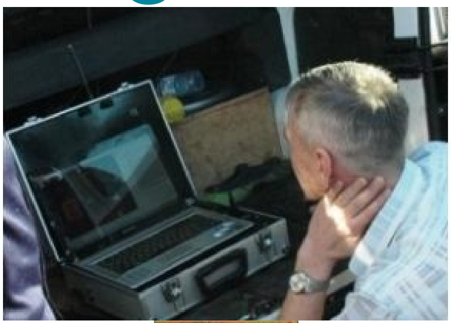
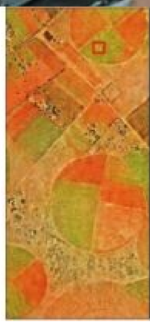
A PILOT PROJECT IN CUBA

UAS in Farming





The popularity of unmanned aerial systems (UAS) is on the rise in many countries for a multitude of applications. In one such development, the UAS is rapidly becoming a tool for crop monitoring and management, which is essential for food security. GeoCuba has been successfully testing UAS technology for farming purposes. Here, the authors describe a pilot project conducted in Cuba in co-operation with the Russian firm Uniintex-Ginus.

Figure 1, Preparing the Delta-Photo system for flight

Cuba covers a land area of nearly 110,000 square kilometres, of which nearly two-thirds is cultivated. With an annual sugar production of 5 million tons, Cuba was once the largest sugar exporter in the world. Today, the production is just one-third of what it was in its heyday. Cuba prioritises food security, hand in hand with sustainability. The country's main products currently include vegetables (tomato, onion and pepper), root crops (potato, sweet potato and taro), cereals (rice and maize) and banana. The typical size of an individual farmer's parcel is 10 to 15ha, while parcels owned by the state or by private agricultural companies may cover several hundred hectares. To plan optimal dates for ploughing and sowing and to check crop health and the need for fertiliser and watering, farm land has to be inspected regularly.

Conventional Methods

Conventionally, Cuban farmers checked soil and crop conditions by walking or riding across their land. The former Soviet Union's Intercosmos programme introduced multispectral analogue photographs in Cuba which allowed inspection from above. At the end of the 1980s, digital satellite images became available which were processed and analysed with the help of computers. Satellite imagery has been and still is widely used for planning and monitoring crop production and assessing yield, since it pairs high spatial resolution with high temporal resolution and extended coverage. In the early 1990s, Cuba gained access to SPOT, LANDSAT and NOAA AVHRR imagery which enabled a variety of information on crops to be determined by means of multispectral classification. Cuba has neither Earth observation satellites nor image receiving stations of its own, so satellite images have to be purchased; an expensive matter associated with delays in delivery. Therefore, UAS appears to be a welcome alternative.

Figure 2, Manual launching.

UAS

Compared to satellite imagery, a UAS offers the following anticipated advantages for agricultural applications: low costs and high flexibility in terms of time and date of data capture, thus enabling high temporal resolution. The spatial resolution is also high. A UAS can be deployed much more flexibly than conventional aerial surveys and has a lower dependence on weather conditions. Although the extent of the area covered by a UAS is limited, the above reasons were sufficient for the present test to be conducted. The UAS used was a Delta-Photo system from AeroKartaKompleks. This company manufactures UASs for various civilian applications. The aircraft of the Delta-Photo system weighs 5kg, is steered from a ground control station (GCS) and is equipped with GPS/IMU (Figure 1). The system is accompanied by PhotoScanPro, a photogrammetric software package running on desktop computers. The maximum flight duration of the aircraft is 80 minutes and the cruise speed is 70km/h. The non-metric camera on board is a 16MP SONY NEX-5N which gives a ground sampling distance (GSD) of 4.8cm at an altitude of 100m.

Site and Flight

The pilot site was an area of 3 square kilometresin Güira de Melena, a municipality where farming is the main economic activity and which produces nearly 50 thousand tons of potatoes and taro annually. However, the yield is less than the figures reported worldwide. The flights were conducted on 20 March 2013. To prepare the flight plan on site using the NEVA software Navigator module, a high-resolution SPOT image with GSD 2.5m was uploaded to the GCS as backdrop. Furthermore, the software required elevation data, either in the form of digitised contour lines extracted from a topographic map or in the form of a digital elevation model (DEM). A DEM was uploaded in the form of the Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010). Further, the preparation of the flight plan needed input on the UAS type, average and maximum flying height, speed, landing site and a polygon demarking the borders of the area. Since the area was relatively flat, the along-track overlap was set at 72% and the across-track overlap at 52%. The number of images necessary to cover the area was 1,192. The flight plan was wirelessly uploaded to the automatic pilot. The UAS was launched manually (Figure 2) and piloted remotely. The images were taken automatically at a rate of one image per two seconds. Nine ground controls points (GCPs), well distributed along the border of the area, were measured by RS-20 DGPS with a precision of 1mm.

Results

After the flight, the imagery, GNSS/IMU data and the coordinates of the GCPs were loaded into PhotoScanPro

Figure 3, Orthomosaic (top) and detail.

allowing the highly automatic creation of georeferenced products, including 3D models, orthoimagery and DEMs. Just four computation processes were needed to generate the above products. Processing of the 1,192 images took 24 hours of continuous computing using an HP Elitebook with Intel I5 processor and 4GB RAM. An orthomosaic with a GSD of 10cm was generated (Figure 3). The differences in colour and shape of the same kind of crop are clearly visible in zoom-in at the bottom of Figure 3; light green indicates a healthy crop. The health differences can be caused by differences in groundwater level due to terrain undulation or by uneven spreading of fertiliser. This information is valuable as an alert to farmers so that they can determine the real cause by field inspection. Once measures have been taken, a second flight could check their effectiveness and also estimate the yield.

Concluding Remarks

A UAS offers great flexibility to quickly acquire data in sufficient spatial resolution at low cost. However, the use of UASs is restricted to small areas. Moreover, flexibility has its limits as the use of a UAS for civilian applications is still subject to the same regulations as for manned aircrafts; permission must be requested a few days in advance**.**

Acknowledgement

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GeoCuba Business Group, established on 1 May 1995, is the result of the integration of two Cuban institutes specialised in hydrography, geodesy and cartography. Today GeoCuba focuses on a variety of geo-related activities including topographic mapping, cadastre, marine studies, navigation, remote sensing and environmental studies. GeoCuba IC, based in the city of Havana, provides research and development support to the GeoCuba Business Group. The research centre also provides high-level education and training in the diverse fields of geosciences.