# Informatics

## Immersive Analytics of Multidimensional Volumetric Data

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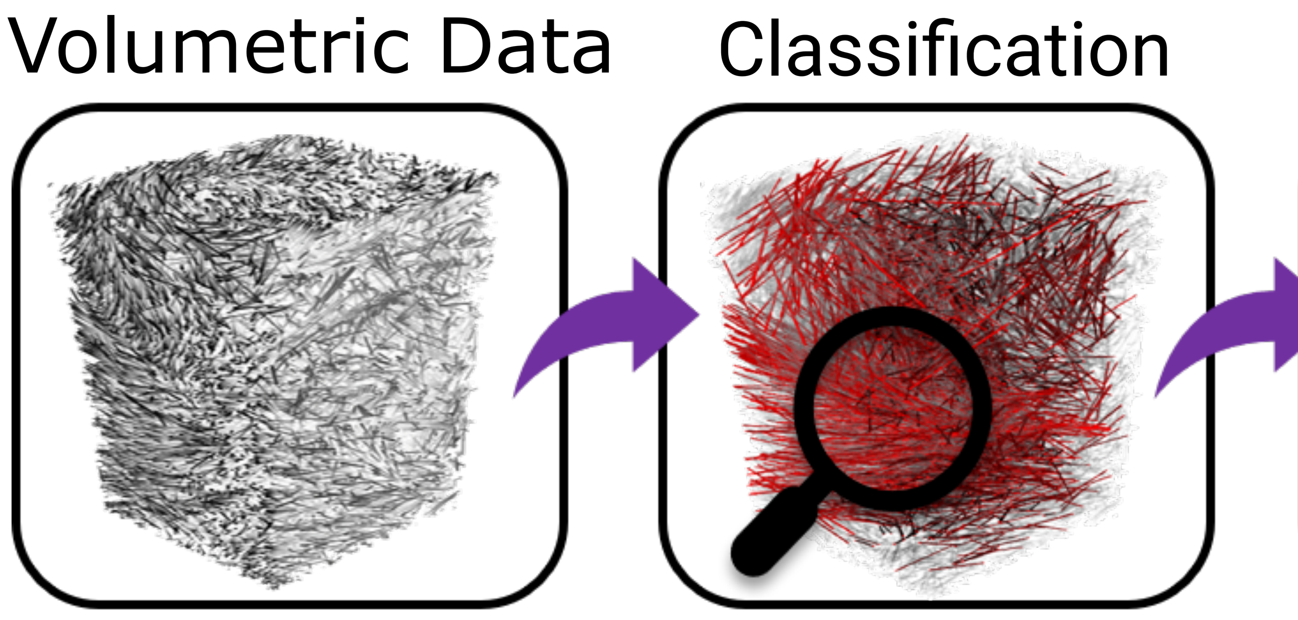
## Motivation

