Connecting the Dots and Points in the Geospatial World

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ABSTRACT

Aerial photogrammetry developed into a rather mature and highly production-level discipline. The whole process, starting with mission planning, through image capture, triangulation, ortho-production as well as DTM/DSM generation is already a predictable machinery, creating valuable geospatial data products used in all kinds of applications. This arena is progressing towards ever more pixels captured and many sensor technologies are being employed in parallel during aerial campaigns. At the same time though we observe a commoditization as well as rapid technology acceleration in several directions. The proliferation of close-range photogrammetry, dense point-cloud matching, 3D, integrated batch processing, data fusion and automated feature extraction all show that the classic aerial photogrammetry is changing rapidly. A wide range of use cases where photogrammetry is now rather the key feature of a particular solution and not any longer on the product level. Trimble Geospatial is highly active in connecting the dots and points of the geospatial sensor world by creating high performance photogrammetic production modules for new environments such as UAVs, and by tightly linking such modules with automated feature extraction capabilities. Examples are product packages for rapid response aerial camera systems and aerial laser scanning systems tightly integrated with high performance photogrammetric production.

1. INTRODUCTION

To connect the dots and points in the geospatial world one needs to analyse the sum of trends on the sensor side. Figure 1 illustrates – in a rather simplistic view – where the world of sensors is moving to. All in all we see a proliferation of new devices so far only employed for mapping tasks, starting to enter the surveying world, we see a trend towards ever higher integrated sensors, and overall we see that photogrammetry is reaching a whole lot of devices and arenas.

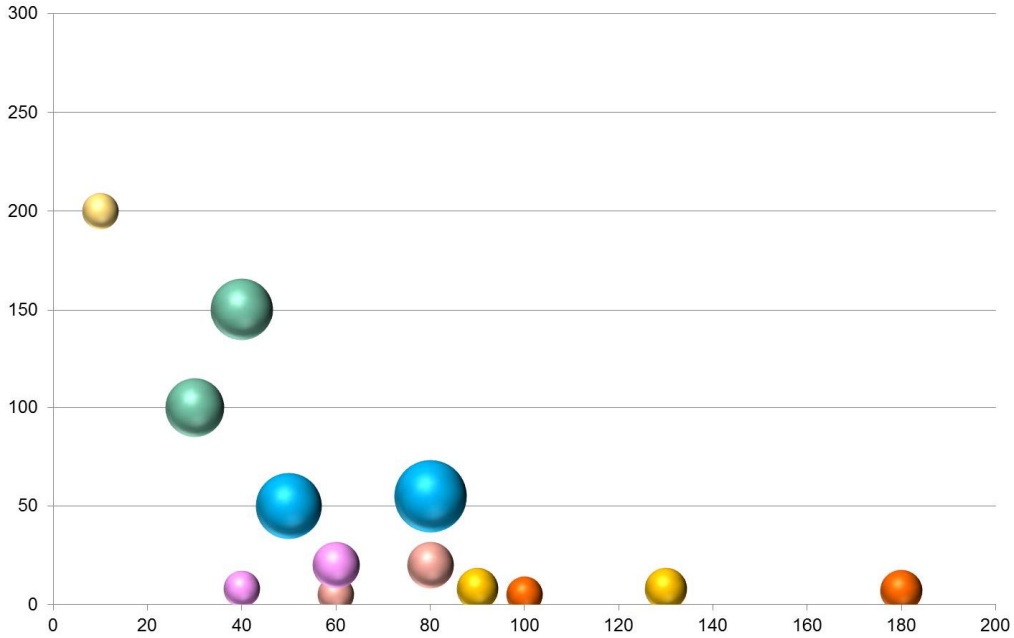

Figure 1: Relative quantity of geo-sensors (y-axis) vs relative quantity of pixels (x-axis) orange: high-end mobile mapping systems; yellow: large-format aerial cameras; pink: mid-range mobile mapping systems; violette: commercial UAV; blue: total stations; purple: mobile data capture devices; green: geo-smartphones; the 'lower-left' point characterizes 2013, the 'upper-right' point indicates 2016.

Now, connecting the sensor dots we can derive the ongoing requirements for photogrammetry: a broad diversity of sensors, and ever more throughput. Figure 2 illustrates how the whole industry shall move forward.

