3D Multi-Temporal Monitoring of Vineyards Using Mobile Robotic Systems

A. Dib[1], M. Mabrouk[1], F. Baldacci[2], J.P. Da Costa[1,3]

[1]Univ. Bordeaux, CNRS, Bordeaux INP, IMS, UMR 5218, , 351, cours de la Libération, F-33400 Talence, France,
[2]Univ. Bordeaux, CNRS, Bordeaux INP, LaBRI, UMR 5800, 351, cours de la Libération, F-33400 Talence, France,
[3]Bordeaux Sciences Agro, 1, cours du Général De Gaulle, F-33170 Gradignan, France;

Abstract

Precision agriculture relies on continuous crop monitoring to optimize management, particularly in perennial crops like vineyards. This study explored the use of mobile robotics equipped with a Realsense camera to collect weekly RGB-D data in a vineyard in Bordeaux, France, enabling the tracking of key plant structures across the growing season. In particular, a novel algorithm, sliding sequential global/local registration (SS-GLR), was developed to align pointclouds with sub-centimetric accuracy to reconstruct 3D models of vines at multiple phenological stages, addressing reconstruction challenges such as dense foliage and variable lighting changing from one week to another. The algorithm was validated using a homemade protocol, demonstrating its ability to generate precise 3D reconstructions. In addition, comparative evaluations of the Realsense with an Orbbec camera with different depth resolutions revealed variations in performances in capturing dense foliage in changing conditions. These findings open up new perspectives in multi-temporal vegetation monitoring for precision agriculture or phenotyping.

Figure 1. Left: robot Agile X Scout 2.0 in the vineyard in Château Luchey Halde, Bordeaux, France. Middle and right: examples of RGB and depth images captured by the realsense camera

Figure 2. 3D reconstruction of a vine span in September using the SS-GLR algorithm with a sliding window of size .