

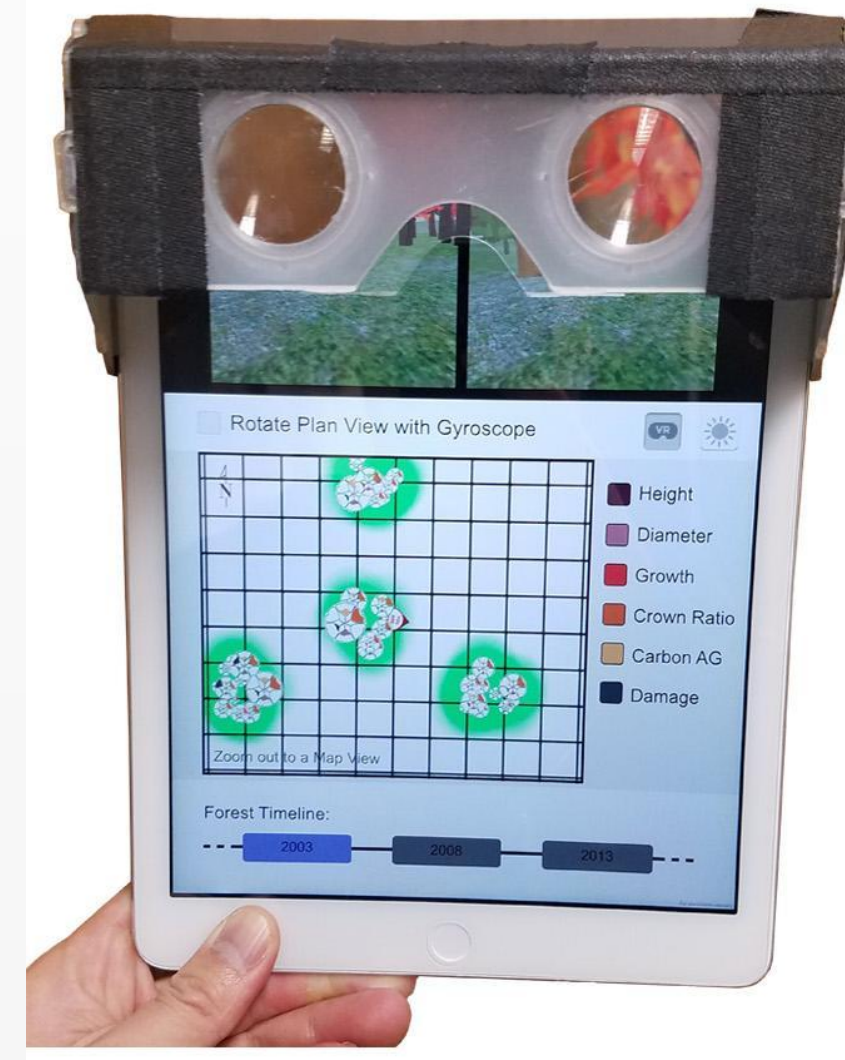
Linked View Visualization Using Clipboard-Style Mobile VR: Application to Communicating Forestry Data

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Introduction

- There are some examples (e.g. [4,5,6]) of multiple complementary linked views in 3D immersive visualization of spatial data, but these systems have required large, custom hardware.
- Recent advances in low-cost VR displays such as Google Cardboard and Samsung's GearVR
- (Goal) exploring these new widely assessable forms of VR for data visualization
- We present the *first* example of a 2D + 3D VR linked view visualization on a mobile device.



Two Viewing and Interaction Modes on a Mobile Device

- Inspired by the iNVerse low-cost viewer developed at USC's MxR lab [3]
- The top third of the device is a stereoscopic display (we fitted an iPad with a pair of low-cost lenses).
- Unlike traditional low-cost VR, e.g. Google Cardboard, the bottom two-thirds can also be used for data visualization and for multi-touch input.

