Abstract

It is unquestionable that the conservation of plant species is essential for the preservation of nature, climate, and human wellbeing. Classically, the task of conserving threatened plant species was generally done through direct field supervision by natural resources managers. Thanks to the advances in sensor technologies and also in aircrafts such as unmanned aerial vehicles (UAV), high resolution remote sensing (RS) data are becoming an important resource for monitoring threatened plant species in large areas. Such RS data are usually multi-spectral images, with three or more bands, of up to 3 cm/pixel resolution, providing an orthogonal or quasi-orthogonal view of the considered plant species. This information may not be as complete as the information provided by natural images; however, it might be sufficient to monitor tree species located in very large areas with difficult access.

The task of analyzing RS images is usually performed using classical algorithms that require a high level of human intervention. In the last ten years, Deep Learning (DL) models in general and deep Convolutional Neural Networks (CNNs) in particular have shown impressive results in extracting spatial patterns from natural images. Indeed, CNNs constitute the state-of-the-art in all computer vision tasks, in image classification, object detection, and segmentation. Nevertheless, the potential of deep CNNs have not been fully explored in high resolution orthogonal and quasi-orthogonal images, especially in plant species conservation.

This thesis presents one of the first studies in exploring the potential of deep CNNs, data preprocessing and high resolution RS data, in addressing plant species conservation problems. In particular, this thesis presents the results and analysis of deep CNN models in three different problems from natural sciences:

1. The detection of Fir trees (*Abies Sibirica*) damaged by the bark beetle in UAV images using DL.

2. The estimation of olive tree biovolume from UAV multi-resolution image segmentation using Mask R-CNN.

3. The detection of Spruce trees (*Picea Abies*) infected by bark beetle in UAV images using YOLOs architectures.

The main objective of this thesis is to develop robust and accurate DL models for the monitoring of different plant species using UAV images. The particular objectives to achieve the main objective are:

- To build three high-quality datasets for each one of the three considered problems.

- To design the appropriate pre-processing methods that reduce noise and uncertainty in the features and annotations.
- To develop robust and accurate CNN-based models for each case study.

The results of the first two chapters of this thesis have been published in two journals ranked as Q1 and Q2 in JCR. The results of the third chapter have been