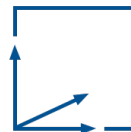# Design and Implementation of a System for Visualizing Common 2D and 3D Geospatial Data in a Real-Time 3D Engine

Paul Pernsteiner

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Final: Bachelor Informatics: Games Engineering

Supervisor: Prof. Gudrun Klinker, Ph.D.

Advisor: Sven Liedtke, M.Sc.

Introduction

- Effective GIS use during COVID-19

- Increasing demand for 3D geodata visualizations

- High interest in collaborative applications

- TallShipEngine project with similar goal

Related Work

- "Real-time collaborative GIS: A technological review" (Y. Sun and S. Li, 2016)

- "GDAL/OGR Geospatial Data Abstraction software Library" (GDAL/OGR contributors)

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3

Goals of this Thesis

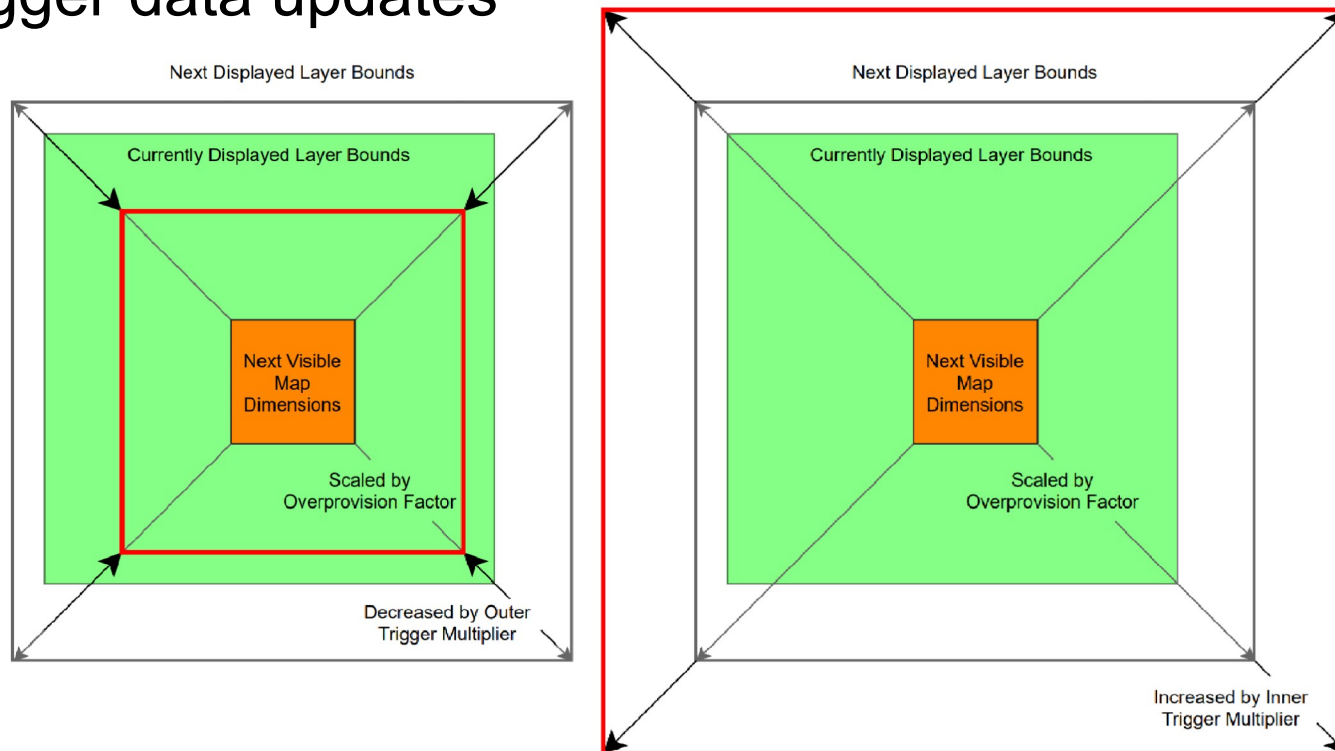Extendable system for displaying geodata in TSE