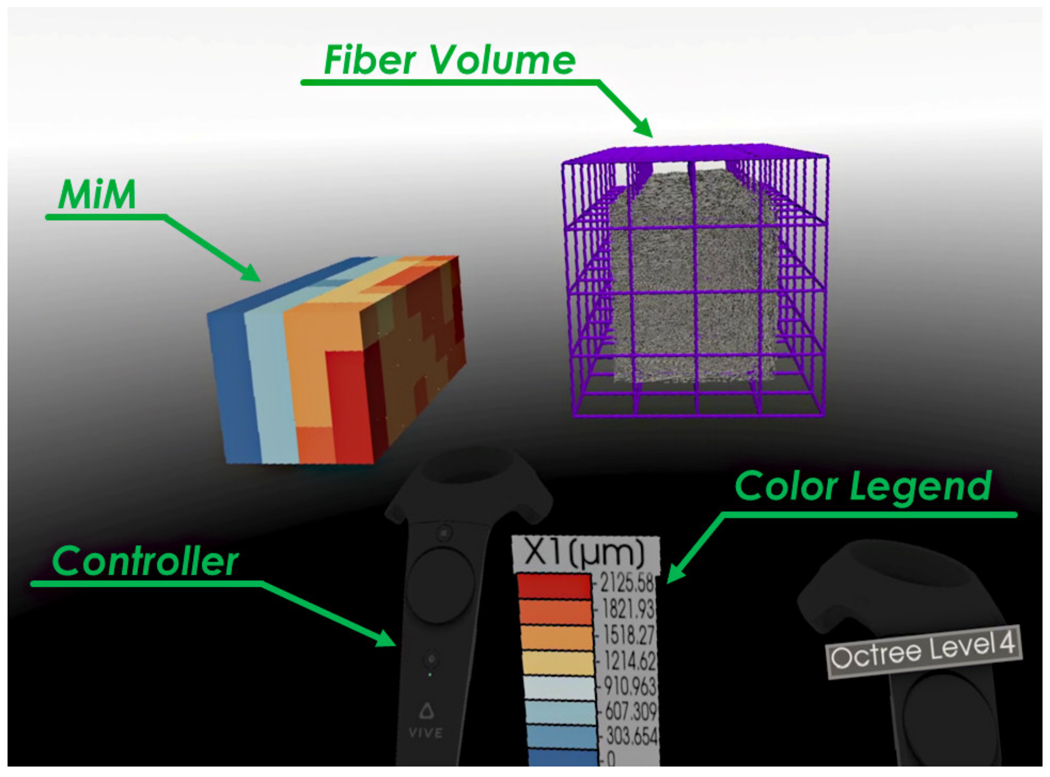



Multidimensional Data

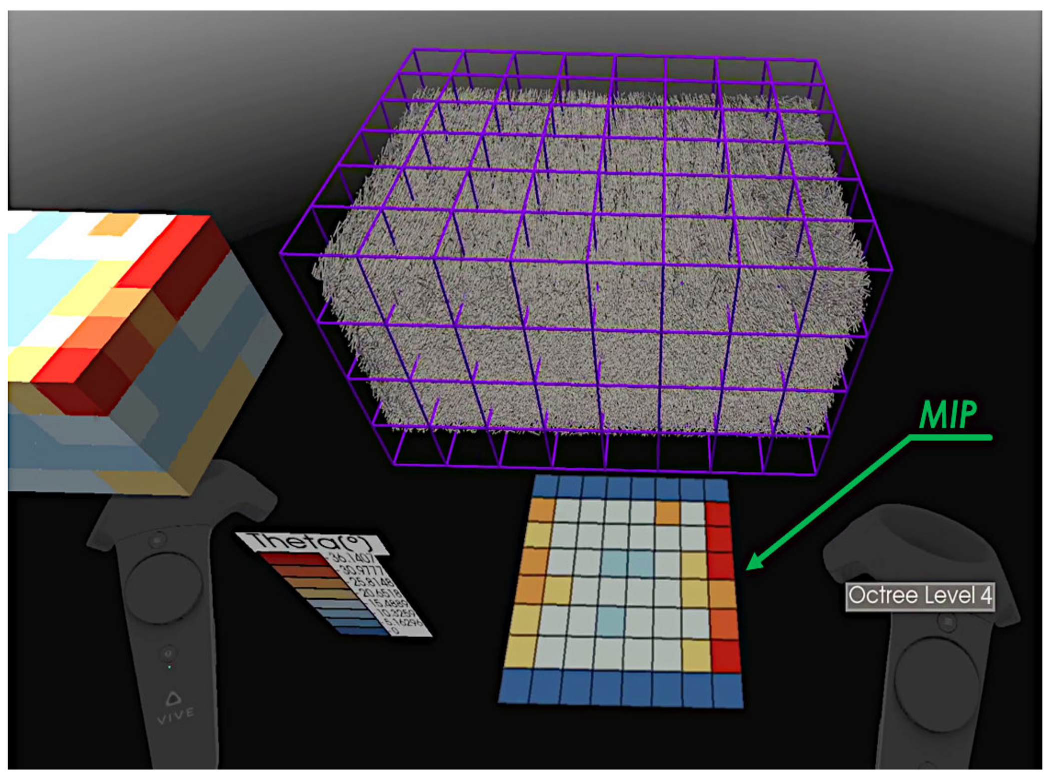
| Object | (x, y, z) | Feature 1 | Feature 2 | Feature 3 | ... |
|---|---|---|---|---|---|
| 1 | (9, 10 ,1) | 40 | 4.10 | 700 | ... |
| 2 | (1, 20 ,8) | 50 | 8.20 | 550 | ... |
| 3 | (31, 15 ,2) | 35 | 16.05 | 610 | ... |
| 4 | (17, 8 ,20) | 55 | 6.7 | 386 | ... |
| 5 | (4, 11 ,12) | 39 | 2.2 | 477 | ... |
| ... | ... | ... | ... | ... | ... |

Understanding and interpreting volumetric multidimensional data is a complex and cognitively demanding task. Non-destructive testing (NDT) plays an essential role in industrial production, regarding the analysis, visualization, and optimization of new, highly complex material systems such as fiber composites. The high-dimensional data spaces, which are increasingly becoming the basis of data analysis can often only be evaluated in a limited form or not at all using 2D standard visualization techniques on desktop monitors. Therefore, novel immersive visualization and interaction techniques using Virtual Reality (VR) were developed in this thesis. We make use of the latest findings from the field of Immersive Analytics to render spatial data in a more comprehensible, i.e., immersive way, and tested the results in a qualitative study with domain experts.

