Project: GEOkolibri

Low Altitude Remote sensing on Svalbard using unmanned aerial vehicles (UAV) 2008 - 2009

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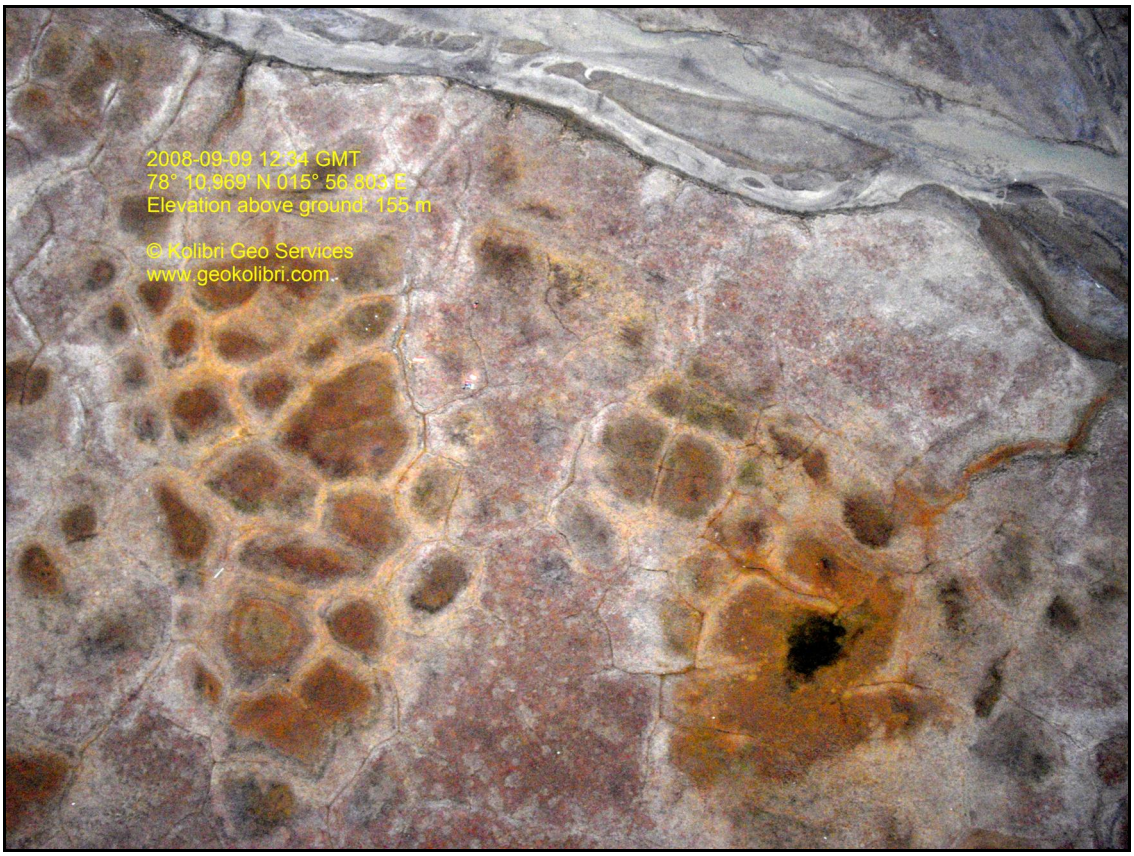

Figure 1. Ice wedge polygons in inner Adventdalen obtained with Kolibri platform

Abstract

Using photographs taken from the air has a long tradition and there is an increasing demand of aerial photographs for a wide range of applications. Beside the increasing

demand of such data, rapid advances in technology made it possible to replace expensive manned aircrafts in several applications with low-cost solutions just as remote controlled model airplanes, often also called Unmanned Aerial Vehicles or short UAV's. The main advantages of applying UAV's compared to manned aircrafts are: no limitations concerning low-level flights, high resolution images, flexible mission planning, recent images and repeated over flights become affordable. The project encompasses the development and operation of such a UAV on Svalbard. The main focus of this flying platform is primarily mapping, photography and atmospheric measurements on Svalbard. The UAV will map crevasse pattern on Glaciers as an alternative to manned helicopters within the GLACIODYN research project. The UAV will furthermore be used as a new method to map avalanches in Nordenskjøldland as part of the CRYOSLOPE research project. Manny more application lay on hand: monitoring of environmental changes on the Tundra introduced by traffic on Svalbard or documenting historical sites on Svalbard by aerial photography just to name some.