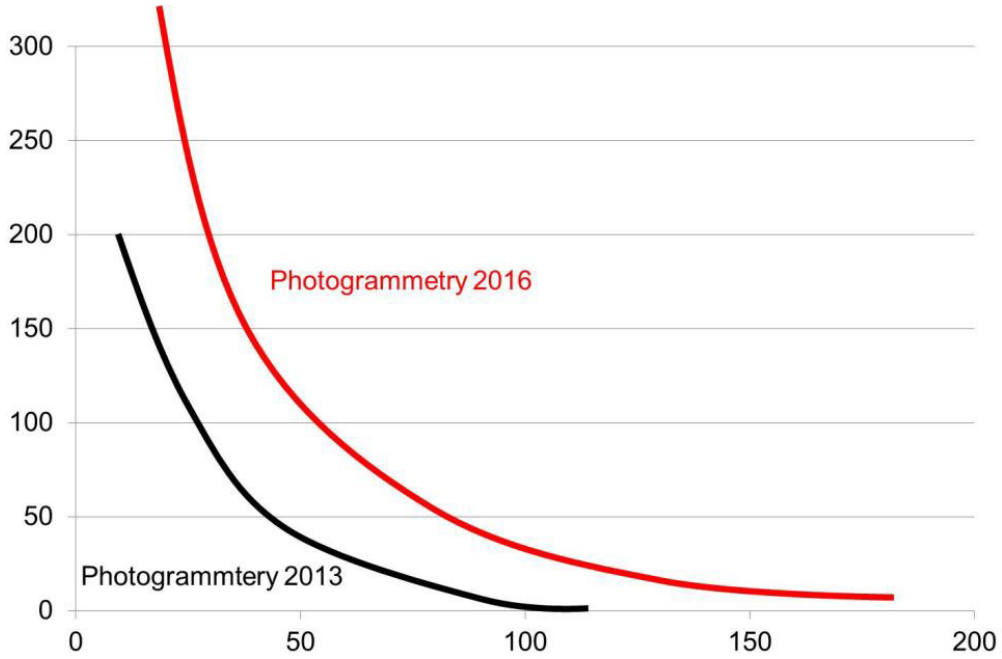

Figure 2: Continued evolution of photogrammetry needs, both in required throughput (x-axis) and quantity of sensors (y-axis).

In the professional and semi-professional measurement markets, which include surveying and mapping in this context, we see a continued evolution of photogrammetry needs based on todays high-performance production. Therefore, we briefly review Trimble's photogrammetric capability 2013.

2. INPHO PHOTOGRAMMETRIC SOLUTIONS

Trimble's Inpho photogrammetric processing software covers the complete workflow for aerial photogrammetry, all based on 64-bit operating systems, multi-core CPU set-up and excellent processing times per image or ground unit.

2.1. Automated DEM extraction

The automated Digital Elevation Model (DEM) extraction from aerial images is a major process step of the photogrammetric production workflow. DEM's are used for various purposes, like orthophoto generation, digital terrain modelling, slope and volume calculation.

2.2. Orthophoto Production

Similar to the DEM generation orthophoto production is another major processing step in the photogrammetric workflow. The overall process is subdivided into several tasks, like ortho rectification, color balancing, image corrections, seam finding, mosaicking, tiling etc. The heavy batch processing has been increased in performance by optimizing tasks and by leveraging the multi-core technology of modern computer hardware.

2.3. UAV data processing

In line with the recent introduction of versatile and professional light-weight UAV's such as Trimble X100 and UX5, we see a large number of uses for such aircraft. Easy deployment over mines, forests or critical areas, these new UAVs allow for rapid mapping as well as monitoring tasks which were so far only possible either very expensively or required a lot of planning. Trimble considered it to be essential to equip such light-weight UAVs with state-of-art photogrammetric solutions. Integrated into the Trimble Business Center, the Inpho UAS Box delivers rapid orthophoto production as well as DEM/DTM generation in a very convenient fashion.