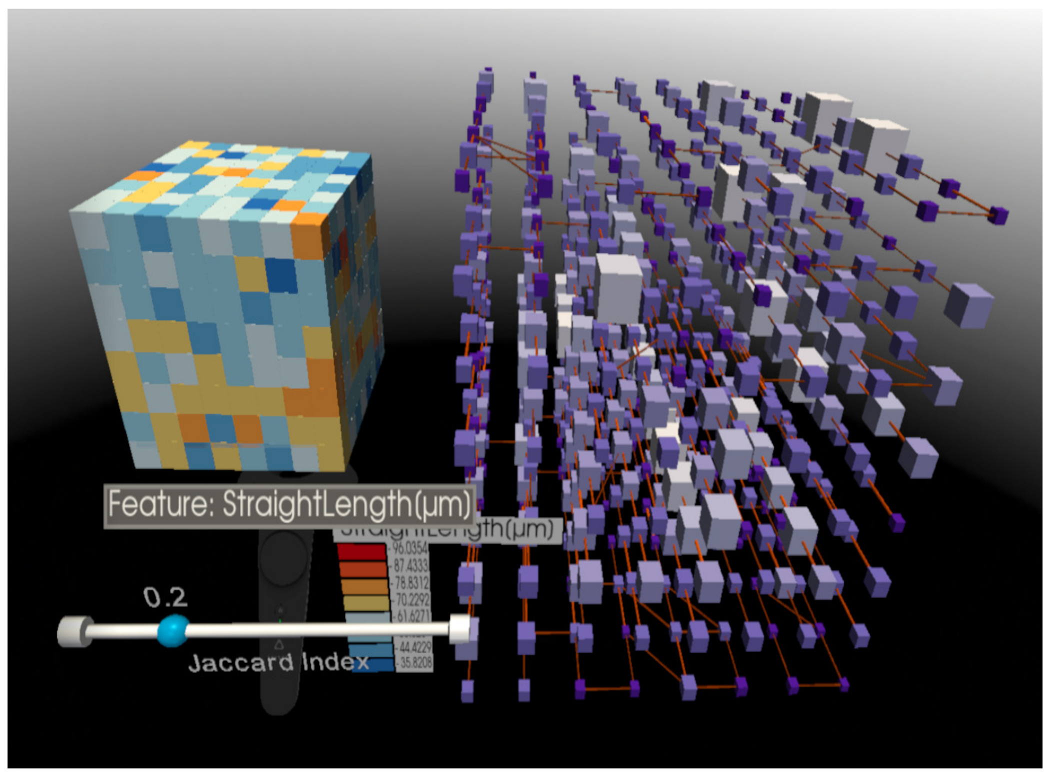
## Immersive Workspace & Model in Miniature



