Geophysical Research Abstracts
Vol. 14, EGU2012-8167, 2012
EGU General Assembly 2012

Generating High resolution surfaces from images: when photogrammetry and applied geophysics meets

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Airborne digital photogrammetry has been used for some years to create digital models of the Earth's topography from calibrated cameras. But, in the recent years, the use of non-professionnal digital cameras has become valuable to reconstruct topographic surfaces.
Today, the multi megapixel resolution of non-professionnal digital cameras, either used in a close range configuration or from low altitude flights, provide a ground pixel size of respectively a fraction of millimeters to couple of centimeters.
Such advances turned into reality because the data processing chain made a tremendous break through during the last five years.

This study investigates the potential of the open source software MICMAC developed by the French National Survey IGN (http://www.micmac.ign.fr) to calibrate unoriented digital images and calculate surface models of extremely high resolution for Earth Science purpose.

We would like to report two experiences performed in 2011. The first has been performed in the context of risk assessment of rock falls and landslides along the cliffs of Normandy seashore.
The acquisition protocol for the first site of "Criel-sur-Mer" has been very simple: a walk along the chalk vertical cliffs taking photos with a focal of 18mm every approx. 50m with an overlap of 80% allowed to generate 2.5km of digital surface at centimeter resolution.
The site of "Les Vaches Noires" has been more complicated to acquire because of both the geology (dark clays) and the geometry (the landslide direction is parallel to the seashore and has a high field depth from the shore). We therefore developed an innovative device mounted on board of an autogyre (in-between ultralight power driven aircraft and helicopter). The entire area has been surveyed with a focal of 70mm at 400m asl with a ground pixel of 3cm.
MICMAC gives the possibility to directly georeference digital Model. Here, it has been performed by a net of wireless GPS called Geocubes, also developed at IGN.

The second experience is a part of field measurements performed over the flanks of the volcano Piton de la Fournaise, La Réunion island. In order to characterize the roughness of different type of lava flows, extremely high resolution Digital Terrain Models (0.6mm) have been generated with MICMAC. The use of such high definition topography made the characterization possible through the calculation of the correlation length, the standard deviation and the fractal dimension.

To conclude, we will sketch a synthesis of the need of geoscientists vs. the optimal resolution of digital topographic data.