- Common 2D and 3D data formats

- Loading data at runtime

- Supporting different Spatial Reference Systems

- Low performance impact => AR, VR and mobile

Critical Research Issues

- Implementing GIS-typical layer structure

  - Multithreaded layer access

  - Supporting real-time map navigation

- Loading geodata into TSE renderable objects

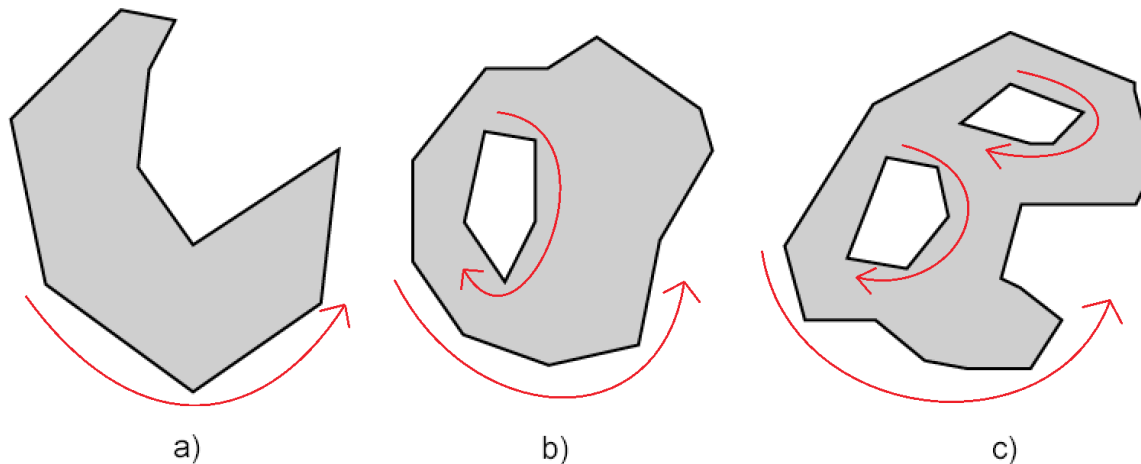 - Runtime engine object creation

  - GDAL data conversion

Approach (Layer Updates)

- Separation of Engine, <u>Scheduler</u> and Worker threads
- Load larger area than visible
- Trigger data updates
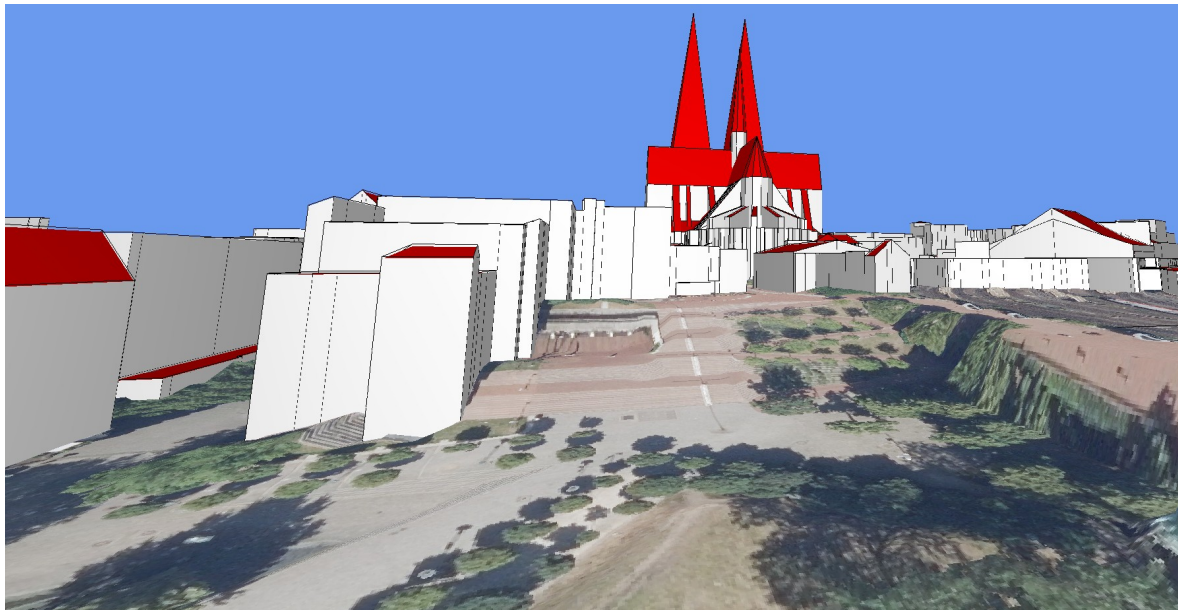
Approach (3D Mesh Creation)

