

Remote sensing of forests is the subject of many current research, and the main technique for data acquisition is the laser scanning. Unfortunately, the potential of laser scanning data in agriculture and fruit-production is still unexplored and undervalued.

Classical laser scanning from a plane deck is economically unjustified for orchard areas. In such a case laser scanning can be obtained with unmanned aerial vehicle (UAV). Laser scanning data of very high density, so called point cloud, allows to determine various characteristics of the orchard and of individual trees i.e. tree height, shape and volume of the crown. With these parameters it is possible to predict harvest and to plan agricultural treatments like pruning and fertilizer dosage.

The main scientific problem aimed to be solved by the proposed project is to develop a new methodology and prototype algorithms for an automatic estimation of geometric parameters of selected species of agricultural trees from ALS LiDAR data obtained with UAV. For this purpose some modified methods commonly used in forestry will be used, as well as new algorithms for data processing will be developed.

UAV derived point clouds have different specific than classical airborne laser scanning (ALS) data, due to the use of small and light sensors, which results in a lower accuracy of the point cloud. On the other hand, UAV can fly relatively low and in orchard areas it can even operate between trees, in order to obtain not only aerial but also side reflection. Moreover, agricultural trees have different structure than forest trees – they have short stem with a biomass located mainly in the crown. The differences in data quality and tree geometry constitute a barrier for using forestry methods in orchard inventory. On the other hand, due to artificial planting and regular pruning, agricultural trees are kept at a distance, so other algorithms may be more robust and efficient for orchard areas.

In this project measurement campaigns are planned, in order to acquire laser scanning data for several orchards during leafless and covered periods. In each orchard a group of test trees will be selected, for which direct classical and GPS measurement of some geometric parameters will be performed. Measurement results, as well as a photographic documentation and airborne imagery will be used to verify the developed method and assess the accuracy of estimated parameters of agricultural trees.

Research tasks will be related with development and implementation of data processing algorithms. It will be analyzed what is the influence of point cloud density and the character of the orchard (e.g. tree size and species) on the quality of the results. As an outcome, a list of recommendations will be created for ALS laser scanning data acquisition and processing in agricultural studies, including the list of optimal input parameters for automatic data processing. In case when the orchards structure is more complex or unknown, a more general processing methodology will be proposed. In this approach the processing parameters will be automatically adjusted based on some field measurements of selected parameters of representative trees in the orchard. The final step will be to find a relationship between estimated parameters, fruit harvest and crown pruning.

This project will establish a basis for further interdisciplinary studies, by connecting geodesy (remote sensing) and agriculture (fruit growing) disciplines in a unique and innovative way. It will make a strong contribution to further development of applications of great economic impact, for Polish agriculture in particular.