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Editorial

Electronics, Close-Range Sensors and Artificial Intelligence in Forestry

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The use of electronics, close-range sensing and artificial intelligence has changed the management paradigm in many of the current industries in which big data analytics by automated processes has become the backbone of decision making and improvement. Acknowledging the integration of electronics, devices, sensors and intelligent algorithms in much of the equipment used in forest operations, as well as their use in various forestry-related applications, we are still seeing that many disciplines within forestry and forest science still rely on data collected traditionally, which is resource-intensive. In turn, this brings limitations in characterizing the specific behaviors of the forest product systems and wood supply chains, and often prevents the development of solutions for improvement or inferring the laws behind the operation and management of such systems.

Undoubtedly, many solutions still need to be developed in the future to provide the technology required for the effective management of forests. In this regard, the Special Issue "Electronics, Close-Range Sensors and Artificial Intelligence in Forestry" highlights many examples of how technological improvements can be brought to forestry and to other related fields of science and practice.

For instance, the work of [1] has shown a new approach on how to improve tree ring identification technology which, in turn, supports the science in many scientific topics, including forest growth and dendrochronology, and the effect that climate changes have on forests. The work of [2] describes a solution for the long-term monitoring of sawmilling operations by developing a highly accurate machine learning framework which works on limited amounts of data and enables the use of inexpensive sensors for extended periods of time. Changing the existing modalities of accounting for quantitative estimates in the wood supply chain has been found to be one of the drivers of automation in forestry which will support a more effective management. The comparative study of [3] concluded that there is a lot of potential in using affordable digital solutions in wood measurement applications, which could be a feasible alternative when balancing the running costs and the ergonomics of wood measurement activities. The management of future forests would have to rely on high amounts of data collected in real time. In turn, this would have to use proper protocols to extract useful information. To support such needs, the work of [4] describes and operationalizes a concept to support data curation for Tree-Talker-based applications. Prototyping technologies that meet practical and scientific sampling purposes is one of the challenges in many scientific disciplines. The work of [5] describes the design of an Unoccupied Aircraft System with a lot of potential in physical sampling, thereby enhancing our ability to obtain samples from rather inaccessible parts of the trees. Remote sensing coupled with statistical learning may support large-scale spatial forest management. The work of [6] successfully tests these solutions for dense forests with the aim of removing the bottlenecks brought by traditional field sampling in estimating the aboveground biomass of trees. Understanding the drivers behind the land use change, including forest loss, may help in designing better policies and practices. The work of [7] evaluates the drivers of forest loss using a machine learning approach in a spatially heterogeneous space. LiDAR technology has been proved to support many applications and decisions in forestry. LiDAR-based data twinning may even be a prerequisite in our attempt to create virtual copies of forests in the future. The work of [8] describes a non-biased highly accurate tree-segmentation platform which supports the extraction of tree-level attributes such as diameter at breast height (DBH), tree height and estimates of tree volume. At our level of development, forest management is not possible without a well-designed road infrastructure, which should provide the connectivity to resources, and should enable mobility for various purposes. The management of forest roads by monitoring provides the possibility to take early action and requires advanced solutions to support management's responsivity. The work of [9] proposes an ultrasound-based solution which has strong potential for road monitoring, with a road geometry interpretation rate of up to 91.2%. Forest disturbances, including forest fires, are shaping our forests in ways that can hinder their sustainability. For this reason, the early detection of fire can contribute to taking responsive measures in order to prevent losses due to damage. In this regard, and based on convolutional neural networks, the work of [10] provides a competitive solution for fire detection. The work of [11] provides a solution for monitoring motor-manual operations, in order to remove the effects brought by the variability in placement of acceleration sensors; although the solution was tested on a specific equipment, the approach has the potential of being adapted to many other applications in which motor-manual tools are used in operations. Last, but not least, the technique of ensemble learning may help discover patterns that are rather inaccessible to conventional machine learning. Guided by this, the work of [12] describes a novel ensemble learning method to detect forest fires in various scenarios, which improves detection performance by 2.5%–10.9%.

In summary, to promote a better understanding of the usefulness of advanced solutions in forest management, the Special Issue "Electronics, Close-Range Sensors and Artificial Intelligence in Forestry" compiled advanced knowledge, techniques and solutions specific to several disciplines, starting with the monitoring of forest resources and infrastructure, and ending with the tools needed in disturbance management, sampling, and operational forestry.

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