Application to Exploring the Forestry Data [8]:

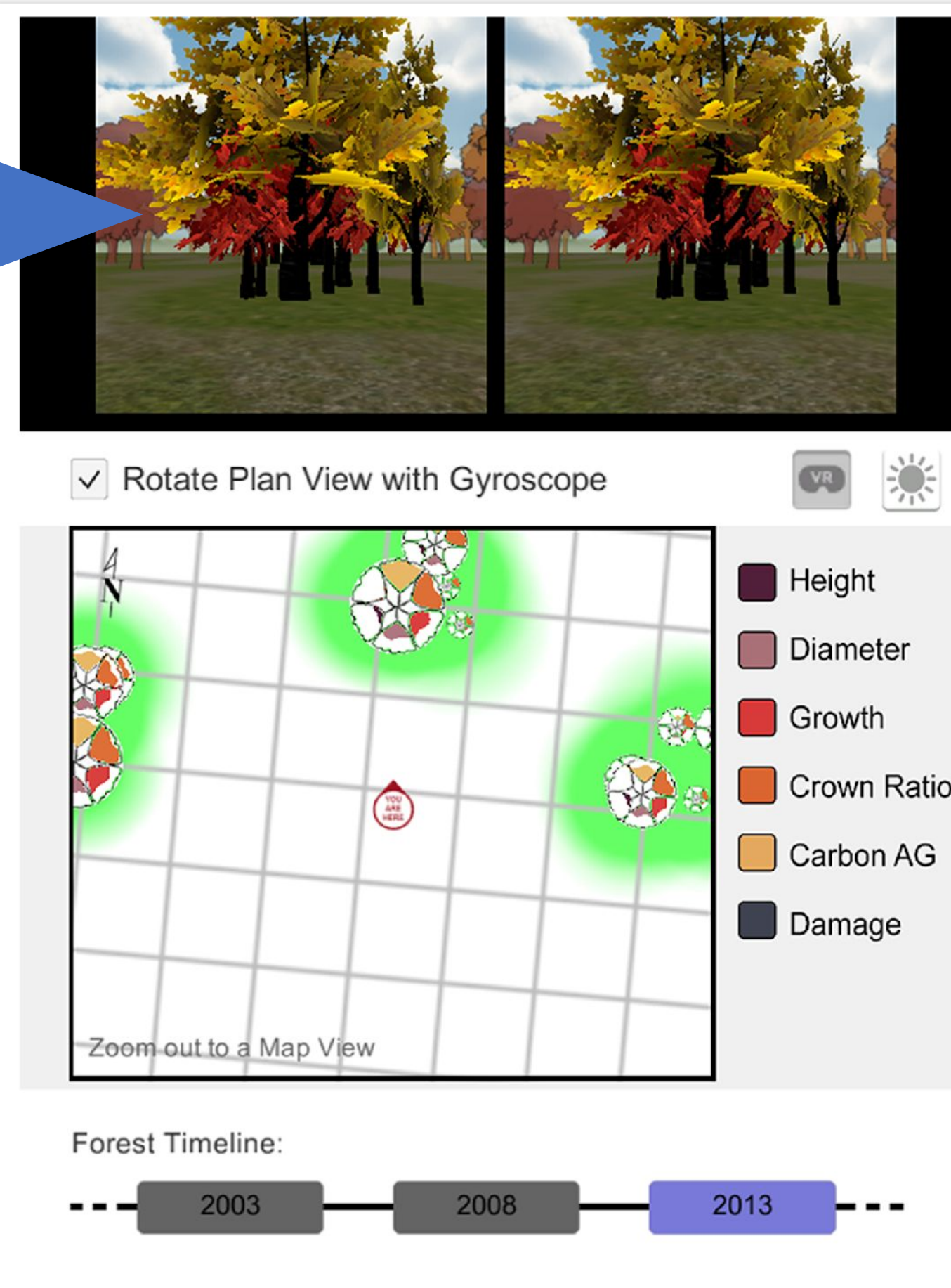
- The prototype visualization includes three forests:
 1. a forest with high basal area
 2. a forest with significant recent growth
 3. a forest with significant changes in tree count over the years.
- Each forest includes measurements for 2003, 2008, and 2013.

