Photogrammetry Notes and Observations

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Contents

Common Variables

- H - Height of the camera above ground, *Flying Height*
- B - Distance between two image, *Air Base*

Common Programs and Usage Notes

This section is dedicated to solving easy problems using common programs.

GDAL Binaries

Many of the included gdal programs can be installed using a package manager.

Ubuntu sudo apt-get install gdal-bin

gdalinfo

Description

gdalinfo is an application bundled with GDAL which provides the user with the ability to extract information about a particular geographic file to the console.

This application works on elevation information, vector files (KML, KMZ), imagery (NITF), and many more.

Information Provided

- Corner Coordinates
- Geographic Projection Used
- Image Raster Datatype
- Date Taken
- more Metadata and image info

Usage

```
./gdalinfo  data/dted/w119/n036.dt2

Driver: DTED/DTED Elevation Raster
Files: data/dted/w119/n036.dt2
Size is 3601, 3601
Coordinate System is:
GEOGCS["WGS 84",
    DATUM["WGS_1984",
        SPHEROID["WGS 84",6378137,298.257223563]],
    PRIMEM["Greenwich",0],
    UNIT["degree",0.0174532925199433],
```

```
    AUTHORITY["EPSG","4326"]]
Origin = (-119.000138888888884,37.000138888888884)
Pixel Size = (0.000277777777778,-0.000277777777778)
Metadata:
  DTED_VerticalAccuracy_UHL=0007
  DTED_VerticalAccuracy_ACC=0007
  DTED_SecurityCode_UHL=U
  DTED_SecurityCode_DSI=U
  DTED_UniqueRef_UHL=G18 063
  DTED_UniqueRef_DSI=G18 063
  DTED_DataEdition=02
  DTED_MatchMergeVersion=A
  DTED_MaintenanceDate=0000
  DTED_MatchMergeDate=0000
  DTED_MaintenanceDescription=0000
  DTED_Producer=USCNIMA
  DTED_VerticalDatum=E96
  DTED_HorizontalDatum=WGS84
  DTED_DigitizingSystem=SRTM
  DTED_CompilationDate=0002
  DTED_HorizontalAccuracy=0013
  DTED_RelHorizontalAccuracy=NA
  DTED_RelVerticalAccuracy=0009
  AREA_OR_POINT=Point
Corner Coordinates:
Upper Left  (-119.0001389,  37.0001389) (119d 0'0.50"W, 37d 0'0.50"N)
Lower Left  (-119.0001389,  35.9998611) (119d 0'0.50"W, 35d59'59.50"N)
Upper Right (-117.9998611,  37.0001389) (117d59'59.50"W, 37d 0'0.50"N)
Lower Right (-117.9998611,  35.9998611) (117d59'59.50"W, 35d59'59.50"N)
Center      (-118.5000000,  36.5000000) (118d30'0.00"W, 36d30'0.00"N)
Band 1 Block=1x3601 Type=Int16, ColorInterp=Undefined
  NoData Value=-32767
  Unit Type: m
```

gdaldem

Description

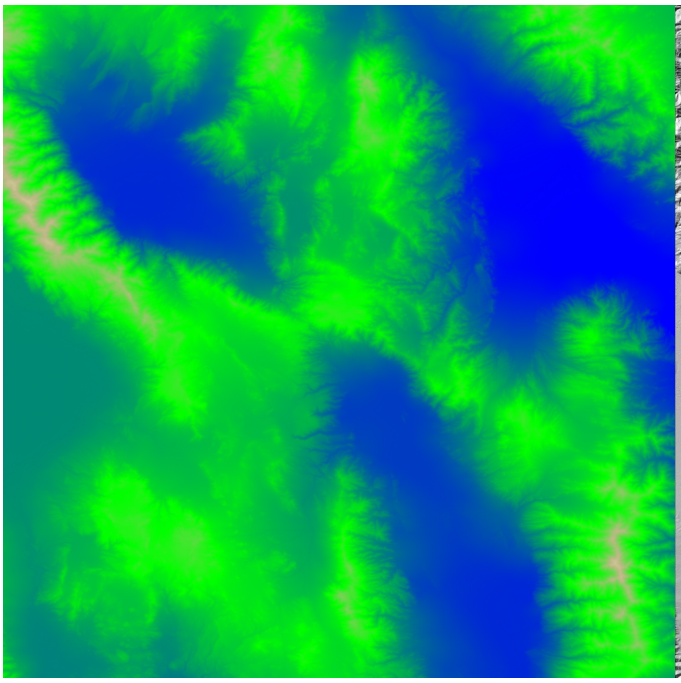
gdaldem is an application bundled with GDAL which provides the user with the ability to construct shaded relief and color maps for digital elevation models.