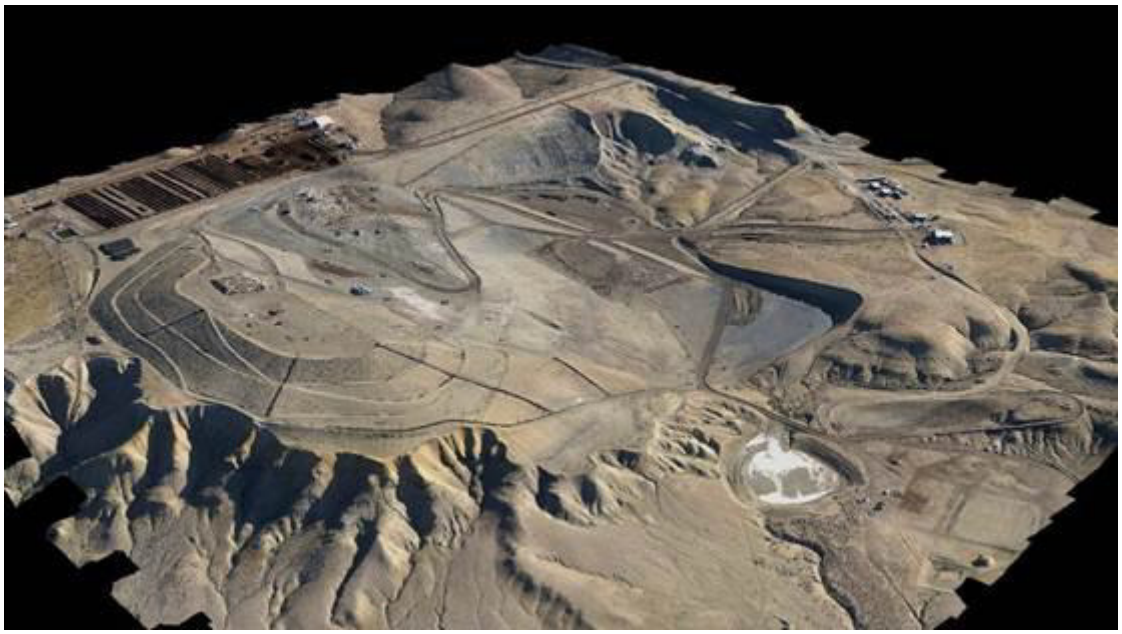

Figure 3: UAV data processing: DSM open pit mine with Trimble X-100 UAV data.

2.4. Connecting the photogrammetry dots with automated feature extraction

Triggered by increasing needs of mapping agencies as well as commercial users, we currently see a strongly increased interest in closely linking photogrammetric output such as ortho-photos and DEM/DTM, link it with further sources such as cadastral information and directly feed this into an automated information extraction engine such as Trimble eCognition. We briefly review this product line below.

3. AUTOMATED INFORMATION EXTRACTION

3.1. eCognition image analysis software

eCognition enables users, like the Department of Surveying and Geo Information of the State Government of Lower Austria(GEOinfo), to analyze large data sets without the need of complex tiling. Users can segment very large and high resolution data sets at a fine scale generating billions of image objects, not only out of various image types but also out of additional data sources, like 3D point clouds or other GIS vector data sets. By using automated object based image analysis software complex projects can be executed even with limited budgets, as most cost-intensive human operator work is no longer needed or reduced to the minimum, as demonstrated by following example.

Tailored applications classify built-up areas and forested areas for example. Further examples are mapping trees and shrubs near power lines, land cover mapping for various object classes, urban tree canopy assessment, impervious surface for private and commercial properties, solar suitability mapping, change detection, agriculture and many more.

Figure 4: Source aerial image.

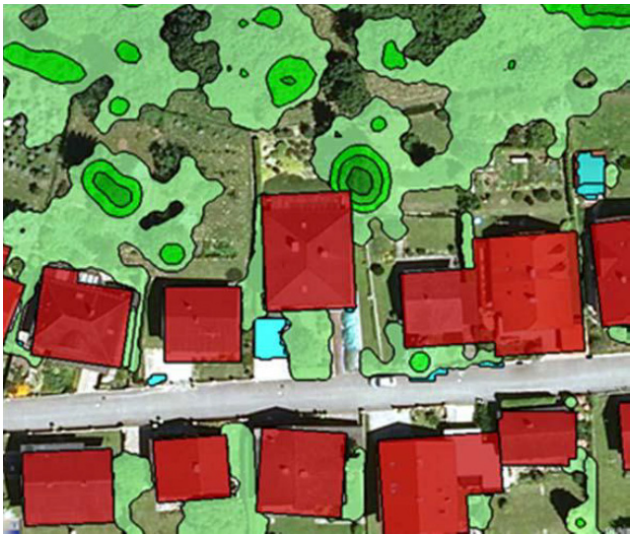

Figure 5: Results of automated classification.

