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Low-cost scanning of tree trunks for analysis and visualization in augmented reality using smartphone LiDAR and digital twins

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Detecting decay in tree trunks is essential in considering tree health and safety. Continual monitoring of tree trunks is possible using a digital model, which can contain incremental assessment data on tree health. Researchers have previously employed non-destructive techniques, for instance, laser scanning, acoustics, and Ground Penetrating Radar (GPR) to study both the external and internal physical dimensions of objects and structures [1], including tree trunks [2]. Light Detection and Ranging (LiDAR) technology is also continually employed in infrastructure and asset management to generate models and to detect surface displacements with millimeter accuracy [3]. Nevertheless, the scanning of structures using these existing state-of-the-art technologies can be time consuming, technical, and expensive.

This work investigates the design and implementation of a smartphone app for scanning tree trunks to generate a 3D digital model for later visualization and assessment. The app uses LiDAR technology, which has recently become available in smart devices, for instance, the Apple iPhone 12+ and the iPad Pro. With the prevalence of internet-of-things (IoT) sensors, digital twins are being increasingly used in a variety of industries, for example, architecture and manufacturing. A digital twin is a digital representation of an existing physical object or structure. With our app, a digital twin of a tree can be developed and maintained by continually updating data on its dimensions and internal state of decay. Further, we can situate and visualize tree trunks as digital objects in the real world using augmented reality, which is also possible in modern smart devices. We previously investigated tree trunks using GPR [2] to generate tomographic maps, to denote level of decay. We aim to adopt a data integration and fusion approach, using such existing (and incremental GPR data) and an external LiDAR scan to gain a full 3D ‘picture’ of tree trunks.

We intend to validate our app against state-of-the-art techniques, i.e., laser scanning and photogrammetry. With the ability to scan tree trunks within reasonable parameters of accuracy, the app can provide a relatively low-cost environmental modelling and assessment solution for researchers and experts.

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