Goal

Traditional manned aircrafts are often used on Svalbard for aerial surveys, mapping, and documentation purposes. The here presented project of the GEOkolibri platform can substitute a traditional aircraft in some of those applications. Herby it reduces the impact on the environment significantly. It is not exaggerated that the GEOkolibri platform leaves nothing behind then the data it collects on the way. The UAV is electric powered and has a very low sound level (no sound compared to a manned helicopter). It produces no exhaust fumes and causes no downwash during take-of and landing. The GEOkolibri platform has no restrictions concerning low level flight and can therefore produce high resolution images which are not possible by similar little environmental impact. This makes it a very valuable tool for documentation and monitoring purposes. All necessary equipment can be transported on a sledge, boat, car and launched on site without big logistical efforts and environmental impact. The project offers new possibilities of low cost aerial mapping, surveying and documentation in a very environmental friendly way. It can help us to monitor environmental changes which where not affordable or acceptable by using conventional aircrafts.

Applications

The UAV is deployable during most times of the year. Flying during polar night is limited and demands special equipment. The platform can bare temperatures far below zero since some essential electronics will be heated internally. The UAV and all necessary equipment can be transported on a scooter sledge, tracked vehicle or in a car. Flight

times range from 15 – 20 minutes. . Commonly the flight range is restricted to about 2 km horizontally and 500m vertically above ground. The platform can land on most surfaces such as Tundra, Snow and soft sediments. If conditions allow a landing net can be deployed to make the landing independent on ground conditions.

Figure 2 & 3. Left: Documentation of the CO2 project during drilling operation at the Northern Light station. Right: Meandering Advent river. Both images obtained using GEOkolibri platform.

Platforms

The project has 2 electric fixed wing aircrafts available with a wingspan of ca. 2,6 m and a weight of 2,5 kg. The aircrafts is powered with an electric motor fed by a Lithium-Polymer Accumulator. One platform is manually controlled during the entire flight mission the second fuselage is equipped with an autopilot that follows a preprogrammed flight pattern. Payloads for this platforms range to 300g. A third platform is a rotary wing aircraft controlled on a manual basis. The platform is powered by an combustion motor and has a rotor diameter of 1,8 m. It has a payload capacity of up to 4 kg.


Figure 4 & 5 . Left: Rotary wing aircraft. Right: Fixed wing aircraft

Payload

The main payload is a digital compact camera. Digital formats are very efficient in many applications and technical advances make it possible to reach high resolution at low costs. The Camera will be mounted in the aircraft and can take picture at different angles. Down looking (nadir) side looking (oblique). The camera is triggered either manually or automatic triggered during flight. In order to geo reference individual images a Global Positioning System (GPS) that stores continuously the position on the platform during flight missions. For more specific aerial surveys the platforms can be equipped with a variety of micro sensors such as thermal sensors, near infrared imaging sensors, but there are not part of the initial part of this project.

Backround

UAV's are not new on Svalbard. Weather balloons where probably the first if we exclude carrier pigeons. More advanced platforms were introduced on Svalbard in 2005 when a radio controlled helicopter took video footage of surroundings in Ny Ålesund as part of a glaciological research project. In 2006 Norut Information Technology, Ltd. Based in Tromsø longed a UAV from Longyearbyen airport. The KOLIBRI project is not a rival to the NORUT technology. Its a rather cheaper, more simple and a more flexible approach for application that differ compared to the NORUT UAV. On the other hand, the platforms have no real time transmission of payload data, less autonomous flying capabilities as the NORUT UAV or the one used in Ny Ålesund. But it is wildly known

that simple things works best up here on Svalbard and are most reliable.

