

Micasense Rededge image processing workflow

In the frame of BELSPO research project SR/10/202 “MS-SOC” we developed an empirical correction methodology for spectral Micasense Rededge imaging to account for the effects of the bidirectional reflectance distribution function (BRDF), based on the calculation of an Anisotropy Factor (ANIF) from drone-based hemispherical-directional reflectance measurements. The correction is meant to provide a spectral normalization of image reflectance values based on nadir measurements. Images corrected with this methodology are less prone to cause spectral artifacts when used for orthomosaic reconstructions with photogrammetric approaches.

The following guide is meant to show the step-by-step workflow to correct a set of Micasense Rededge images in the frame of a photogrammetric orthomosaic reconstruction with the software Pix4D mapper.

1 Pix4D Initial Processing with original images

This preliminary phase is aimed at obtaining calibrated sensor attitude data (pitch, roll, yaw) from Pix4D Structure from motion Bundle Adjustment capabilities.

1.1 Requirements

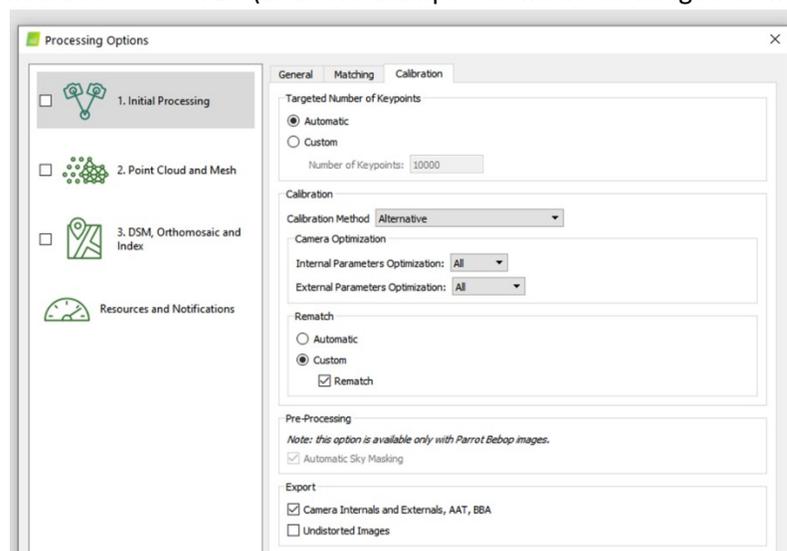
- Pix4D. Available online at <https://pix4d.com/product/pix4dmapper-photogrammetry-software/>
- Providing unique names to all Micasense Rededge images, e.g. appending the master folder name to each image name (“IMG_0001_1.tif” become “0000SET_IMG_0001_1.tif”).

1.2 Running the process

It is sufficient to conclude the “1.Initial Process” in Pix4D with the available set of images. Users can refer to the software manual available at:

<https://support.pix4d.com/hc/en-us/articles/204272989-Offline-Getting-Started-and-Manual-pdf>

to setup this operation. The Internal Parameters Optimization and External Parameters Optimization should be set to “All” (as in the example shown in the image below).



At the end of this processing phase the user will obtain, inside the chosen Pix4D project folder, a specific subfolder ".../1_initial/params" containing the calibrated camera parameters necessary for the ANIF correction model.

2 Radiometric calibration, vignetting correction, black level compensation and conversion to reflectance

This phase is aimed at automatizing with an R script the radiometric calibration, vignetting correction, black level compensation and conversion to reflectance of Micasense rededge images, following the procedure indicated by the original manufacturer (MicaSense Inc., Seattle, WA, USA) at:

<https://support.micasense.com/hc/en-us/articles/115000765514-Use-of-Calibrated-Reflectance-Panels-For-RedEdge-Data>

and

<https://support.micasense.com/hc/en-us/articles/115000351194-Rededge-Camera-Radiometric-Calibration-Model>

