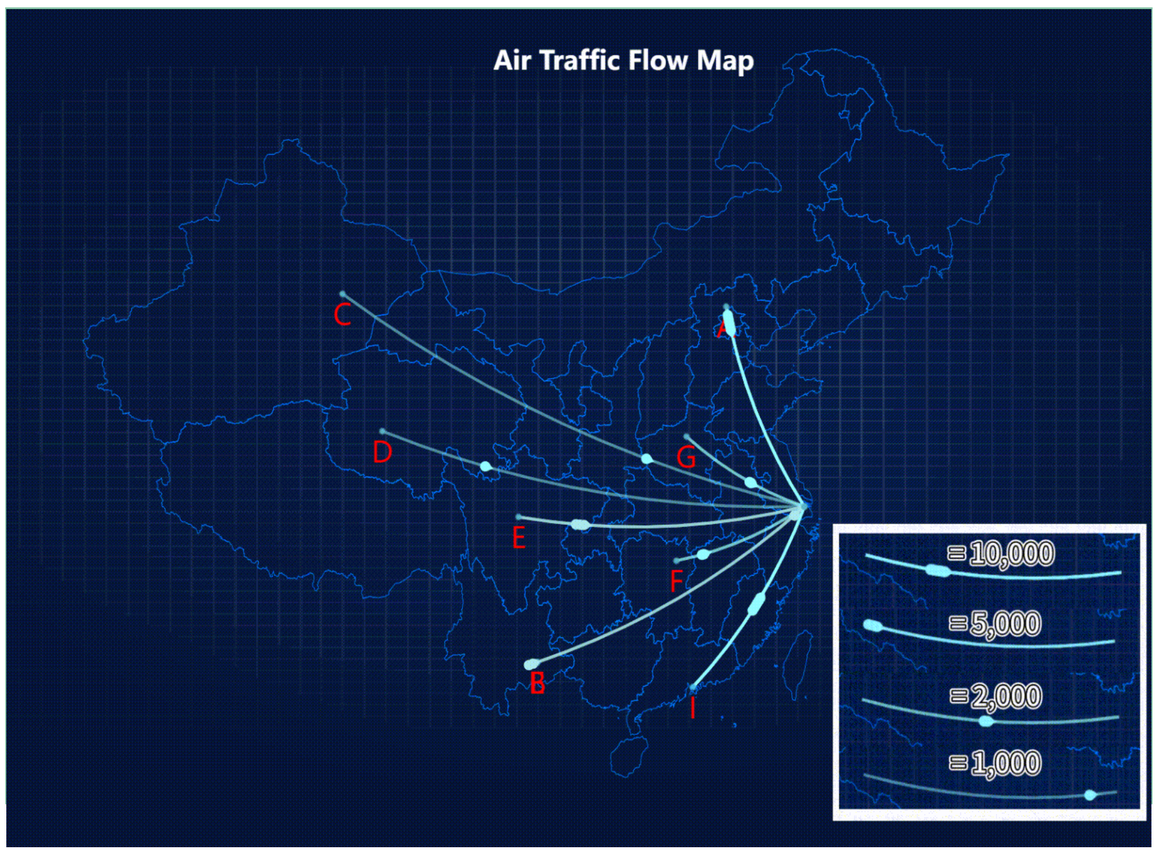
Evaluating techniques and design gaps between static and animated flow maps

by **Zhiheng Jiao**

In a world driven by dynamic spatial information, traditional static maps might fall short in conveying the continuous movements shaping our environment [1] [2]. Animated flow maps offer a alternative solution, allowing us to capture and visualize these dynamic changes in real-time more efficiently [3]. However, the design principles for animated flow maps remain uncharted territory, with limited studies available.

This thesis aims to bridge the gap in animated map design principles by comparing them to static maps and investigating the impact of visual attributes on users' understanding of volumetric data. By exploring existing techniques and design patterns, this research seeks to fill this gap while also laying the groundwork for future advancements in enhancing map users' comprehension of spatial dynamics.



An Animated Air Traffic Flow Map of China in 2022 (used in user study)

OBJECTIVES

The general research objective (RO) is to evaluate techniques for creating animated flow maps and explore differences in design principles between animated and static flow maps.

The study aims to summarize various approaches and techniques for making animated flow maps, highlighting their strengths and areas where they can be used. Additionally, it seeks to identify specific guidelines unique to animated flow maps, as well as those that can be adapted from static flow maps.

METHODOLOGY

The primary method comprises two parts: 1) The research begins by defining dynamic visual variables for animated flow maps, distinct from static visual variables, and explores the techniques employed in generating animated flow maps. 2) Subsequently, the research delves into the evaluation process through a user study, involving the collection of information from participants to assess the effectiveness and usability of the animated flow maps with the dynamic visual variables defined earlier. Finally, it aims to address the research goal concerning techniques for creating animated flow maps and design gaps.

RESULTS

The development of creating animated flow maps has significantly improved thanks to advancements in computer science technology, including Animation Software, GIS software, and Programming and Data Visualization Libraries. The results highlight their applicability to various types of animated flow maps. Notably, while these methods can be used individually, combining them synergistically often yields the most powerful results. For example, one study merged After Effects, ArcGIS, and the D3 library, resulting in a sophisticated and insightful animated flow map [4].

Adapting existing static map design principles, which have developed over time, is crucial. However, this research has revealed that certain design principles may not hold the same significance when applied to animated flow maps. It identifies the principles, such as simplicity, flow line priority, visual balance, and other design considerations, that may require modification to create effective animated flow maps. Additionally, innovative approaches, like the integration of static and dynamic visual variables, have been suggested to enhance comprehension [5].

Furthermore, a user study was conducted to evaluate dynamic visual variables for representing flow volume on animated flow maps. The study revealed that 'tail length,' representing 'duration,' emerged as the preferred dynamic visual variable for conveying quantitative information. This finding aligns with existing literature [6], which emphasizes the efficiency of 'duration' variables.

CONCLUSION

This thesis delves into adapting design principles from static to animated flow maps, uncovering challenges and areas ripe for further exploration. It highlights the need for nuanced investigations into elements like legends in animated maps. While certain principles, such as distinguishing branching and trunk flows and handling overlapping flows, persist, the shift to animated formats introduces complexities. The user study offers insights into visual variable exploration and the efficiency and user experience evaluation. Future research should aim for broader demographic inclusivity and focus more on visual variable combination.

THESIS CONDUCTED AT

Chair of cartography Department of Aerospace and Geodesy Technische Universität München

Technische Universität München

THESIS ASSESSMENT BOARD

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YEAR

2023

KEYWORDS

Flow maps, Dynamic visual variables, animated visualization, Design principles

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This master thesis was created within the Cartography M.Sc. programme – proudly co-funded by the Erasmus+ Programme of the European Union.

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