## ASSIGNMENT 1

Assume that you are given a grayscale aerial image (106.jp2) and the related information, as given below (the spectral bands are ignored purposefully!). Note that the image is free from errors due to intrinsic parameters (i.e. no camera related distortions exist).

| Camera | Focal length | Flying height above Ground | Forward overlap | Side lap | GSD | Spectral bands | Radiometric resolution |
|---|---|---|---|---|---|---|---|
| DMC | 120 mm | 900 m | 60 % | 60 % | 8 cm | IR – R - G | 11 bit |

Table 1: Flight parameters of the Vaihingen 8 cm DMC block. GSD: Ground Sampling Distance.

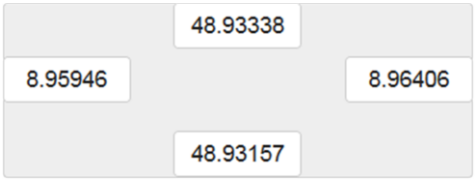
| Camera | file coordinate system | | | camera coordinate system | | | pixel size Δ [mm] |
|---|---|---|---|---|---|---|---|
| | $row_{PP}$ [pixel] | $col_{PP}$ [pixel] | $f$ [pixel] | $x_{PP}$ [mm] | $y_{PP}$ [mm] | $f$ [mm] | |
| Intergraph/ZI DMC | 6912.0 | 3840.0 | 10000.0 | 0.000 | 0.000 | 120.000 | 0.012 |

Table 3: Interior orientation of the digital images of the Vaihingen Block.

| Strip | Image file | Projection Centres | | | Rotation Angles (ω: primary, x; φ: secondary, y; κ: tertiary, z) | | |
|---|---|---|---|---|---|---|---|
| | | $X_0$ [m] | $Y_0$ [m] | $Z_0$ [m] | $\omega$ [gon] | $\varphi$ [gon] | $\kappa$ [gon] |
| 3 | 10030060.tif | 496803.043 | 5420298.566 | 1163.983 | 2.50674 | 0.73802 | 199.32970 |
| | 10030061.tif | 497049.238 | 5420301.525 | 1163.806 | 2.05968 | 0.67409 | 199.23470 |
| | 10030062.tif | 497294.288 | 5420301.839 | 1163.759 | 1.97825 | 0.51201 | 198.84290 |
| | 10030063.tif | 497539.821 | 5420299.469 | 1164.423 | 1.40457 | 0.38326 | 198.88310 |
| 4 | 10040081.tif | 496558.488 | 5419884.008 | 1181.985 | -0.87093 | -0.36520 | -199.20110 |
| | 10040082.tif | 496804.479 | 5419882.183 | 1183.373 | -0.26935 | -0.63812 | -198.97290 |
| | 10040083.tif | 497048.699 | 5419882.847 | 1184.616 | 0.34834 | -0.40178 | -199.44720 |
| | 10040084.tif | 497296.587 | 5419884.550 | 1185.010 | 0.81501 | -0.53024 | -199.35600 |
| | 10040085.tif | 497540.779 | 5419886.806 | 1184.876 | 1.38534 | -0.46333 | -199.85010 |
| 5 | 10050103.tif | 496573.389 | 5419477.807 | 1161.431 | -0.48280 | -0.03105 | -0.23869 |
| | 10050104.tif | 496817.972 | 5419476.832 | 1161.406 | -0.65210 | -0.06311 | -0.17326 |
| | 10050105.tif | 497064.985 | 5419476.630 | 1159.940 | -0.74655 | 0.11683 | -0.09710 |
| | 10050106.tif | 497312.996 | 5419477.065 | 1158.888 | -0.53451 | -0.19025 | -0.13489 |
| | 10050107.tif | 497555.389 | 5419477.724 | 1158.655 | -0.55312 | -0.12844 | -0.13636 |

Besides, you are also given a patch of DSM data (ALS.tif) generated from LiDAR point clouds belonging to a part of the aerial image 106.jp2.

1- (15 Points) You are required to download the “buildings” layer available from the Open Street Map (OSM) and visualize them over the LiDAR DSM data. The geographic coordinates of the area of interest are given as:




longitudes 48.93338 - 48.93157 , latitudes 8.95946 - 8.96406

2- (20 Points) You are required to extract elevation values (Z coordinates) from the LiDAR DSM for each building you locate in the OSM database for the given area of interest in step 1. Please note that the elevation values for a building polygon must be extracted for each **vertex** of the building polygon. (You are free to utilize any GIS software you like to complete this step!)

3- (35 Points) For each building, you are required to perform the Object Space -> Image Space transformation with the help of the Projection Matrix in homogeneous coordinates for the grayscale aerial image (106.jp2).

In order to that, first, generate the Projection Matrix with the information given above, and second, perform the transformation using x = P.X formulation.

You are allowed to use any kind of programming language, but using the MatLab Environment is encouraged. However, in any case, utilizing an external library is strictly forbidden!!!

Hint: Compute the rotation matrix formulation as

```
%rotation matrix
R(1,1) = cos(phi)*cos(kappa)+ sin(phi)*sin(omega)*sin(kappa);
R(1,2) = cos(omega)*sin(kappa);
R(1,3) = -sin(phi)*cos(kappa)+cos(phi)*sin(omega)*sin(kappa);
R(2,1) = -cos(phi)*sin(kappa)+sin(phi)*sin(omega)*cos(kappa);
R(2,2) = cos(omega)*cos(kappa);
R(2,3) = sin(phi)*sin(kappa)+cos(phi)*sin(omega)*cos(kappa);
R(3,1) = sin(phi)*cos(omega);
R(3,2) = -sin(omega);
R(3,3) = cos(omega)*cos(phi);
```

and note that the angles are in “gons” (so, convert appropriately)

4- (10 Points) You are required to plot the projected boundaries of all buildings on image 106.jp2. (You are free to utilize any external library to complete this step!)

5- (20 Points) Please comment/discuss/explain the problems/reasons/causes you face in the output building boundaries projected on image 106.jp2.

## ADDITIONAL INSTRUCTIONS FOR REPORT PREPARATION AND SUBMISSION

1. The homework report must be in pdf format.
2. All submitted files should include student’s name and number in the file name.
3. Explanations for the code should be given in the code as comments and also in the report.
4. Attach all files (except the images 106.jp2 and ALS.tif) in a single zip file.
5. Although collaborations are encouraged, plagiarism will not be tolerated!