Two Coordinated, Complementary Views for Exploring the Forestry Data

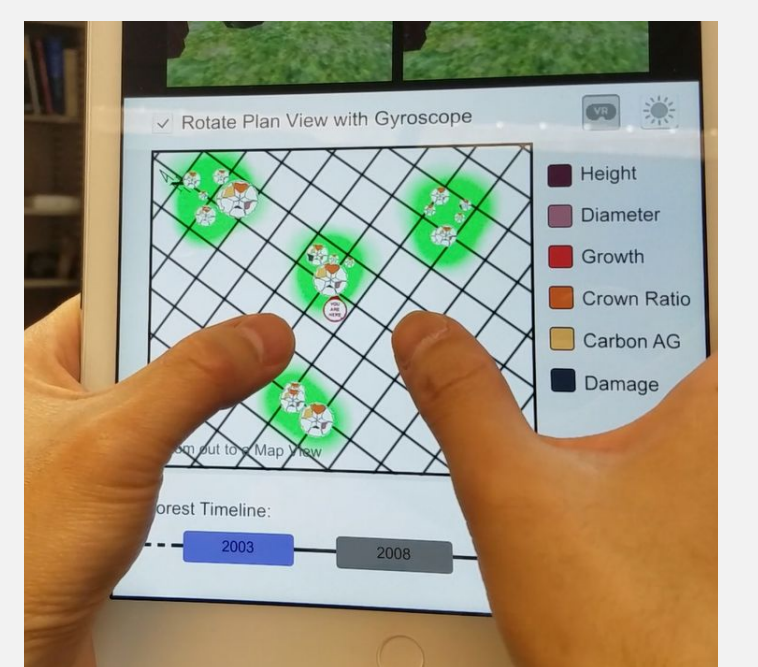
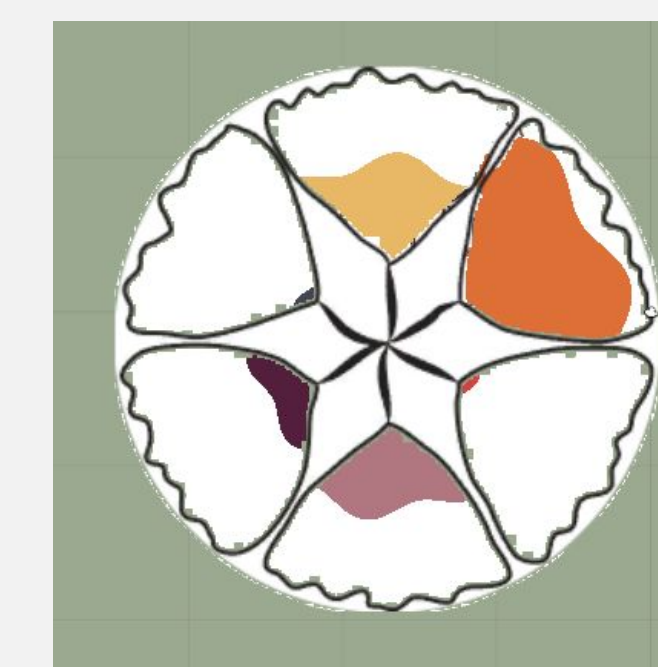
A VR View for Immersive Visualization



- A data-driven 3D forest scene, where the 3D tree models are selected and scaled based upon tree species, height, and trunk diameter variables
- Interaction is done through physical rotation of the device

