Vermeer, Martin; Ayehu, Getachew T.

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Experiences with digital aerial photogrammetry software ’e-foto’ in an educational setting in Bahir Dar, Ethiopia

Martin Vermeer
Aalto University, School of Engineering, Institute of Real Estate, Planning and Geoinformatics, Espoo, Finland

Getachew Tesfaye Ayehu
Bahir Dar University (BDU), Institute of Land Administration (ILA), Bahir Dar, Ethiopia

The digital photogrammetry software e-foto was developed at the State University of Rio de Janeiro for teaching aerial photogrammetry using standard personal computers, without the expense and licence hassle of commercial photogrammetric software packages. The package, though still somewhat deficient in features, offers a largely complete tool chain and is well suited for educational use.

At the University of Bahir Dar, Ethiopia, in 2013 an intensive course took place completed by 15 students. In the course, the complete tool chain was exercised using Intergraph’s ERDAS Imagine LPS software, on imagery from Finland and Brazil. However, the less complex e-foto software was also successfully used and found easier to master.

Using aerial photogrammetry for constructing orthophoto maps is mission critical for the development of a cadastral system in rapidly industrializing and urbanizing economies like Ethiopia.

E-foto works best on Linux. We were inspired by our teaching experience to build a tailored version of 64-bit Ubuntu booting from a memory stick, to easily allow the educational use – including self-study – of e-foto in this fashion.

Keywords: Digital aerial photogrammetry, e-foto, Open Source, education, Ethiopia

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1 Why digital photogrammetry?

Using aerial photogrammetry for constructing orthophoto maps is mission critical for developing a cadastral system in many developing economies including Ethiopia (Hailu & Harris 2013). It is the only technology offering the geodetic mapping precision required especially in urban and peri-urban areas. The Ethiopian ministry of Urban Development, Housing and Construction (MoUDHC) is assisting regional states and urban centers in carrying out the adjudication and registration of landholdings. As a result MoUDHC is preparing orthophoto base maps and offers tailor-made training in digital photogrammetry to experts in close collaboration with BDU ILA and the Ethiopian Mapping Agency (EMA).

2 Description of e-foto

The digital photogrammetry software e-foto (Brito et al. 2011) was developed at the State University of Rio de Janeiro for teaching aerial photogrammetry using personal computers, without the expense and licence hassle of commercial photogrammetric software packages. It offers a largely complete tool chain from camera calibration and interior orientation over exterior orientation to aerotriangulation and feature extraction, and a less complete one for digital terrain model construction and orthorectification aimed at the construction of orthophoto maps. The package is already well sufficient for educational use.

3 Training data used

The aerial images used in the training were three images from Rio de Janeiro provided on the e-foto web site, and five very high quality colour images digitized at high resolution (22,000 x 22,000 pixels) from the Ringroad II project around Helsinki, Finland. Camera calibration documents and ground control point descriptions for both image sets were available. The GCPs and their descriptions were quite different for the two cases, a useful learning experience on professional practices in different countries.

4 Bahir Dar master’s course experiences

At Bahir Dar University an intensive course was organized in October 2013, which 15 master’s students from the Institute of Land Administration completed, see Figure 1. In the course, the complete digital photogrammetry tool chain was exercised based on the ERDAS Imagine LPS (‘Leica Photogrammetry Suite’) software from Intergraph. However, the e-foto software was also used as an introductory learning experience.

In the half year preceding the intensive course, the course instructor (MV) trained the use of both softwares, completing the processing chain in both. He even submitted one bug report with code patch back to Rio. It would however be rash to call him an expert, especially on the more complex ERDAS/LPS.
Functionalities used by the students were Interior and Exterior Orientation (‘Spatial Resection’), aerotriangulation, and Feature Extraction. Generally this appeared to be a good learning experience. ERDAS is more versatile, which benefits the experienced user but gets in the way for a novice.

