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| **Immersive Visualisation of Dense Point Cloud Data in Forest Inventory**  |
| **Introduction/Aim:** Forestry management relies on accurate and efficient assessment of tree populations. In this study, we explore innovative approaches to enhance forest inventory using immersive visualisation (Virtual Reality - VR) and machine learning techniques. Our primary aim is to develop operational methods and workflows that empower forest professionals to make informed decisions based on dense point cloud data. **Methods:** Our research introduces a novel **human-in-the-loop framework** that integrates a human-operated VR immersive environment with machine learning-based automated individual tree measurements. This framework empowers operators to assess high-density point cloud tree data effectively. We conducted two user experiments to evaluate the impact of tree visualisation and assess the design of the human-in-the-loop framework. Here’s how the human-in-the-loop framework works:**Immersive VR Environment:** Operators step into a virtual forest, where they can explore and interact with 3D representations of trees. The immersive experience allows them to assess individual trees more intuitively.**Machine Learning for Tree Measurements**: We employ machine learning algorithms to automatically extract critical tree parameters from dense point cloud data such as stem diameter. **Human Assessment**: Operators review the automated measurements and provide feedback. Their expertise ensures accuracy and refines the assessment and system.**Results:** Our research yields several key findings:**Potential of Immersive VR:** The initial usability test demonstrates that immersive visualisation significantly impacts the accuracy of virtual tree assessments. Operators can visualise complex forest structures more effectively, leading to improved inventory outcomes.**Challenges in Framework Design**: The second usability test highlights the need for careful design. Balancing user interaction, machine learning algorithms, and real-world forest conditions poses challenges. We discuss strategies for overcoming these hurdles**Conclusion:** This research sheds light on both the promise and obstacles of introducing a new forest inventory practice—virtual inventory using VR technology and machine learning. By bridging human expertise with cutting-edge machine learning algorithms, we can revolutionise how we assess and manage our forests. |