- Known vertex indexing order

- Calculate surface normal direction

- Project onto 2D plane

- Open source ear clipping triangulation algorithm

From OpenGIS Implementation Specification – Simple Feature Access. https://www.ogc.org/standards/sfa

Approach (Map Object Shader)

- Restrict object drawing to displayed boundaries

- Elevate selected layers based on Digital Elevation Map

Cologne Cathedral
Level Of Detail 2 buildings (Geodatendienste NRW) & Digital Orthographic Photo & Digital Elevation Map (Open Geodata NRW)
(https://www.bezreg-koeln.nrw.de/brk_internet/geobasis/webdienste/geodatendienste/index.html) & (https://www.opengeodata.nrw.de/)

Demo

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9

Suggested Future Work

- Revisit after upcoming 3D geodata specification update

- Layer interaction using raycasting

- Test GDAL support on different platforms

- Network map state synchronization

- Specific use-case interactive demo
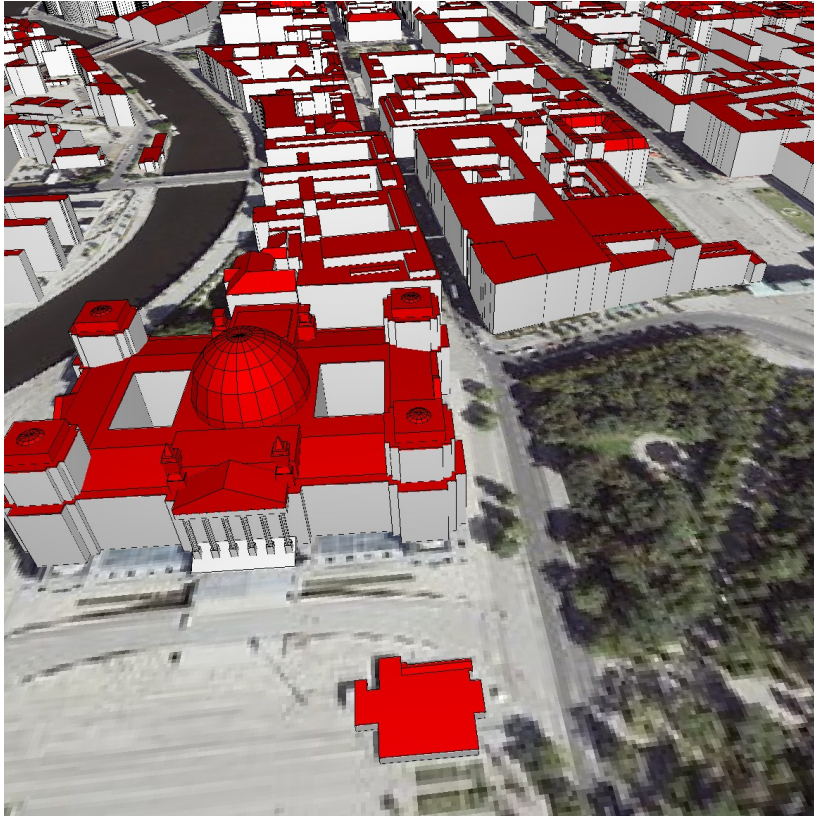
Conclusion