We are very sure that the highly automated and very accurate results of high performance photogrammetric production will carry along a strong wave of automated feature extraction needs.

Whilst Trimble photogrammetry and feature extraction software are available for the open markets – and as such in principle designed for all kinds and varieties of sensors – many aerial system operators found it to be advantageous to acquire fully integrated aerial solutions. Therefore, we briefly introduce the Trimble Harrier.

4. TRIMBLE AERIAL SENSORS PORTFOLIO

The Trimble Harrier is a very robust but flexible aerial scanning systems, equipped also with a Trimble Aerial medium format camera. This system allows for a broad variety of uses, including corridor mapping, regional area mapping as well as special campaigns. The highly precise laser scanners, in combination with 65/80 MPixel cameras provide excellent data input for high performance photogrammetry as well as automated feature extraction. The system is used on fixed-wing aircraft, ultra-light aircraft as well as helicopters.

The product LPMaster connects the Harrier smoothly and tighly with the whole Inpho suite of products, providing a seamless operational experience from field to the office.

5. CONNECTING THE DOTS AND POINTS IN THE GEOSPATIAL WORLD

Photogrammetry's basic capability is to provide imagery which allows for precise and accurate measurement. This capability is drawing a lot of attention, and combined with light-weight UAVs, versatile mobile mapping systems, ubiquitous total stations and vastly growing number of smart phones and professional data collector systems, photogrammetry will very likely evolve into a

'commodity technology', same as word processing, inertial technology, GPS and email. Figure 6 illustrates what that will mean for Trimble as a technology and product supplier: many new applications plus the never ending appetite for more data from single sensors.

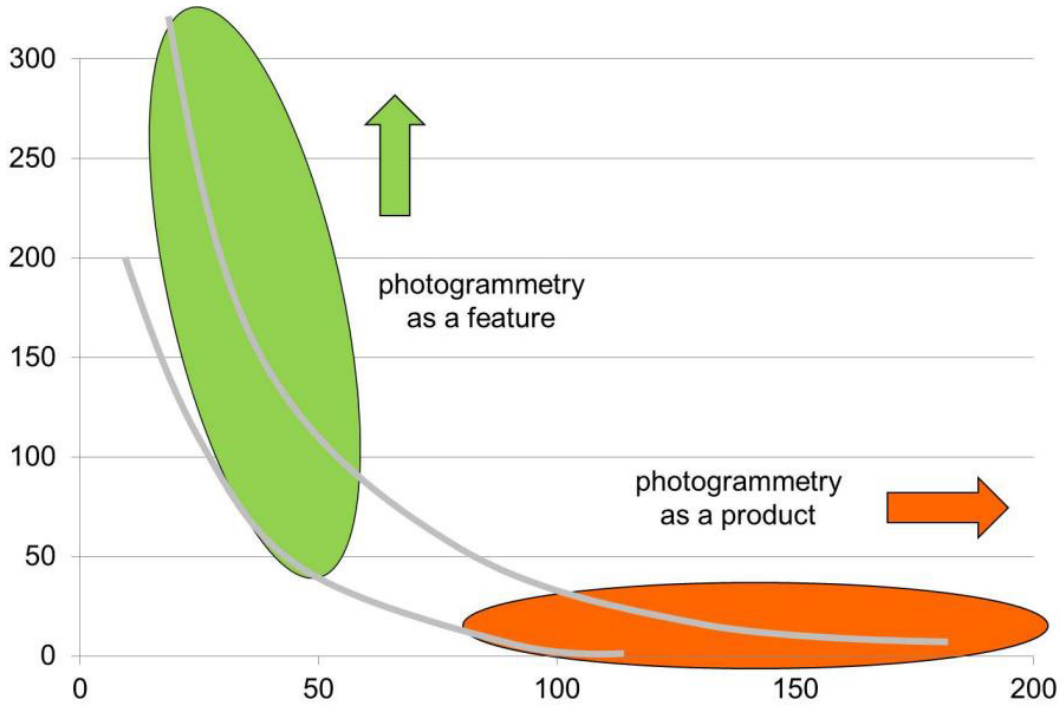

Figure 6: Professional photogrammetry reaching a tipping point: one branch becoming a feature in all kinds of devices, whilst the current main branch in aerial photogrammetry keeps on expanding its throughput.