Augmented Reality Graph Visualizations
Investigation of Visual Styles in Three-Dimensional Node-Link Diagrams

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Visualization of Relations

Node-Link Diagrams of (abstract) graph data
Visualization of (physical) network data
Connections between (virtual and physical) artifacts in situated visualizations

[Büschel et al., MobileVis Workshop 2018]
[Prouzeau et al., ISS 2019]
Research Contributions

Investigation of AR Graph Visualization

Here: Focus on Edge Visualization

1. Exploration of the design space for visual edge styles
2. User study comparing six edge variants
Related Work

Mixed Reality & 3D Node-Link Diagrams

Visualizing Graphs in 3D
[Ware & Mitchell, TAP 2008]

AR Graphs
[Belcher et al., ISMAR 2003]

Collaborative Network Analysis
[Cordeil et al., TVCG 2016]

Edge Visualizations of Node-Link Diagrams

Directed-edge Representations
[Holten et al., Pacific Vis 2011]

Animated Edge Textures
[Romat et al., CHI 2018, Romat et al., Interact 2019]

Link Attributes in AR Graphs
[Büschel et al., MobileVis Workshop 2018]
Studying Edge Variants for 3D Graphs

Effects of Augmented Reality
› Perspective
› Occlusion
› Visual clutter
› Color reproduction & transparency

As a Starting Point
› Focus on basic visual encodings for undirected & directed edges
› Simple graph analysis tasks on connectivity/pathfinding
› Which edge variants are most suitable for these tasks?
Study Design – Overview

Controlled lab study in two parts (undirected and directed edges)
Within-subject designs, 18 participants, 9 male, 9 female, avg. age 30

IV: edge style (3) x task complexity (2)
Task complexity: number of nodes (18 or 36) & path length (1 or 2)

Logging of task completion times, error rates & position data
Questionnaires on suitability & aesthetics
Study Tasks

Series of graphs presented to the participant

Decide, if a path fulfilling task-dependent criteria exists between two highlighted nodes

Task 1: Undirected Edges

› Is there a path of length 2 between the two nodes?

› Two levels of complexity: 18 nodes vs. 36 nodes

Task 2: Directed Edges

› Is there a directed path from start to end node?

› Two levels of complexity: path length 1 or 2
Selected Edge Styles
Selected Edge Styles

- Undirected Edges
- Directed Edges
Selected Edge Styles
Selected Edge Styles
Selected Edge Styles
Selected Edge Styles
Results – Undirected Edges

**Task Completion Times**
- Straight and dashed edges faster
- Smaller graphs faster

**User Ratings**
- Straight edges highest suitability
- Aesthetics rated higher for straight and curved edges
Results – Directed Edges

Task Completion Times

› Animated and tapered edges faster
› Shorter paths faster

User Ratings

› No significant differences between techniques
Conclusion

Graph visualization in Augmented Reality is important
Many aspects so far under-explored
Our investigations of edge styles serves as a starting point
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▷ imld.de/ar-graph-vis
Project website with article and slides download

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References


