



Project Management and Software Development
for Medical Applications - WS 15

Visualizing the Volumetric Accuracy of Medical Tracking Solutions

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Final Presentation

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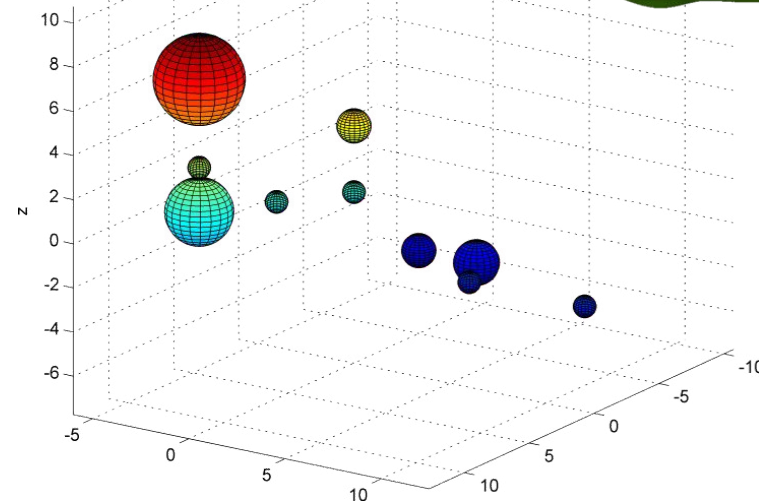
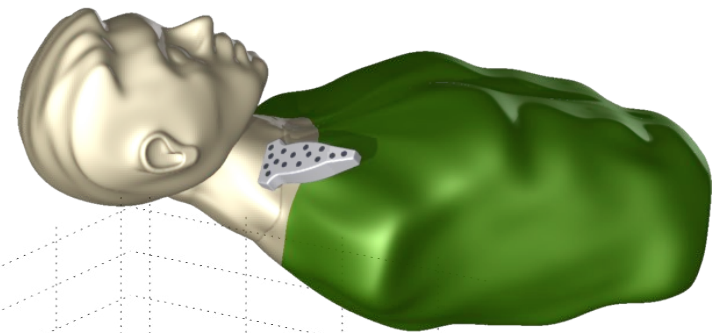
Outline

- Project Outline
 - Motivation & Problem Statement
 - Requirements & Specifications
 - Scoping & Planning
- Software Design
 - Software Architecture & Design Patterns
- Project Results
 - Demo
- Project Outlook
- Project Retrospective



Project Outline

- Motivation
 - Position and orientation information in real-time
 - Different systems
 - Spatial accuracy often unknown
- Problem Statement
 - Visualizing the volumetric accuracy
 - Interactive GUI



* Figures of US probe and tracking setup kindly provided by FRAMOS GmbH



Project Outline

- Requirements & Specifications
 - Different visualizations
 - Show live tracking error and poses (FRAMOS Optical Tracking System^[1])
 - Additional reference points or medical devices
 - Camera calibration^[2]
 - GUI
 - Interactive, real-time
 - Input
 - Pose & accuracy via TCP / IP
 - Output
 - Rendering
 - Environment
 - Windows, Visual Studio, C++, OpenGL, OpenIGTLink, GitLab, OpenCV