- Base geodata formats implemented

- Visualization of previously prepared scene

- Real-time navigation of visible map area

- In-depth understanding of geodata is helpful

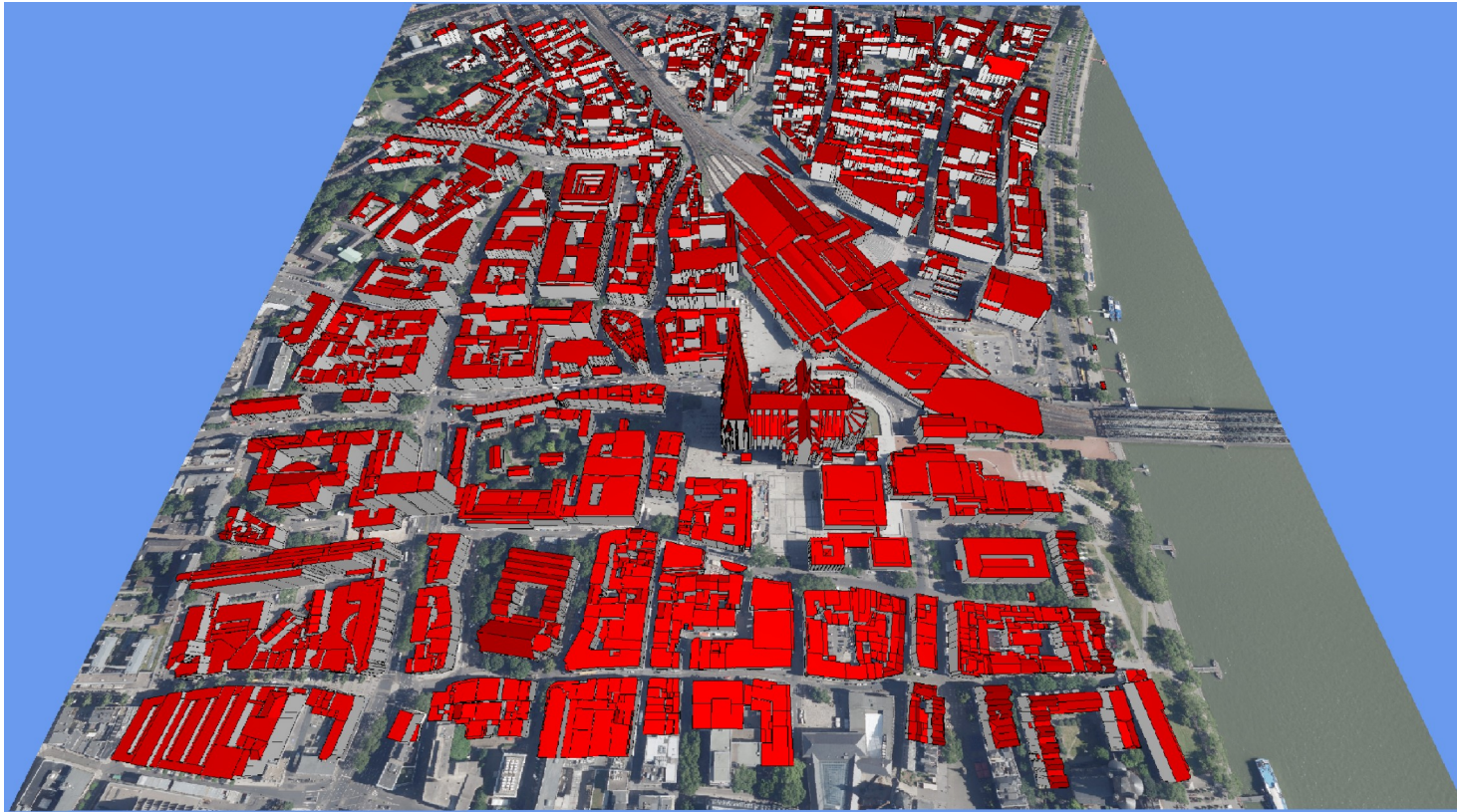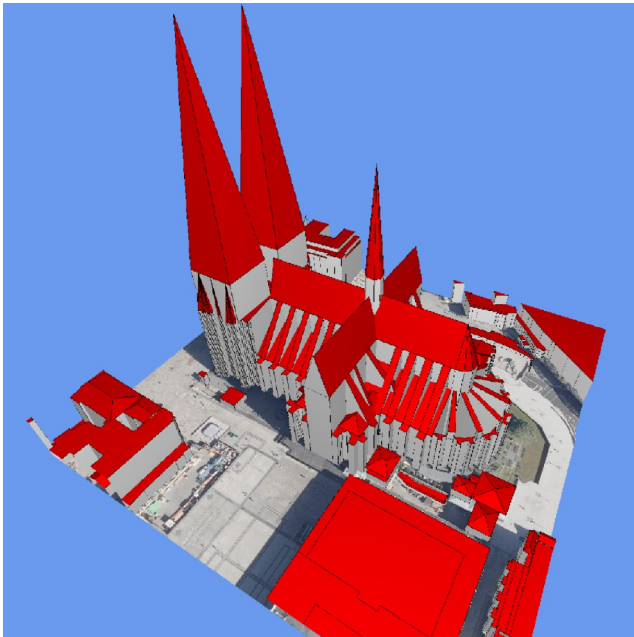- Focus on available data advised

