UAV Photogrammetry for Archaeology

ifgicopter @ swsl

Ifgicopter Project

The ifgicopter group of the Institute for Geoinformatics is working on applications of UAVs in the various fields of geoinformation science. In particular, two different UAV systems (microdrones and mikrokopter) form the starting point of the ongoing research. One of the current research projects deals with the extraction of digital surface models (DSM) from stereoscopic images taken with a 3D camera mounted on the ifgicopter UAV.

UAVs

Unmanned Aerial Vehicles (UAVs) are basically aircrafts without an onboard pilot, controlled by remote control. As highly flexible and low-cost sensor platforms they provide new opportunities of data acquisition for various environmental and geoscientific purposes (e.g. environmental monitoring, forestry, collection of geobase data etc.). Its spatial and temporal versatility due to small size, low weight and little operating costs also makes these UAVS an attractive tool for monitoring and observation purposes in the various fields of geoinformation science.

The ifgicopter group currently owns one microdrone md4-200 and two versions of a mikrokopter with integrated GPS modules. Recently, a QuadroKopter-XL was aquired which has a diameter of 60cm and a payload of up to 1kg. The flight time varies between 15-25 minutes, strongly depending on the payload and the battery.

The kopter has multiple built-in sensors, like a height, orientation and velocity which are necessary for a stable flight. The Inertial Navigation Sensor (INS) contains each three gyroscopes and acceleration sensors to measure changes of orientation or velocity in the x-, y- and z-axis. It is embedded in the main plate, the Flight control (FlightCtrl ME V2.1), together with the main processor. It is possible to equip the MikroKopter with additional sensors like global positioning (GPS), humidity, temperature or imaging. For this project, an imaging sensor is used.

View over excavation site at Dülük Baba Tepesi (Image from www.doliche.de)

Statue found at the excavation site (Image from www.doliche.de)

Excavation in Doliche, Turkey

The resulting system will be tested in an archeological excavation project in Doliche in the province of Gaziantepe in South East Turkey. In ancient periods, this region has been famous as the homeland of the Roman God Iupiter Dolichenus, who especially gained popularity in the Roman Empire during the first three centuries AD. It has been verified that the mountain Dülük Baba Tepesi has been used for religious practices continously from the 1st millenium a.C. to Late Antiquity. In the past years, numerous findings on top Dülük Baba Tepesi have proven the outstanding importance of this cult place in the ancient world.

The field research in Doliche will be carried out in September 2012 in close collaboration with the research group "Asia Minor" of the University of Münster who are working on the excavation since 2001.

Mikrokopter Quadro-XL (Image from http://www.mikrokopter.de)