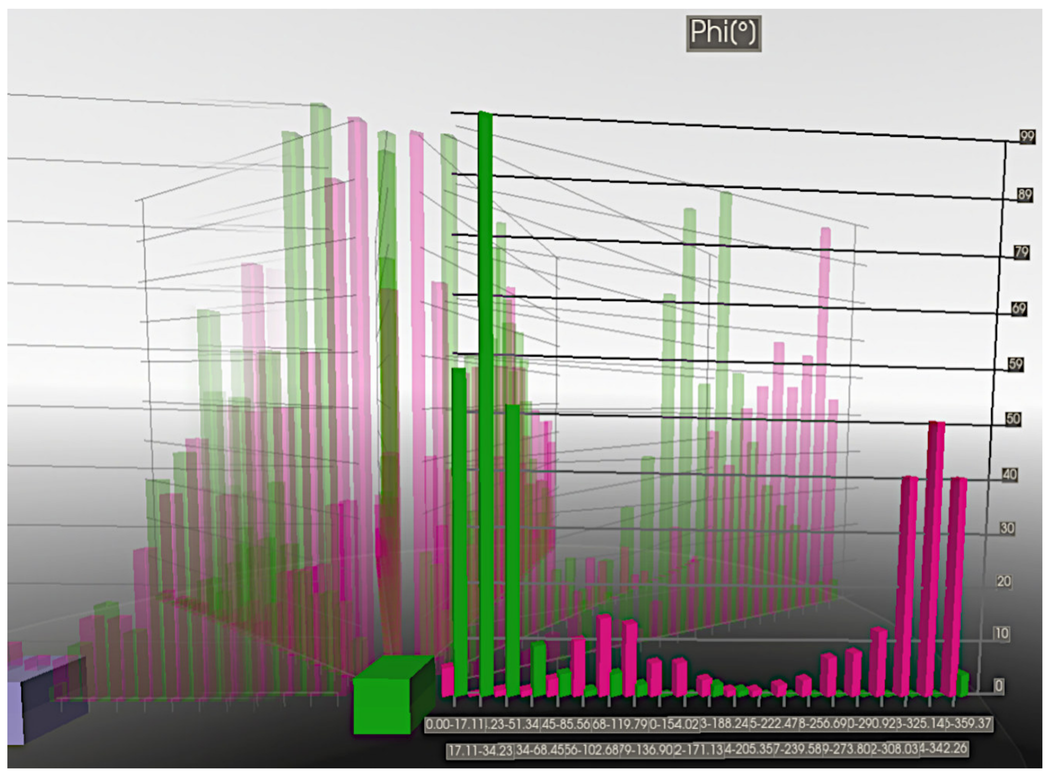

**Core Features/Benefits:**
- Embodied interaction and navigation
- Abitrary view angles possible, which enable the user previously impossible insights
- Fiber volume is subdivided by a octree structure
- Abstract interaction and visualization technique called Model in Miniature (MiM) to guide and facilitate the exploration
- MiM is a miniaturized abstract copy of the volume and used for selection, filtering, as well as 3D Heatmap
- View dependent Maximum Intensity Projection (MIP) gives quick Overview of 3D Heatmap



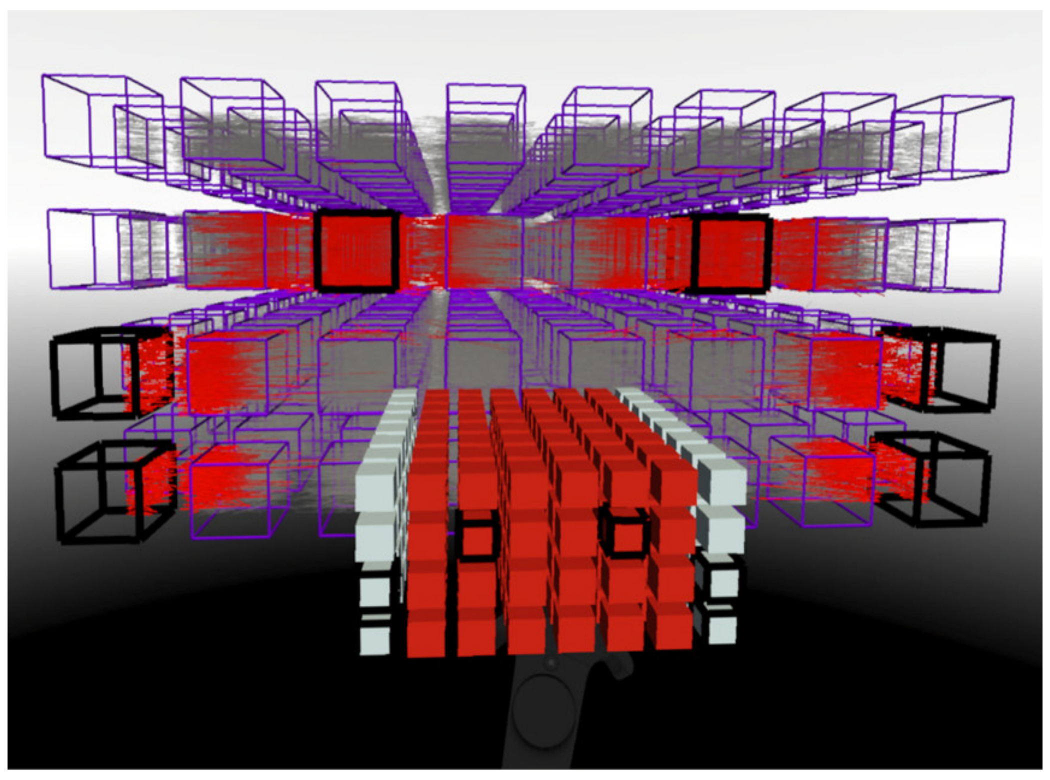

## Node-Link Diagram & 3D Histogram




**Core Features/Benefits:**
- Overview of the volume structure
- Nodes represent fiber density in regions
- Links display relationship between regions
- Similarity relationship filtered by Jaccard index
- 3D histogram to investigate the distribution of the fiber characteristics and verify hypotheses
- Comparision of two regions based on the numerical values of the fibers
- Book metapher of histograms enables a natural interaction for the user through page-turning gesture and view dependent highlighting




## Results & Future Work



We conducted a qualitative user study with 7 participants (4F, 3M) to evaluate whether the framework supports domain experts and novices in the exploration of fiber composites. We performed a semi-structured interview, as well as Likert scale evaluated questionnaire in order to investigate the effectiveness of the chosen visualization techniques with domain experts.

Future work could consider using curved fibers, pores, or apply our techniques to other areas or research such as the analysis of blood vessels or tumors from the medicine domain.