Applications

Mapping from the air is a very effective way to survey glaciers due to there inaccessibility. Surges are known phenomena on Svalbard's glaciers. During surges, glacier velocity increases suddenly for a period and the glacier becomes heavily crevassed. These phenomena can cause a thread to people traveling on Svalbard. Beside its a phenomena which is studied for climate research purposes. Monica Sund, PhD student at UNIS, is very interested to use the GEOkolibri platform to map crevasse pattern on surging glaciers. During fieldwork the UAV should survey the way ahead if crevasses makes the travel on snowmobile too dangerous. The images the GEOkolibri platform takes along its flight path can be immediately displayed and the route can be evaluated. At the same time the UAV will be used to map crevasse pattern and document the changes on the glacier over time. Until now a manned helicopter was the only way to perform such work. The UAV would be more efficient, more environmentally friendly and of course much cheaper.

In Svalbard's past, avalanches have cause destruction, injured and killed people. Currently, there is a large focus on avalanche safety within the Longyearbyen community. A research project called CRYOSLOPE is set up since 2006 with the main focus on observing snow avalanches. The GEOkolibri platform will be used within the project to make observations more accurate by aerial photography of avalanches. Furthermore will the GEOkolibri platform decrease the exposure to avalanche risk that is involved by mapping avalanches in very steep terrain. It would be pioneer work.

Many more applications are easily possible to be performed by the GEOkolibri platform.

- Historical sites could be mapped from the air. Aerial photographs are a invaluable tool for archaeologists all over the world. Its used both to trace human activities on site and for documentation.

- It is wildly known that environmental changes can easily been traced on aerial photographs. The GEOkolibri platform could monitor change in tundra vegetation introduced by scooter traffic for example.

- Temperature measurements in the lower atmosphere are often performed using balloons. The GEOkolibri platform can perform measurements with a larger expansion for the measurement and even faster by beeping more flexible.

- The GEOkolibri platform could be applied to take aerial photographs of important public events on Svalbard such as Tarsjansen or the 17th of May parade. Aerial photography, if taken in an 45 degree angle (oblique) ads a very interesting and

appealing 3rd dimension to the photograph. A good example is the photograph taken of the Longyearbyen population during the 100 year anniversary 2007. For applying UAV over larger crowds an approval needs to be obtained from the appropriate authorities.'

- GEOkolibri platform could be used to document current development within the settlement, building sites, areal planning sites. There is a variety of many more usefull application we the GEOkolibri platform could be introduced to the "job".

Project time line

Spring 2008, March - June
- Continuously training on the PC-flight simulator (accomplished)
- Purchase (accomplished)
- Assembling the GEOkolibri platform (accomplished)
- Modification of the fuselage for camera set up and payload (accomplished)

Summer 2008, July - September
- continuing training and upgrading of the equipment (accomplished)
- deployment in Adventdalen for photographing ice wedges (accomplished)
- deployment of the UAV for upcoming projects

Autumn and Winter 2008, October – February
- continuing training and upgrading of the equipment

Spring to summer 2009
- deployment for glacier-crevasse mapping in connection with PhD student Monica Sund, UNIS and the GLACIODYN project.
- Deployment around Longyearbyen for avalanche purposes within the CRYOSLOPE project
- deployment in Adventdalen for photographing ice wedges (accomplished)
- deployment of the UAV for upcoming projects

Outlook

There are a large amount of applications which could make use of UAV's that are based

on Svalbard. Spectral analyses of the sea, tundra and rock surfaces give valuable information's of environmental status. Sensors for atmospheric pollution could monitor environmental pollution around Svalbard on areas which are difficult to access. UAV's with a larger payload capacity could carry a larger variety of sensors, camera and video.

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