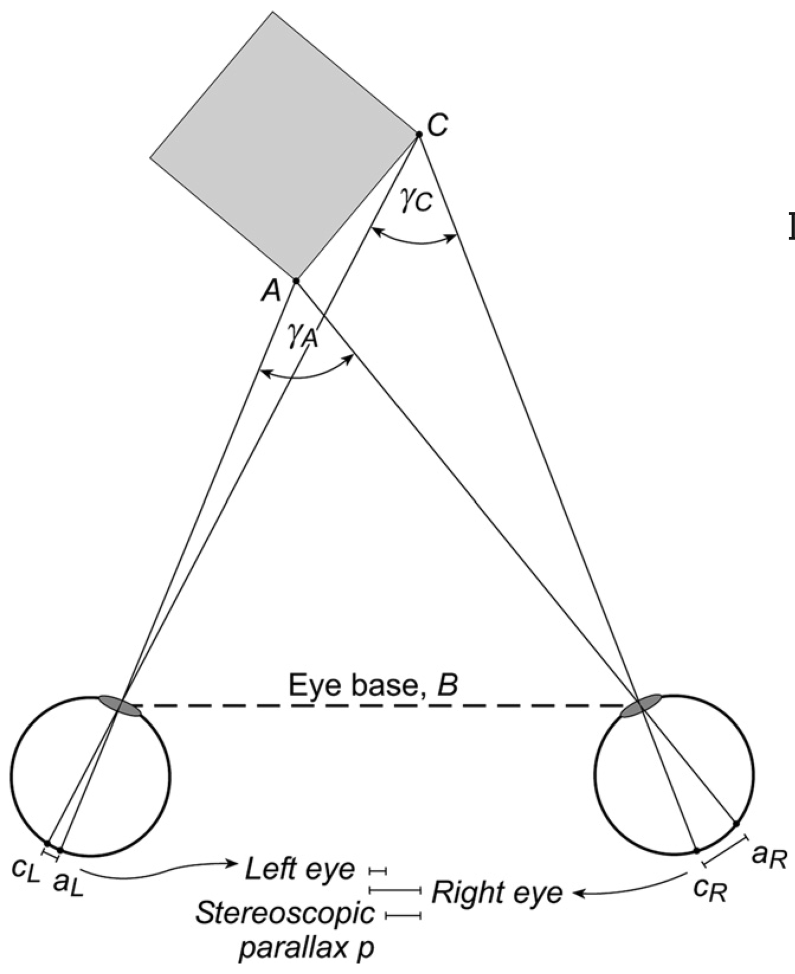
Stereoscopic camera

Fujifilm Finepix REAL 3D W3

The Fujifilm Finepix REAL 3D W3 is a small-format stereoscopic digital camera. As it has a compact and lightweight body, it can be attached to one of the ifgicopters. Unlike conventional cameras, it is equipped with two lenses enabling it to take 3D images. By calibrating this camera and then using it for aerial photography, the images can easily be used for photogrammetric purposes like the creation of orthophotos or digital surface models.

Therefore, the camera had to be calibrated since each individual camera has different inner orientation parameters. The 3D pass point field at the Photogrammetry lab of the Fachhochschule Würzburg-Schweinfurt consists of 91 pass points whose position has an accuracy at a mean accuracy of 0,15mm. Test images were taken from several positions at different heights in order to improve the accuracy of the results. Each calibration is only valid for a specific setting of the camera so the most suitable settings for aerial photography use-cases were used which are wide angle and a centered focus.

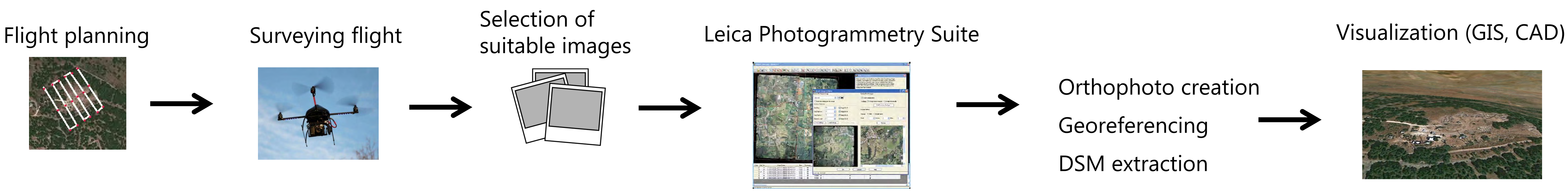
The software Pictran-B by thetechnet GmbH was used to determine the inner orientation of a camera. It applies the bundle-block adjustment to all input photos and hence calculates distortion parameters for the camera.



Eye base B and parallactic angle (Aber, Marzolff, Ries: Small-format aerial photography, 2010)

In contrast to conventional remote sensing methods using professional camera equipment for aerial or satellite imagery and photogrammetry, low-cost stereo cameras propose the problem of a quite narrow distance between two stereo images (the eyebase, see figure left). The smaller the parallax angle γ, the more imprecise a stereoscopic measurement. That is why the flight height is in some way restricted in order to sustain a high resolution.

In order to determine which is the optimal shooting distance for surface extraction, test flights will be conducted shooting images at several heights.



Workflow for the digital surface model creation as planned for the documentation of the excavation in Doliche

Digital Surface Model

Daily or sub-daily survey flights of the area are planned in order to document the progress of the excavation. We will use pre-installed ground control points spread over the excavation site in order to georeference the images. After the flight, duplicate, blurry and images from the starting and landing are removed. Using the Leica Photogrammetry Suite, a georeferenced Orthophoto and Digital Surface Model of the site will be created. The resulting 3D model can both be used as a way to identify the position of findings and as an easily interpreted visualization for the public.

By creating the model, it will be evaluated to what extent the combination of an UAV and a stereoscopic camera can fulfill the needs of archeological science. This will also answer the question whether the outlined approach can serve as a reasonable alternative for archeological documentation purposes.

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