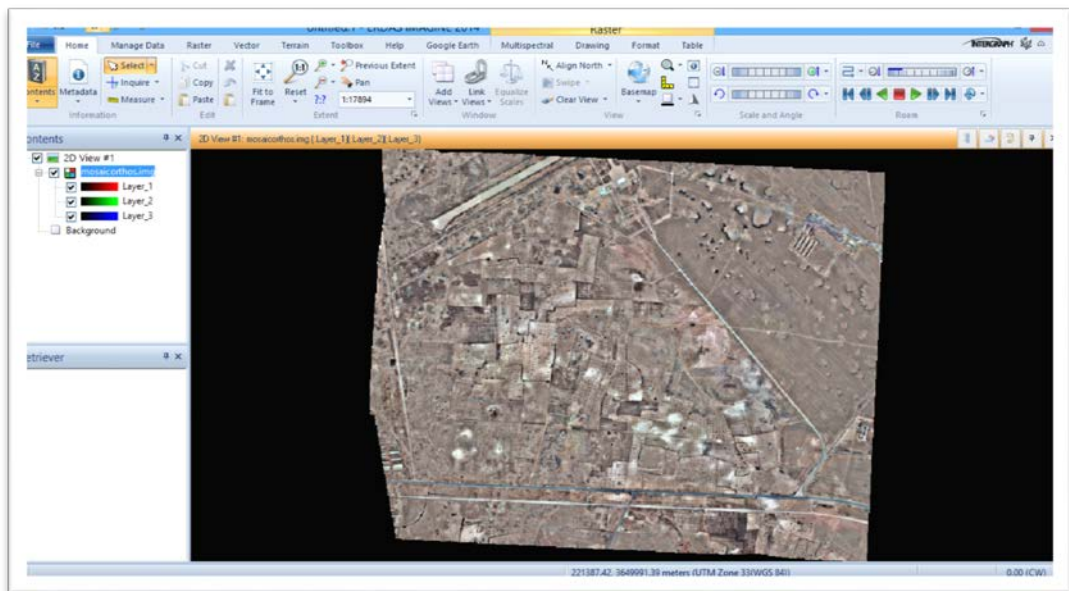

Figure5: Mosaic of the digital orthophotos

5. Conclusion

In this work, we produced Orthoimages (digital Orthophotos) using Erdas LPS software. The procedure successfully generated a total of 36 orthoimages of 9.635 centimeter resolution. During the production processes, sometimes we used the default setting, consequently we had results with optimal quality, but sometimes we needed to choose the suitable strategies with the right parameters to achieve the wishful quality. All of this was done after we had checked the quality of every input used in each one of the steps.

References

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