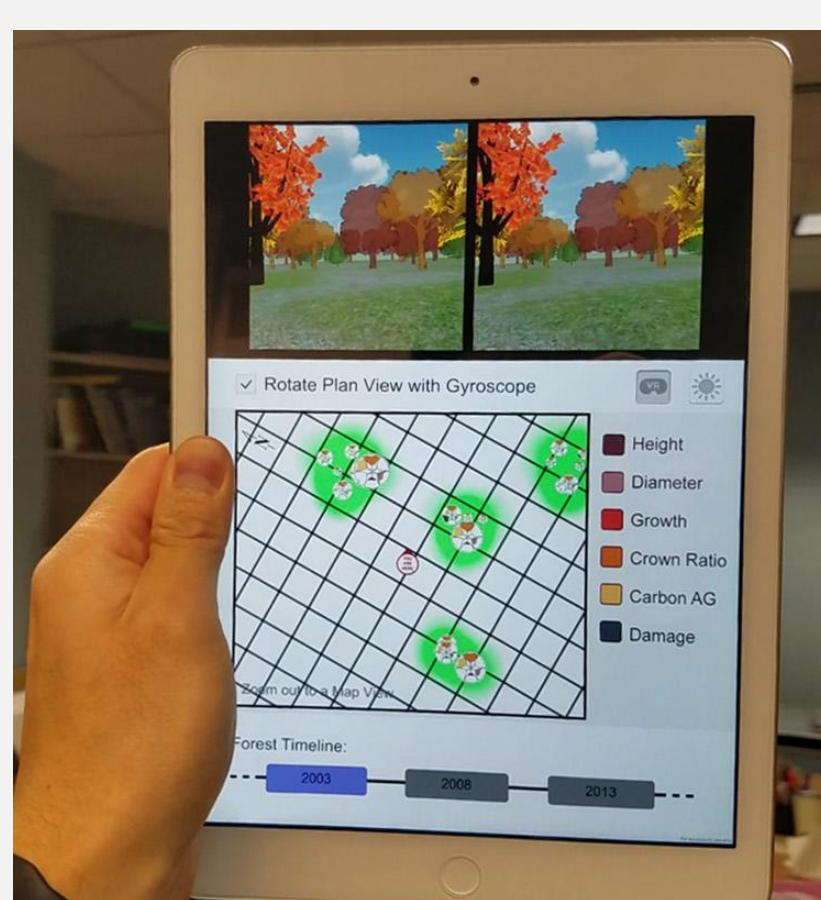


A 2D Multivariate Glyph View

