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MONITORING WITH UNMANNED AERIAL VEHICLES

The newly founded UGent research center will focus on new technology for making UAV based monitoring more application-relevant, more economic, and of higher quality. One key aspect will be automation, which encompasses real-time flight planning based on image analysis and streamlining of the data processing chain. Another key aspect will be adapting and interpreting the imaging process to and for specific applications, based on state-of-the-art crop and ecosystem research.

Leading scientists:

Prof. Dr. ir. Kathy Steppe (Laboratory of Plant Ecology, Faculty of Bioscience Engineering); Prof. Dr. ir. Wilfried Philips (Image Processing and Interpretation, Faculty of Engineering and Architecture); Prof. Dr. Philippe De Maeyer (Department of Geography/Geomatics, Faculty of Sciences)

Consortium partners:

Faculty of Bioscience Engineering: Prof. Dr. ir. Kathy Steppe (Laboratory of Plant Ecology); Prof. Dr. ir. Frieke Van Coillie (Laboratory of Forest Management and Spatial Information Techniques); Prof. Dr. ir. Abdul Mouazen (Precision Soil and Crop Engineering research group); Prof. Dr. ir. Niko Verhoest and Prof. Dr. Diego Miralles (Laboratory of Hydrology and Water Management); Prof. Dr. ir. Kris Verheyen (Forest and Nature Lab); Prof. Dr. ir. Hans Verbeeck (Laboratory of Computational and Applied Vegetation Ecology), Prof. dr. ir. Jan Pieters (Biosystems Engineering)

Faculty of Engineering and Architecture: Prof. Dr. ir. Wilfried Philips (Image Processing and Interpretation); Prof. Dr. ir. Clara M. Ionescu (Dynamical Systems and Control research group); Prof. Dr. Guy De Tré (Database Document and Content Management group);

Faculty of Sciences: Prof. Dr. Philippe De Maeyer (Department of Geography/Geomatics); Prof. Dr. ir. Alain De Wulf (Department of Geography/Geomatics)

 # new professorships: 2

Project description

In just a few years, 'drones' or UAVs (Unmanned Aerial Vehicles) have become ubiquitous in the media and also in reality. Nowadays, new applications continue to emerge as they become progressively more reliable and affordable. Several UGent research groups use UAVs in their research. An international success was, for instance, the creation of the UGent spinoff company GateWing. Still, at UGent, UAV-related research is fragmented, and the potential of this new technology remains largely untapped. In this proposal, we have the ambition to bring together this fragmented knowledge and create an interdisciplinary expert center on UAV research.

Whereas the rapid technological advance on UAVs has facilitated commercially available UAV platforms, their full potential in applications is yet to be reached, especially in monitoring and remote sensing applications of terrestrial agricultural and natural ecosystems targeted by the proposal. Here, the unsolved challenge is the full automation of the capture, analysis and dissemination pipeline. A tight interplay between drone flight control and the treatment of its observations will allow much better solutions than available today. Yet, application knowledge is essential to achieve optimal solutions. In other words, an interdisciplinary approach provides a strategic advantage, which is why in this proposal we combine the technological and applied expertise of the faculties of Engineering and Architecture, Bioscience Engineering and Sciences.

1. Technological expertise to be provided by the expertise center:

- Smart UAV imaging: development of smart UAVs, defining their own flight track based on real-time analysis of incoming information to cover areas of interest (e.g. stressed canopy) and controlling their own path

- Image processing: improvement of the structure-from-motion software and fusion (automatic co-registration) for thermal, multispectral and hyperspectral cameras and LiDaR, incorporating atmospheric corrections and sun-sensor viewing angle influence;
- Data extraction: automated quantification of crop growth, detection of vegetation stress and monitoring of changes over time, 3D models from point clouds;
- Database technology: for managing the large amounts of data derived from the observations, and all relevant flight parameters, for querying the data and disseminating it to end users.

2. Applied expertise to be provided by the expertise center:

- Data analysis: relating extracted data to variables relevant for the application;
- UAV-optimized remote sensing products: rethinking remote sensing products (e.g. estimates of plant transpiration) by combining UAV data with continuous point measurements such as soil moisture or sap flow, or incorporating information from different viewing angles and 3D models;
- New and innovative remote sensing technologies: such as sun-induced fluorescence (photosynthesis and productivity), and its combination with thermal remote sensing (transpiration) and microwave remote sensing (moisture content in soil and canopy);
- UAVs as 3D sampling/measurement (e.g. air quality, microclimatic measurements) or goniometer measurements devices (e.g. bidirectional reflectance distribution function (BRDF) of complex natural systems).

Although the core research of the expertise center will focus on innovative aspects of UAVs in terrestrial ecosystems, activities will cover other UAV monitoring applications as well. Examples are identification of the exact location of polluting gas emissions, sea-based wind turbine inspection, water pollution monitoring, archeology,.... The center will also provide a crucial service to other research groups – within and outside UGent – and industry partners, carrying out flights and data processing for those who find it difficult to fly UAVs for practical, technical and/or legal reasons.

Proposed impact

The proposed center will be of strategic importance to both UGent and Flanders. The Flemish industry has created the innovation network EUKA1 to promote this technology. The example of the UGent spinoff GateWing shows that even a modest investment can result in over 100 high-tech jobs in Flanders.

There are several ways in which this research center can have a positive economic impact:

- The development of smart UAVs will be ground-breaking in numerous applications (precision agriculture, forest canopy and land degradation monitoring, monitoring and inspection of damage in industrial installations, 3D mapping ...) and has clear potential to become incorporated into commercially available UAVs.
- The global market for specific UAV software is growing parallel with that of the UAV market. With the increased availability of advanced cameras (thermal, multi- and hyperspectral) and sensors such as LiDaR, more advanced software, such as will be developed in this research center, will be required.
- Precision agriculture, which plays an important role in the sustainable agriculture of the future, requires the assessment of the spatial variation of the canopy conditions and productivity (e.g. fertilization requirement, irrigation requirement, detection, identification and severity indication of diseases and weeds). The new methods for detecting and mapping vegetation status and stress, developed in this project, can be used for future commercial applications in precision agriculture.

In addition to the economic impact, this research can bring several social and environmental benefits:

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- Contributing to a more sustainable planet, specifically to sustainable development in developing countries, where automated low-cost precision agriculture technologies are expected to have a large impact. For instance, currently, UGent IPI and the Ecuadorian Espol University are cooperating on monitoring of crops and ecosystems (Galapagos) in which low cost is of obvious importance.
- UAVs offer eco(physio)logists and ecohydrologists a new tool to study within-ecosystem differences of sensitivity to environmental drivers. These new insights are crucial for understanding and predicting of how ecosystems will respond to climatic changes and how we can manage them to be more resistant and resilient.