This application works on elevation information to include DTED and SRTM.

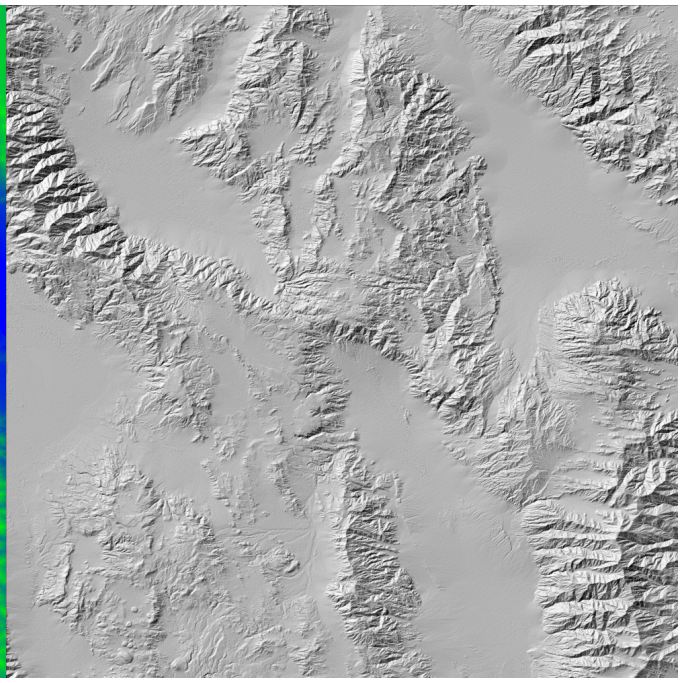
Usage

```
# For color relief maps
gdaldem color-relief data/dted/w118/n36.dt2 color_model.txt output.tif

# For shaded relief maps
gdaldem hillshade  data/dted/w118/n36.dt2 output.tif -s 100000 -z 5

# You can merge the images together with a t=0.7 such that  Out(x,y) = t*Color(x,y) + (1-t)*Hill(x,y)
# to get a great output image
```

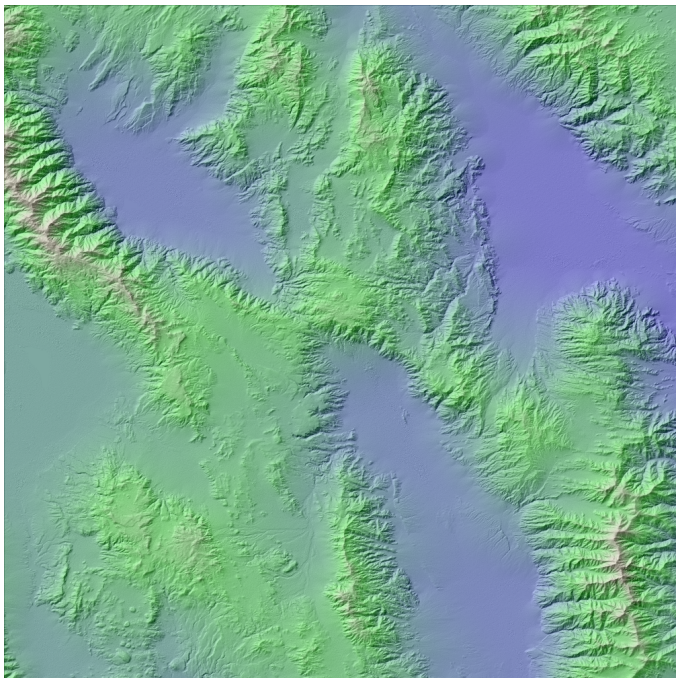
For more information, see manual pages and http://developmentseed.org/blog/2009/jul/30/using-open-source-tools



(a) Color Relief Results



(b) Hillshade Relief Results



(c) Merged Results

Figure 1: Results from typical *gdaldem* usage.

