## Title: Realization of an Unmanned Aircraft Magnetometer System

## Tutor: Giovanni Florio

## Research program

Remote sensing, a technique for capturing information from a distance, is traditionally performed by satellites or manned aircrafts. Over the past decade there has been rapid development of 'Unmanned Aircraft Vehicles' (UAV) as well as of the remote sensing equipment installed onboard (the system integrating the vehicle and the instrumentation is called 'Unmanned Aircraft System', UAS). UASs are becoming a desirable alternative or a complementary approach for remote sensing, since they allow for high versatility and flexibility in comparison to traditional airborne and satellite systems. Operations with manned systems also pose high risks to humans (e.g., during low altitude flying) which do not exist with the use of UASs. Furthermore, UASs are also capable of flying at very low altitudes (as low as 2m AGL) and at much slower flight speeds, giving them the ability to acquire higher resolution data.

UASs are being developed for many different applications such as military or imaging (video cameras in the visual spectrum; thermal infrared video sensors, Lidar systems, multispectral and hyperspectral sensors). In the last years instruments for geophysical investigation of the subsoil were also mounted on UASs, such as gamma rays' measurement devices, Very Low Frequency (VLF) sensors, radar systems and magnetometers.

Magnetometric systems mounted on drones allow to carry out surveys with intermediate characteristics between traditional aeromagnetism and ground surveys in terms of resolution, extension of the investigation area, elevation and speed. Probably, in most cases they represent the most cheap and versatile solution for acquiring magnetometric data, in particular in remote or difficult access areas, including lake and marine areas.

Currently, in the world various UASs equipped for aeromagnetic surveys are at the operational level or in development. In a few years these systems have changed both for the type of carrier (from large fixed-wing aircraft or helicopters with wingspan or rotor length of 4-5 m, to small multi-rotor drones) and for the instrumentation, given the recent availability of miniature magnetometric systems with a weight not exceeding 1-2 kg and therefore suitable for small and light aerial vehicles.

DiSTAR's geophysical research group on gravimetric and magnetic methods has internationally recognized experience in the acquisition, analysis and interpretation of these data, with the development of numerous original algorithms and approaches to model the density and magnetization distribution at depth. A latest generation alkaline vapor magnetometer (Geometrics MFAM Development kit) is also available in the group which, due to the characteristics of the system miniaturization, accuracy and sampling frequency, is suitable for being integrated into a drone aeromagnetic system. An agreement was recently signed between DiSTAR and the Istituto per i Sistemi Agricoli e Forestali del Mediterraneo (ISAFOM-CNR), with which a collaboration

has been formalized that will allow the use of aerial platforms own by this research Institute. Currently, therefore, there are the conditions to implement an original drone magnetometric system at DiSTAR, but for this purpose study and research about the resolution of various scientific and technical problems is needed.

## Proposal for a PhD position

A position for a PhD will be required to carry out research aimed at creating a system for the acquisition of magnetometric data from drone.

The research will have to face some preliminary main problems which include: 1) the compensation of the fields induced by the mobile platform, to be realized both from a structural point of view (realization of an aerodynamic housing (bird); choice of the optimal structure to tie the bird to the drone ; choice of the optimal distance from the vehicle), both from the point of view of noise estimation for different sensors attitude (pitch, roll, yaw), and, finally, from the point of view of filtering the recorded signals; 2) the evaluation of the optimal distance between the sensors to estimate the spatial gradients of the total magnetic field; 3) the evaluation of the optimal orientation of the sensors to maximize the signal and reduce the possibility of falling into "dead zones"; 4) the development of software for the management of the data flow and for the integration with post-processed GPS positioning data (PPK).

The present research project includes, after an adequate testing phase and the comparison with data acquired on the ground with different magnetometers, the application of the new magnetometric system for research in different study areas of geological, archaeological and engineering interest, in the frame of existing collaboration projects with various entities, internal and external to the University of Naples 'Federico II'.

The project falls within the University of Naples ENHANCING POMPEII project ('Pompeii between the archaeological site and the modern town. Knowledge, restoration and enhancement of the Insula Occidentalis'), co-proponents Renata Picone and Giovanni Florio (€ 50000).