Questions?

Thank you

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12

Demo (Screenshots 1/4)

Level Of Detail 2 buildings (Berlin Business Location Center) & Digital Orthographic Photo (Geoportal Berlin)
(https://www.businesslocationcenter.de/downloadportal/) & (https://www.stadtentwicklung.berlin.de/geoinformation/)
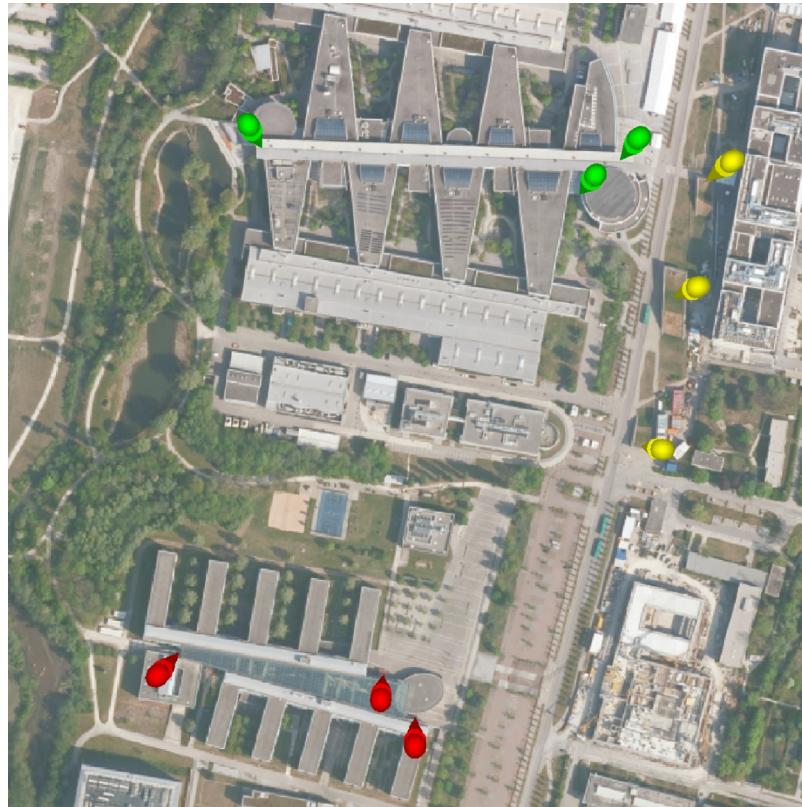
Demo (Screenshots 2/4)

Level Of Detail 2 buildings (Geodatendienste NRW) & Digital Orthographic Photo & Digital Elevation Map (Open Geodata NRW)
(https://www.bezreg-koeln.nrw.de/brk_internet/geobasis/webdienste/geodatendienste/index.html) & (https://www.opengeodata.nrw.de/)

Demo (Screenshots 3/4)

Level Of Detail 2 buildings (Geodatendienste NRW) & Digital Orthographic Photo & Digital Elevation Map (Open Geodata NRW)
(https://www.bezreg-koeln.nrw.de/brk_internet/geobasis/webdienste/geodatendienste/index.html) & (https://www.opengeodata.nrw.de/)

Demo (Screenshots 4/4)

Digital Orthographic Photo (Geoportal Bayern) & manually created Points of Interest
(https://geoportal.bayern.de/)