Camera Calibration Notes

Intrinsic Parameters

Common Intrinsic Camera Parameters

- Focal Length (f)
- Radial Distortion

Orthorectification Notes

This section is divided into the following sections···

Camera View Rectification

Perspective to Parallel Transformation

Camera Distortion Rectification

Camera View Rectification

In order to orthorectify aerial imagery, you must first correct the image camera angles such the image appears in a "bird's eye" view. Here is my current approach to accomplishing this...

Compute required parameters.

Build output image structure

Iterate over every pixel in the output image

Compute the intersection of the pixel-output camera orgin line with the ground plane.

Compute the intersection of the ground point-input camera origin with the camera's image plane.

Compute the difference between the principle point and the image plane intersection.

Use this vector as the pixel location to reference the input image with.

Required Parameters

Camera Origin, P_O

Rotation Angle, θ, and the Rotation Axis $\bar{R}$.

Ground View Point

- Depends on the camera world coordinates, camera rotation angle, and focal length (as a help).

Derived Parameters

Principle Point, P_P

Principle Ground Point, P_G

Computing the Principle Point

Unless otherwise stated, the principle point on the image is assumed to be the center of the image. This may not be the case for all cameras, however it allows for a more simple model if unknown.

$$P_P = \text{Rotation\_Matrix}(\theta, \bar{R}) \cdot (f \cdot ||R||) + P_O \tag{1}$$

Glossary

Aerotriangulation The process of assigning ground control values to points on a block of photographs by determining the relationship between the photographs and known ground control points.. 10

Boresight Boresight is the physical mounting angles between an IMU and a digital camera. Basically, if the IMU defines a flight axis, the Boresight defines the angles from the axis of which the camera is pointing.. 10

Bundle Adjustment The process of simulaneously refining 3D coordinates derived from multiple viewpoints. This requires that the user has multiple 3d coordinates measured from multiple image pairs. This is often solved with Levenberg-Marquardt.. 10

Camera Origin The center of the camera in world coordinates. In reality, this should be the latitude, longitude, and elevation of the camera if described in geodetic coordinates. symbol. 8, 10

Focal Length The distance between the focal point and the image plane. This is relevant as the focal length determines attributes such as the clarity of the image and the depth of field. It is an essential part of camera calibration.. 10

Georectification A method of stretching and warping an image to align with another map projectin or spatial data in GIS. This is comparable to Google Earth and other systems which implement overlays. If an image is rectified, Ground Control Points (GCP) can be used to create a transformation which aligns one image to the GIS data. This is different from orthorectification as well because it is assumed that the image is already orthorectified. Georectification just changes the projection and/or coordinate system.. 10

Georeference Same as Georectification . 10

Orthorectification A method of correcting an image to align with real-world coordinates on a map. This involves measuring the exact location of the image center as well as the camera angle. This is followed by the computation of the camera calibration parameters to remove camera and lens distortions. Finally, you may terrain induced distortions using DEM data.. 10

Principle Ground Point Using the ray defined by the Camera Origin and the line $P_O P_P$, the intersection of this line with the surface of the Earth creates a coordinate on the surface which is located in the principle point of the image. This is relevant because images can only give you 3D information up to scale and depth. This will provide the depth attribute. symbol. 8, 10

Principle Point The intersection of the ray which defines the center of the camera view with the image plane. This is the physical location in world coordinates of the center of the image view. This subtracted with the Camera Origin define the vector which points "straight ahead".. 8, 10

Bibliography

[1] Bon A. DeWitt and Paul R. Wolf. *Elements of Photogrammetry(with Applications in GIS)*. McGraw-Hill Higher Education, 3rd edition, 2000.

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