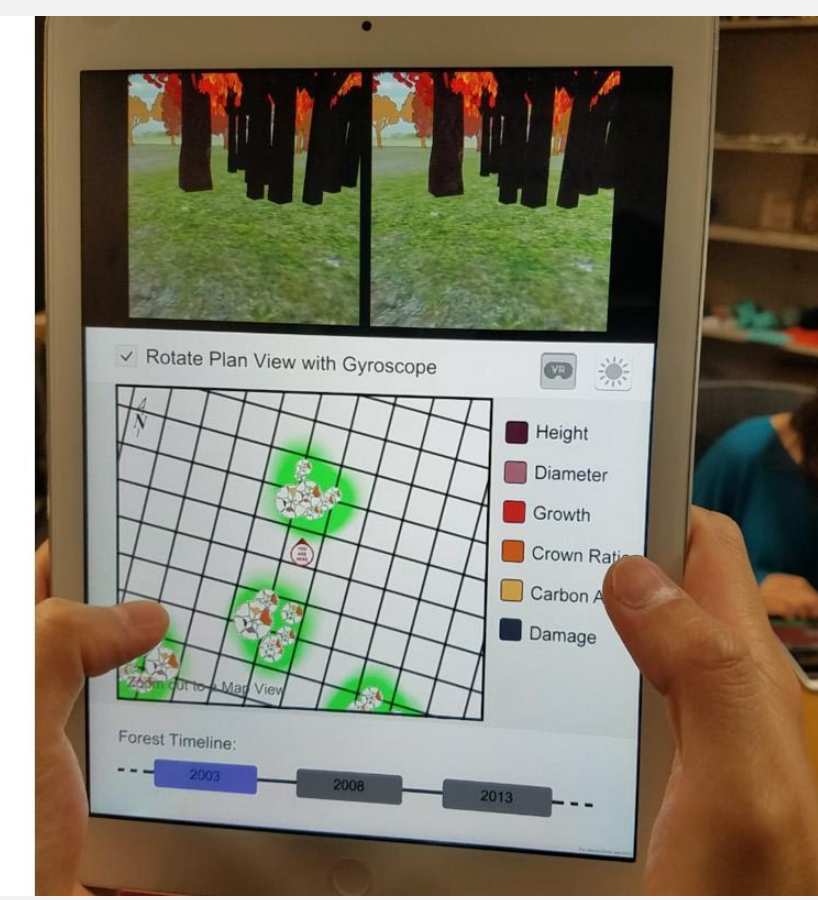
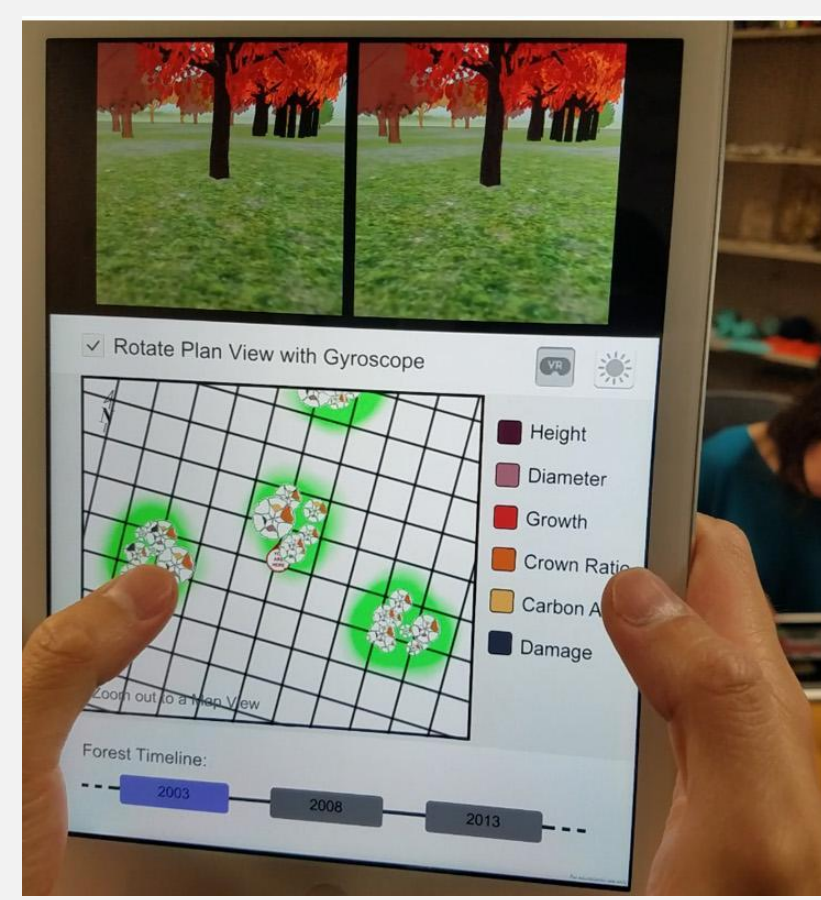


