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Low-cost assessment and visualization of tree roots using smartphone LiDAR, Ground-Penetrating Radar (GPR) data and virtual reality

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Continual monitoring of tree roots, which is essential when considering tree health and safety, is possible using a digital model. Non-destructive techniques, for instance, laser scanning, acoustics, and Ground Penetrating Radar (GPR) have been used in the past to study both the external and internal physical dimensions of objects and structures [1], including trees [2,3]. Recent studies have shown that GPR is effective in mapping the root system's network in street trees [3]. Light Detection and Ranging (LiDAR) technology has also been employed in infrastructure management to generate 3D data and to detect surface displacements with millimeter accuracy [4]. However, scanning such structures using current state-of-the-art technologies can be expensive and time consuming. Further, continual monitoring of tree roots requires multiple visits to tree sites and, oftentimes, repeated excavations of soil.

This work proposes a Virtual Reality (VR) system using smartphone-based LiDAR and GPR data to capture ground surface and subsurface information to monitor the location of tree roots. Both datasets can be visualized in 3D in a VR environment for future assessment. LiDAR technology has recently become available in smartphones (for instance, the Apple iPhone 12+) and can scan a surface, e.g., the base of a tree, and export the data to a 3D modelling and visualization application. Using GPR data, we combined subsurface information on the location of tree roots with the LiDAR scan to provide a holistic digital model of the physical site. The system can provide a relatively low-cost environmental modelling and assessment solution, which will allow researchers and environmental professionals to a) create digital 3D snapshots of a physical site for later assessment, b) track positional data on existing tree roots, and c) inform the decision-making process regarding locations for potential future excavations.

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