2.1 Requirements

- R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Download and follow instructions to install at <https://www.R-project.org/>. (tested on version R-3.6.3)
- RStudio Team (2019). RStudio: Integrated Development for R. RStudio, Inc., Boston, MA URL. Download and follow instructions to install at <http://www.rstudio.com/>. Make sure to have the R Studio plot device visible and accessible.
- R libraries to be installed (just run the following code lines in R console):

```
install.packages("devtools")
install.packages("exifr")
install.packages("raster")
install.packages("rgdal")
install.packages("spatstat")
install.packages("doParallel") #(useful on Linux OS only)
install.packages("doSNOW") #(useful on Linux OS only)
```

- Exiftool
 - For Windows users:
 1. download the executable at <https://exiftool.org/exiftool-12.28.zip>
 2. unpack the file and rename it to "exiftool.exe".
 3. in R, configure Exiftool by running:

```
configure_exiftool("<your unpack
directory>/exiftool.exe")
```

this line has to be run every time R is rebooted.

- For Linux users, run the following code in the command line:

```
cd <your download directory>
gzip -dc Image-ExifTool-12.28.tar.gz | tar -xf -
cd Image-ExifTool-12.28
```

- The certified reflectance data of your Micasense Rededge Calibrated Reflectance Panel (CRP). They consist of 5 reflectance values located on the panel itself (in the area marked by yellow circle in the below image) or sent by the manufacturer on user request.



2.2 Data preparation

Organize the Micasense Rededge images in two folders:

- One folder containing only the images to be corrected. In the example of this guide, we will name the folder “mica_images”. Make sure that the folder contains all sets of spectral bands (5) per image, and no other files.
- One folder containing all and only the 5 spectral band images of the Calibrated Reflectance Panel (CRP). In the example of this guide, we will name the folder “mica_CRP”.

2.3 Running the script

1. Load in R the function script from the github repository. Choose from:
 - a) Base function, works for both Windows and Linux users

```
source_url("https://raw.githubusercontent.com/Debrisman/Mi
casense_Rededge_correction/main/FUN_RededgeM_processing.R"
)
```

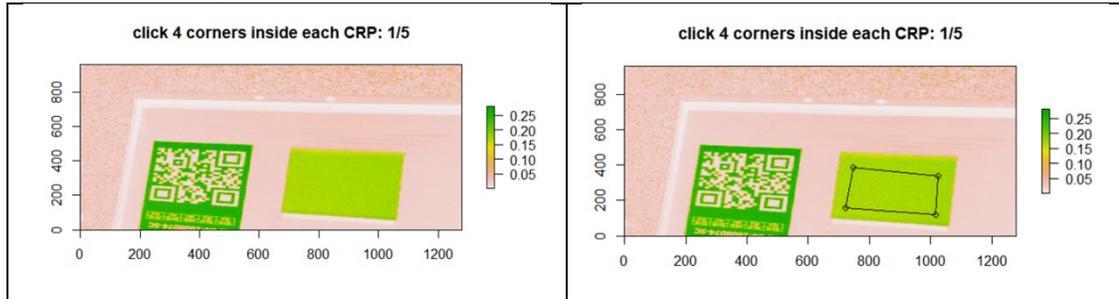
- b) For Linux users only, to take advantage of parallel computing:

```
source_url("https://raw.githubusercontent.com/Debrisman/Mi
casense_Rededge_correction/main/FUN_RededgeM_processing_DP
.R")
```

2. Execute the script, specifying:
 - a) dir_CRP = the user path to the folder containing the CRP images;
 - b) dir_images = the user path to the folder containing the Rededge images;
 - c) CRP_refl = a vector with the 5 calibrated reflectance values of the CRP.
 - d) (change function name to “RededgeM_processing_DP” if using solution 1b – Linux only)

```
RededgeM_processing(dir_CRP = "<your directory>/mica_CRP",  
dir_images = "<your directory>/mica_images", CRP_refl =  
c(0.4927, 0.4930, 0.4913, 0.4913, 0.4901), metadata_trsf =  
TRUE)
```

3. A first progress bar will complete in R console. When finished, the image of the first CRP will appear in the plot device. Use the mouse pointer to click 4 corners inside each CRP area, as shown in the image below.