These students had already a good background in Geographic Information System (GIS) software and operations, but photogrammetry is different. The very precise measurement in the images of fiducial marks and ground control points, followed by a least-squares adjustment that mercilessly exposes any operator error, was a new experience for them. As was the extreme precision, in three dimensions, that the technology uniquely affords.

In this two-weeks full-time course the students completed a full processing chain in ERDAS/LPS, from the five Finnish images given to the end product, an orthorectified photomosaic of the area, ready for mapmaking use in any GIS product. They also completed a partial processing chain in e-foto for this imagery, doing Interior and Exterior Orientation and aerotriangulation. The Feature Extraction, Digital Elevation Model generation and orthorectification modules were tried out individually on the Rio de Janeiro imagery.

5 Experience details and comparisons

The reason for the above limitation in use of e-foto is that the relevant functionalities were not mature enough for practical use. These modules, Feature Extraction, DEM Extraction and Orthorectification, have working core functionality, but do not provide a way to export/import data files in compatible formats, making it impossible to build a processing chain. Also they are less integrated within e-foto, not offering the same processing-chain management (i.e., keeping track of which operations were completed on which images) that ERDAS provides also for these functionalities.

We did not receive any extensive comparative comments from students. One sentiment expressed by students was that it was useful to have been made aware of the existence of e-foto. Students appreciated e-foto’s ease of installation, learning and use by beginners, while also understanding its more limited capabilities.

We noticed one problem with ERDAS/LPS happening several times: camera calibration data entered somehow did not make its way to later stages of processing,
undoubtedly due to operator error. In e-foto this cannot really happen as there is only one camera per project and it applies to all images.

It may be noted that ERDAS and LPS started out as two separate pieces of software by different companies; even after integration the “seamline” remains visible. E-foto has a clearer design, but its photogrammetric roots show in the photogrammetric measurement and adjustment modules being mature and production-ready, while the DEM extraction and orthorectification modules again have a “demo feel” over them. Feature Extraction, e.g., exports a flat text file, where geoinformatics folks might expect shape files. All these will require work especially on the data I/O interfaces to become production ready.

Of course ERDAS/LPS is more sophisticated. E.g., it can automatically generate tie points, and in Interior Orientation it predicts the location in the image of the next fiducial point after a couple have been measured, saving operator time. This does however require the operator to correctly identify the fiducial point numbering scheme used, causing some puzzlement with our students.

6 The future of e-foto, and our future plans

E-foto has already found its place in the teaching of digital aerial photogrammetry at low cost and free from licencing restrictions. Weaknesses, in addition to those mentioned, include paucity of high-quality instruction materials in English. This prompted the writing of our own lecture notes for the course, and planning of a textbook.

Open Source software development typically addresses the ‘itches’ of developers, which so far have been traditional aerial photogrammetrists from Brazil. It would take little development effort to also make the later modules in the processing chain, leading up to orthophoto mosaicing, mature enough for production use. Most of that work would involve better integration within the e-foto framework and with the rest of the map-making world.

We are experimenting with booting a tailored version of 64-bits Ubuntu from a USB stick (‘memory stick’) to allow educational use, including self-study, of e-foto on any 64-bits work station or laptop that allows such booting. These sticks nowadays come at large capacities – 8 GB and over – at reasonable prices. Software exists for Linux – remastersys and unetbootin – to create such a booting stick with a ‘persistent’ area for user data. There we store the aerial imagery, calibration documents, ground control point data files, etc.

One must use a USB stick with a fast enough data rate. We found that all e-foto modules and their imagery loaded within some tens of seconds even with a ‘cheapo’ stick, and after that, all operations are in memory and fast. The completely soundless loading of gigabytes of stuff is eerie to experience.

A digital aerial photogrammetry textbook is in early stages of preparation. We have permission to use the Finnish Ringroad II imagery from the Municipality of Espoo for educational purposes without charge. Include the e-foto bootable USB stick and red-cyan anaglyphic glasses with it, and the laptop-owning reader could start self-study immediately!

www.ogrs-community.org
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