



Practitioner's Guide:

Low Cost Amateur Aerial Pictures with Balloon and Digital Camera



Low Cost Orthophoto Production in Battambang Town, Cambodia



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wirtschaftliche Zusammenarbeit
und Entwicklung



Centre for International
Migration and Development

a joint operation of GTZ and the
German Federal Placement Agency



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Example: Low Cost Orthophoto Production in Battambang Town, Cambodia

Since 1992 several aerial photos missions have been carried out in Cambodia by contracted international remote sensing companies funded by different international grants and loans. However, most of this spatial data is collected in some Cambodian ministries while a transparent and administratively controlled access or exchange to remote sensing data, even among different ministries is not yet established in Cambodia. In contrast, recent spatial information of fast changing environments is crucial for several administrative, planning, observation and assessment reasons. Interpretation of high resolution remote sensing data is tempting in the frame of land management, land use classification, degradation assessments, urban and infrastructure planning as well as monitoring of rapid land cover changes in any kind of environment.

Digital high resolution imagery together with up to date computing power now at nearly everyone's disposal, even in developing countries, has provided a change in scale with more detailed information being sought through the means of digital image analysis. For example, it is noticed that highly sophisticated and expensive analog devices are no longer required in photogrammetry if amateur digital camera devices are connected with GPS and GIS image enhancements and geo-rectification techniques. Currently several remarkable attempts in balloon born amateur digital photogrammetry have been applied during the last five years. Since several years this technology has been applied in a number of projects on different scale levels in Cambodia. This example introduces and assesses the highly efficient amateur aerial balloon photo technique, which makes aerial photos affordable at a price of 0.10 – 0.35 US cents per hectare, even for low budget projects in developing countries.



Photo 1: Camera with GPS receiver



Photo 2: Filling of the Balloon with Hydrogen



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The aim of this methodology is to incorporate and geo-reference unregistered data from a balloon, ultra light or delta born aerial photography to a coordinate system topographical map. The resolution quality of low-altitude aerial photography far exceeds that of other surface imagery such as Spot or even Ikonos satellite imagery, making it a valuable tool for urban planners, environmental scientists and nature protectionists. Detailed spatial information below 1m pixel resolution such as vegetation associations or housing types is not detectable on inexpensive but larger airborne imagery while high resolution Quickbird images are often not available or cloud covered for Cambodian regions. Detailed construction types and multi-temporal spatial features such as vegetation vitality and small scale clearings are not easily to detect on conventional satellite imagery. Due to geo-referenced aerial photos these features could easily be digitized into separate layers using GIS mapping techniques. However, amateur aerial photos do not generate automatically compass orientation nor any spatial reference information or exact scale. Geo-referencing or ortho-referencing methods needs to be applied, i. e. using referencing tools in ArcMap, Erdas Imagine, ENVI, PCI or any other Remote Sensing software which allows the user to align geographically unregistered data to data that exists in geographical coordinates.

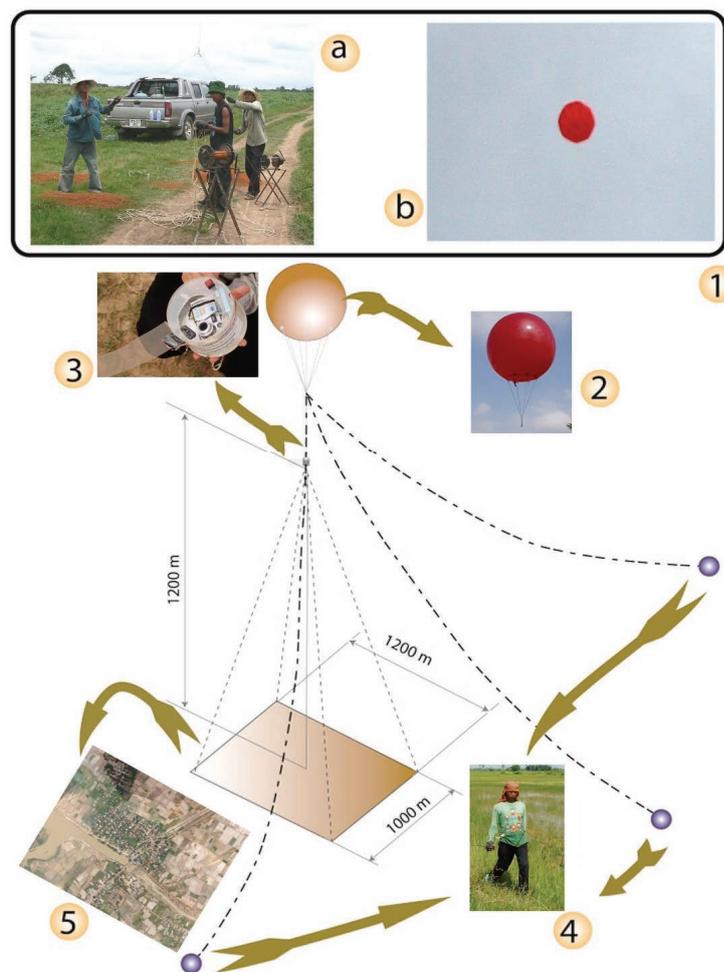


Figure 1: Model of image acquisition technique



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Ortho-rectified photography has the potential to be more accurate while the photographic image is draped over a digital terrain model based on land survey control. The main benefits are of improved accuracy in horizontal as well as vertical plan shape, particularly where there is high relief across the area. But this accuracy again is strongly dependant upon the accuracy of the DTM used as base model. In contrast, Ortho-rectification is far more difficult, requires more RS or geodetical user capacity and a considerable amount of digital calculation power regarding the amount of data being handled.

