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Towards new frontiers for environmental sensing: a UAV-based Active Laser Fluorescence Imaging System

Chenglong Zhang, Hasib Mustafa, Harm Bartholomeus, and Lammert Kooistra

Sustainable solutions are key in dealing with challenges attributed to food security and climate change. The I-Seed project, funded by H2020, strives to pioneer a novel generation of self-deployable and biodegradable soft miniaturized robots. Drawing inspiration from the morphology and dispersion abilities of plant seeds, these robots are designed for cost-effective, environmentally responsible, in-situ detection of crucial environmental parameters in both air and topsoil. In this concept, Unmanned Aerial Vehicles (UAVs), will be utilized to distribute, localize, and capture the fluorescence signal emitted by the artificial seeds. For the aerial read-out of the fluorescence signal, a prototype of UAV-based Active Laser Fluorescence (ALF) Imaging System was designed. It comprises an RGB camera, a spectral and hyperspectral camera, a laser, and a Time-of-Flight (ToF) Lidar. The integrated setup was evaluated in an optical laboratory. The fluorescence emission from the artificial seeds was measured at a distance of 4m, utilizing varying excitation intensities with an integration time of 3s and temperatures ranging from 5 to 40°C. Results showed that as the sample temperature increased, the peak ratio exhibited changes, making it a valuable indicator for temperature estimation. A similar behavior was observed in modulated excitation, where the fluorescence lifetime varied with temperature. Within the constraints of exposure time for non-saturated pixels, data from RGB pixels also provided insights into the sample temperature. In addition, the developed system was also tested on a linear stage mimicking a flight under field conditions. Present work reveals potential for a revolution in the use of UAVs in environmental sensing.