Repeat the procedure 5 times (one for each CRP image, the progress will be shown in the plot title). When the user input has been completed a message will appear in the console:

```
"CRP selection done. Now applying radiometric and vignetting  
correction..."
```

and the other phases of the correction will proceed automatically.

4. From now on the script will run autonomously till completion. The console will show the progress bars and phase completion messages, in order:

```
"Radiometric and vignetting correction done. Now converting  
values to reflectance..."
```

```
"Reflectance images saved on hard disk. Now transferring  
metadata..."
```

```
"Metadata transferred. Process complete"
```

At the end of the procedure the calibrated reflectance images will be in an automatically created ".../reflectance" subfolder to the original images folder (e.g. ".../mica_images/reflectance"). All images will have a "_r" suffix appended to their name (e.g. "IMG_0001_1.tif" becomes "IMG_0001_1_r.tif"). The images are now ready for the ANIF correction.

5. If the script is manually halted before the conclusion of the process and needs to be re-cast, the user needs to manually delete some automatically generated subfolders in the images (e.g. the "...mica_images/reflectance" subfolder) and CRP (e.g. the "...CRP/corr" subfolder) input folders.

3 ANIF correction

This phase is aimed at automatizing with an R script the application of the ANIF correction factor to Micasense Rededge calibrated reflectance images, following the results discussed in the Final report of BELSPO Contract SR/10/202 “MS-SOC project”.

3.1 Requirements

- (Requirements previously installed in chapter 2.1);
- New R libraries to be installed (just run the following code lines in R console):

```
install.packages("sunalc")
```

- The ANIF correction model, available to download at:
https://github.com/Debrisman/Micasense_Rededge_correction/raw/c45c498be371bd0eaae0f6f44cdd6ef37f0e8eeb/PolyModels_ZenSenZen.rds

3.2 Data preparation

- One folder containing the calibrated reflectance images obtained from the script run in chapter 2 (check for the “_r” suffix in the image name). In the example of this guide, we will name the folder “refl_images”. Make sure that the folder contains all sets of spectral bands (5) per image, and no other files.
- Path to the “PolyModels_ZenSenZen.rds” file downloaded in section 3.1;
- Path to the “.../1_initial/params” folder obtained in chapter 1.

3.3 Running the script

1. (needed only for Windows users, if running a new R session) configure Exiftool by running:

```
configure_exiftool("<your unpack directory>/exiftool.exe")
```

2. Load in R the function script from the github repository. Choose from:

- a) Base function, works for both Windows and Linux users:

```
source_url("https://raw.githubusercontent.com/Debrisman/Micasense_Rededge_correction/main/FUN_ANIF_correction.R")
```

- b) For Linux users only, to take advantage of parallel computing:

```
source_url("https://raw.githubusercontent.com/Debrisman/Micasense_Rededge_correction/main/FUN_ANIF_correction_DP.R")
```

3. Execute the script, specifying:

- a) params_dir = the user path to the “.../1_initial/params” folder;
- b) images_dir = the user path to the folder containing the Rededge calibrated reflectance images;
- c) Input_model = readRSD() call to the “PolyModels_ZenSenZen.rds” file
- d) (change function name to “ANIF_correction_DP” if using solution 1b – Linux only)

```
ANIF_correction(params_dir = "<your directory>/1_initial/params",  
images_dir = "<your directory>/refl_images", Input_model =  
readRSD("<your directory>/PolyModels_ZenSenZen.rds"))
```

- Two progress bars will mark the progress of the correction application, the end of the process will be marked by the message:

"Metadata transfered. Process complete"

At the end of the procedure the calibrated reflectance images will be in an automatically created ".../corr" subfolder to the original images folder (e.g. ".../refl_images/corr"). All images will have a "_cor" suffix appended to their name (e.g. "IMG_0001_1_r.tif" becomes "IMG_0001_1_cor.tif"). The images are now ready for orthomosaic generation in PixD.

4 Pix4D processing with corrected images

The ANIF-corrected images can now be used in the full Pix4D pipeline for the generation of multispectral orthomosaics. The only requirement, when setting up the "Phase 3: DSM and orthomosaic generation", is to set the option for Radiometric processing and calibration to **"No correction"** for each single spectral band (as in the example shown in the image below).