The most accurate acquirable DTM for Cambodia is the SRTM 50m grid with provides high spatial resolution with a grid of interpolated levels at 1m intervals. Unfortunately, it has got some significant miscalculations in huge flat lowland areas like the Cambodian floodplain or the Tonle Sap Lake and its tributaries. Only photogrammetrically derived detailed DTM or air triangulation models would provide higher precision and better resolution. This may allow orthophotos to be produced with a plan position accuracy of approx. +/-1m, but was not applied due to limited data processing capacity.



Digital geo-referenced images of Battambang town (NW Cambodia) were already produced for the district department of urban planning and construction. In 2004 and 2006 aerial balloon surveys were flown on different scales of 40cm and 10 cm ground resolution for urban master plan purposes, for regional development as well as change detection in the urban environment with regards to housing and infrastructure measures for informal settlements in the urban areas (see Photo 1). For a second project, pictures of a scale of 1: 10.000–1:15.000 were taken in in remote rural areas with degraded open forest vegetation in NW Kampong Speu province (see Photo 2).



Photo 1: Market Area Battambang 1:1.000



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Photo 2: Degraded open forest area 1:5.000

The topic is a seasonal to 5 years change detection observation of a degraded open forest environment for a special observation site of forest re-growth and vegetation recovering (see Photo 2). Further images were taken for simple area observation and base maps of two national universities in Cambodia (Royal University of Agriculture and Preah Leap National School of Agriculture) in the surrounding of Phnom Penh. But one of the most advantageous applications of this method is the production of base maps for medium scale infrastructure projects like bridge and road construction, hydraulic engineering and irrigation projects in the Cambodian lowlands.

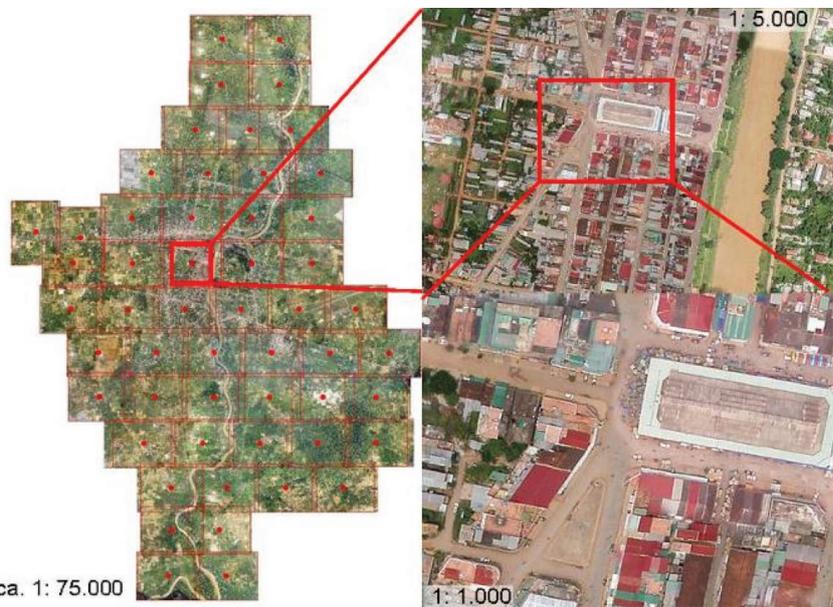
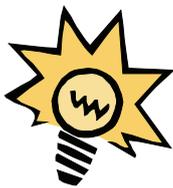


Figure 2: Image acquisition plan for and detailed Battambang images



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Geo-referenced balloon borne amateur aerial digital photos can be an effective replacement for the traditional cost expensive orthophoto image production in land cover analysis and urban planning projects as well as it is practical for field verification surveys as well. With a non-metric, small, relatively inexpensive digital camera, and inexpensive portable balloon, ultra-light or kite solutions large digital aerial photography is now a suitable technique for developing countries to acquire inexpensive planning information. There is no inevitable requirement for an expensive camera equipment and high-level camera calibration. Once they are geo-referenced, they can be used as a map layers in any GIS and remote sensing application. They can be directly geo-referenced and viewed like maps without extra software for orthophoto re-sampling or other sophisticated image rectification and image enhancement technique. The major advantages of digital aerial photography are that digital images often have much higher resolution than conventional aerial photos. As a result they are efficient both in terms of time and cost.



Balloon or ultra-light images offer the following additional detail, relative to conventional orthophoto mapping:

- ▶ Urban structure,
- ▶ Urban infrastructure type and quality,
- ▶ Detailed land use types in urban and peri-urban area,
- ▶ Construction plan for medium scale infrastructure projects,
- ▶ Vegetation classes and vegetation coverage,
- ▶ Tree density per ha,
- ▶ Tree types or morphological vegetation structure,
- ▶ Seasonal and intra seasonal change detection.

However, there are several issues to consider before using digital aerial photography like the storage and image representation capacities as well as much higher number of photos for large-scale projects. This mapping exercise acquired more than 84 photos for a quite small region of Battambang town with 2.4 GB of raw data. The technical camera and GPS capacity is even though important for a successful project design as well as GIS and GPS trained staff for ground surveys and data handling. But future digital improvements will further offer enhanced GPS and picture resolution capacity while reducing size and weight of receivers. The most challenging issues for digital balloon, ultra-light or kite imagery still remain camera calibration, exact flight management, exact GCP surveys as well as detailed high resolution DTM for ortho-rectification with higher accuracy of processed imagery.