- A glyph-based multivariate visualization, like a map of each tree in the plot.
- The icon for each tree is a glyph that encodes 6 data variables for each tree.
- The map in this view can be translated and zoomed via multi-touch input.

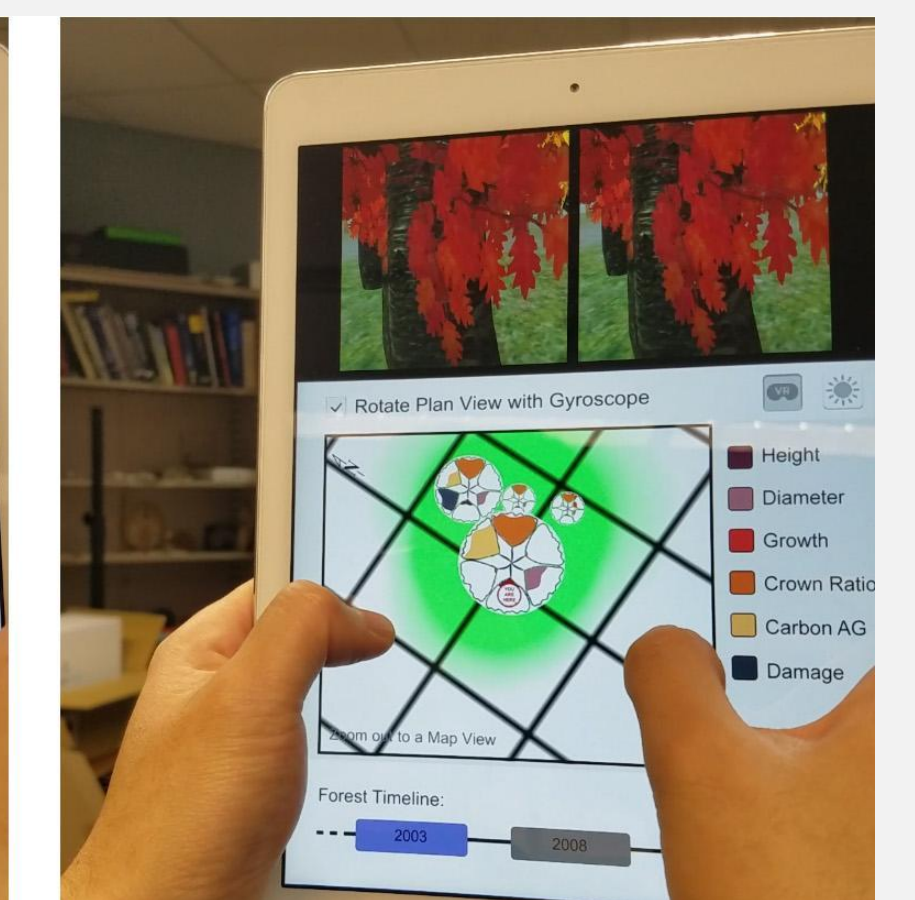
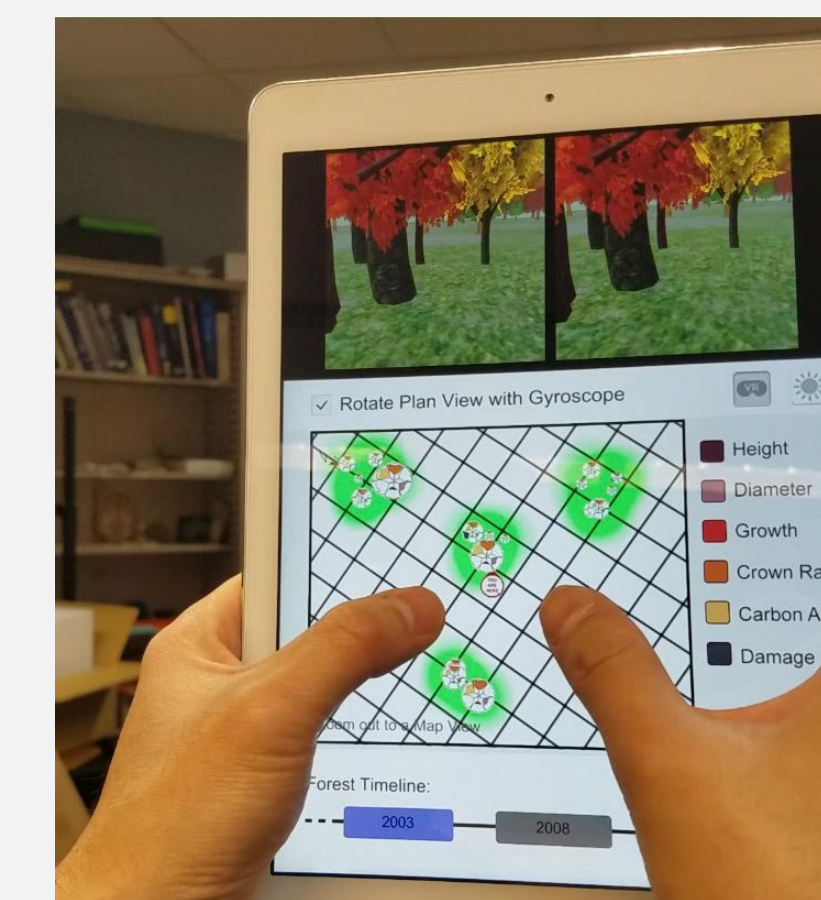
Linked View Interaction for Exploring the Forestry Data



As the 3D view is rotated, the linked 2D view rotates correspondingly.



Multi-touch input in the 2D view updates the linked 3D view so interaction with the map serves as a VR navigation technique.



Multi-touch input also facilitates zooming in for details.

Outlook

More engaging modes of presenting data to the public:

- Use in settings, such as in K-12 classrooms to lead students in virtual field trips to the forests to discuss change over time.

Different visualization scenarios:

- Brain visualization on a stereoscopic 3D display with a complementary slice-based data vis
- Immersive analytics with 2D interactive parallel coordinates and related plots

Nuances for the Forestry Data Visualization:

- The sampling pattern used by the scientists results in quite a bit of blank space in the scene. To address this, we randomly placed billboard trees in the style of architectural models to indicate uncertainty in the data in these sparse regions.
- Touching the timeline at the bottom changes the year of data displayed.

Forest Inventory and Analysis dataset [8]

- Collected by the US Forest Service.
- Contains more than 200,595,807 across 629,644 sampling plots systematically located across the U.S.
- Each plot is sampled via in-the-field measurements every five years.
- The measurements are made for every tree that falls within the bounds of 4 circular subplots.



Scan this QR code with your smartphone to view this paper.

<http://ivlab.cs.umn.edu/generated/pub-Nam-2019-ClipboardForestry.php>

[1] Gear VR. <https://www.oculus.com/gear-vr/>.

[2] Google Cardboard. <https://vr.google.com/cardboard/>.

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Acknowledgments

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