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NATIONAL COUNCIL FOR FOREST RESEARCH & DEVELOPMENT
AN CHOMHAIRLE NÁISIÚNTA UM THAIGHDE AGUS FORBAIRT FORAOISE

Estimating **timber volumes** for multi-purpose forest management using **laser technologies**

Figure 1. A terrestrial laser scanner positioned in a stand ready for a 360° scan.

These days, trees are grown in the forest for many different purposes. Planning and decision-making for modern, multi-purpose and sustainable forest management requires up-to-date and accurate information about the growing trees. This information is used to evaluate the range of potential options for the future development of a forest. At present, this information is mostly obtained by manual, ground-based methods. The use of historic data for forecasting is often restricted because of uncertainties about the inventory methods used and the accuracies achieved. Increased requirements for up-to-date, efficient and reproducible methods for obtaining high quality data, together with the need for problem-oriented data analysis methods, make it necessary to investigate new inventory systems, based on efficient, economic and objective procedures and resulting in multi-purpose data sets and a range of application software that will translate the data into information relevant to forest planning and sustainable management systems.

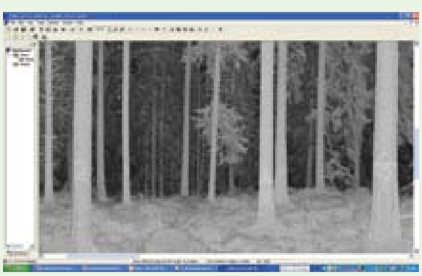

Figure 2. An example of scanning data, consisting of a 3-D point cloud depicting the trees and the ground roughness and vegetation.

A promising new technology that could be of great benefit in multi-purpose forest inventories, are terrestrial laser scanners (TLS). These types of scanners are used in a variety of applications where accurate 3D models are useful, including: architectural, industrial and medical measurements, coastal erosion studies and heritage preservation. The basic principles behind the operation and measurement methods appear to make this technology very suitable for highly automated multi-purpose forest inventories. University College Dublin, Treemetrics Ltd. and Purser Tarleton Russell Ltd., are participating in a COFORD funded research project entitled 'FORESTSCAN - Terrestrial Laser Scanning Technology for Multi-Resource Forest Inventories'.

During the scanning process, the laser scanner rotates 360° in a horizontal direction (Figure 1). A rotating mirror or redirects the laser beam vertically and allows for a 310° vertical scan. Through the simultaneous rotation of the scanner and the mirror, is it possible to produce a continuous scan in all directions except for a cone-shaped area underneath the scanner. When the laser beam hits a tree, branch, leaf, or terrain the reflection is recorded by the scanner, including the distance to the object, the horizontal and vertical angles and the intensity of the reflection.

The size of data sets created by the scanner can be up to 250MB per scan (40 million data points) and they consist of the co-ordinates and intensity values for each data point (Figure 2). The representation is easy on the human eye and is similar to black and white photography. The acquired point clouds can be displayed on a monitor in the forest so that a data check can be carried out before leaving the site. The core of the data processing consists of the allocation of individual data points to actual objects in the stand (object classification) and the creation of actual objects (object reconstruction). In order to make forest inventory methods using scan data economically viable, the object classification process must be automated.

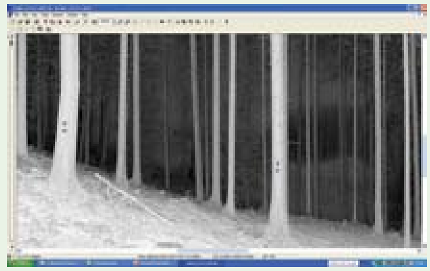

Figure 3. Scanning output depicting a sloping site with deadwood present. The FORESTSCAN project is part of the PLANSFM forest management and planning research programme funded by COFORD.

Prof. Maarten Nieuwenhuis of the School of Biology and Environmental Science is the project coordinator and PhD student Taye Mengesha has recently joined the project. Taye is currently finding out more about the basic principles of terrestrial laser scanning technology and its applicability to multi-resource forest inventories. The project is also evaluating existing data analysis software for forestry applications. The development of new software for a range of applications, both in relation to timber measurements and for non-timber, sustainable forest management purposes, is being investigated. The project will run for another three years and will also investigate issues such as the impact of wind and precipitation on the applicability of the technology and the effect of terrain complexity and understorey vegetation on the capability of the system.

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