Electromagnetic measurement method using unmanned aerial systems

Innovation in exploration
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Summary
The geophysical RADIO EM method (3-component magnetic field measurements in the frequency range 5 kHz to 62 kHz) for use on unmanned aircraft systems was developed and tested as part of the GEOTECHNOLOGIEN project AIDA (From Airborne Data Inversion to In-Depth Analysis). This measuring method uses the electromagnetic alternating field radiated by radio transmitter stations that enables to detect changes in the electrical conductivity in the ground. For recording the electromagnetic field a high-performance data acquisition system was used. It records continuously at data rates up to 130 kS/s with a resolution of 24 bits. A highly sensitive 3-axis coil system detects the alternating field of narrowband radio transmitters. For integration in a UAS (unmanned aircraft systems) a special suspension device has been developed which minimizes oscillation in the measuring system. The complete system has been successfully deployed in two field campaigns and its functionality was proven.

Background and state of the art
In the last 10 years UAS have achieved a high degree of technical maturity and reliability as well as user-friendliness, control and safety. It seems therefore obvious to use UAS as a flying platform for geophysical measuring instruments from the air. Geophysical instruments available on the market, however, do not meet the requirements of compactness and weight. An existing measurement system was therefore modified for the deployment on a drone.

Product and process description
The RADIO EM-system is an electromagnetic measurement method in applied geophysics. The output of the instrument is an...
indicator to make changes in the electrical conductivity in the ground visible such as fault zones, cables and pipelines. A 3-axis coil system senses the 3 components of the electromagnetic field transmitted by radio stations. Using spectral analysis, individual radio channels that are available in the measuring area are selected and the electromagnetic field is evaluated along measurement profiles. A complex data processing analyses the ratios of the individual field components. Spatial changes of individual components are indicators of changes in the electrical conductivity in the ground.

The use of drones in RADIO EM measurements is a novelty. The integration on a UAS first requires an accurate analysis of the interference from electrical sources of the aircraft system itself and oscillations of the sensor below. A special assembly has been developed which minimizes interference and reduces the oscillations of the sensor. Modern UAS can fly autonomously using waypoint navigation and are programmed by specifying the route before a flight. The use of differential GPS enables precise positioning of the measurement points in the range of a few centimeters.

**State of development/ Areas of application**

A data logger system (ADU-07) and sensor (SHFT 02) from Metronix GmbH were modified and miniaturized to enable the deployment on an UAS. This prototype is characterized by its high sampling rate (130kS/s), the large number of radio stations that are available in a survey area, and its compact design. In the frame-work of the AIDA project two field studies in Neuchâtel (CH) and near Cuxhaven (GER) were performed and demonstrated the suitability. Here, a commercial UAS of AeroScout GmbH (Lucerne, Switzerland) was used. Both flight surveys have proven that the RADIO EM system is now commercially available for geophysical exploration purposes.
Applications
- Exploration of metallic and non-metallic materials
- Detection of cables, pipelines, etc.
- Mapping of tectonic faults
- Detection of salt-fresh water boundaries
- Detection of contaminated areas

Technology and potential benefits
- Fast and efficient areal measurement using UAS
- Once mobilized 10-20 times faster than conventional ground-based methods
- Can also be used in inaccessible areas (e.g., swamps, flooded, mined, unstable or collapsed areas)

Target groups
- Mining industry
- Oil&Gas industry
- Exploration companies
- Energy and water utilities
- Engineering firms
- Environmental agencies

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Research project AIDA
Project Aero-ground joint inversion

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