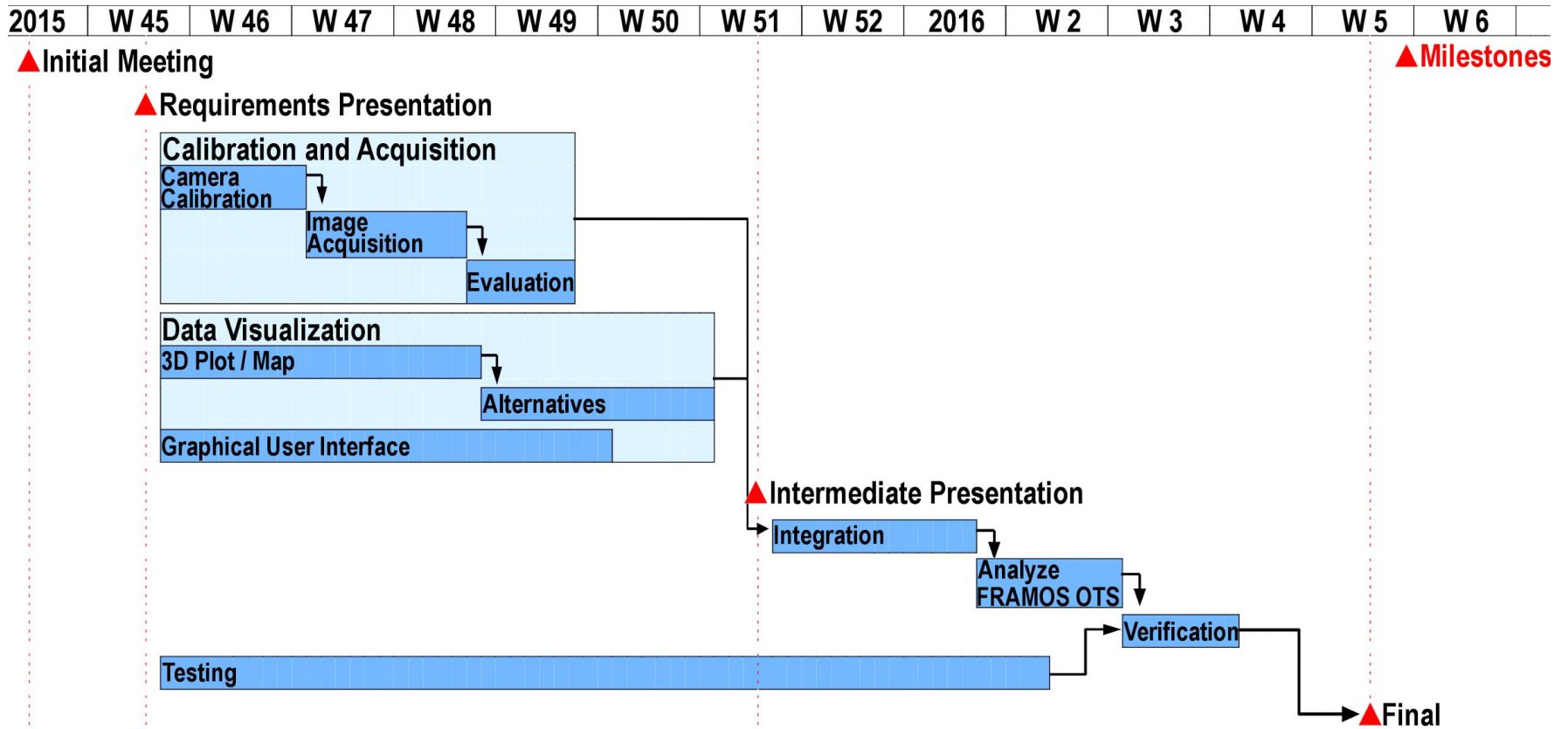


[1] FRAMOS OTS, https://www.amos.com/fileadmin/media/pdf/news/2015/FRAMOS_OTS/amos-ots_flyer_engl.pdf (November 1, 2015)

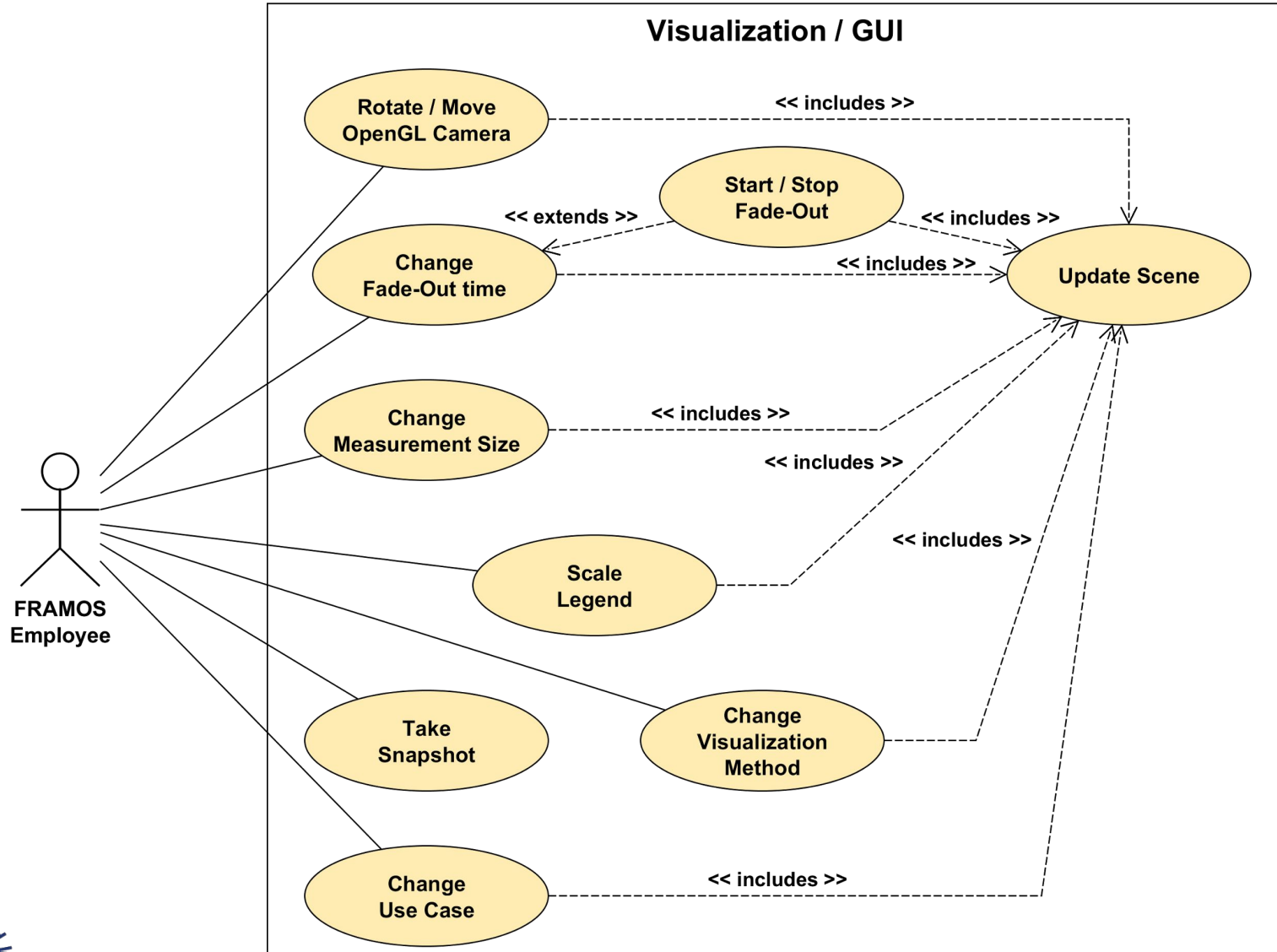
[2] Zhang, Zhengyou. "A flexible new technique for camera calibration." *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 22.11 (2000): 1330-1334.

Project Outline

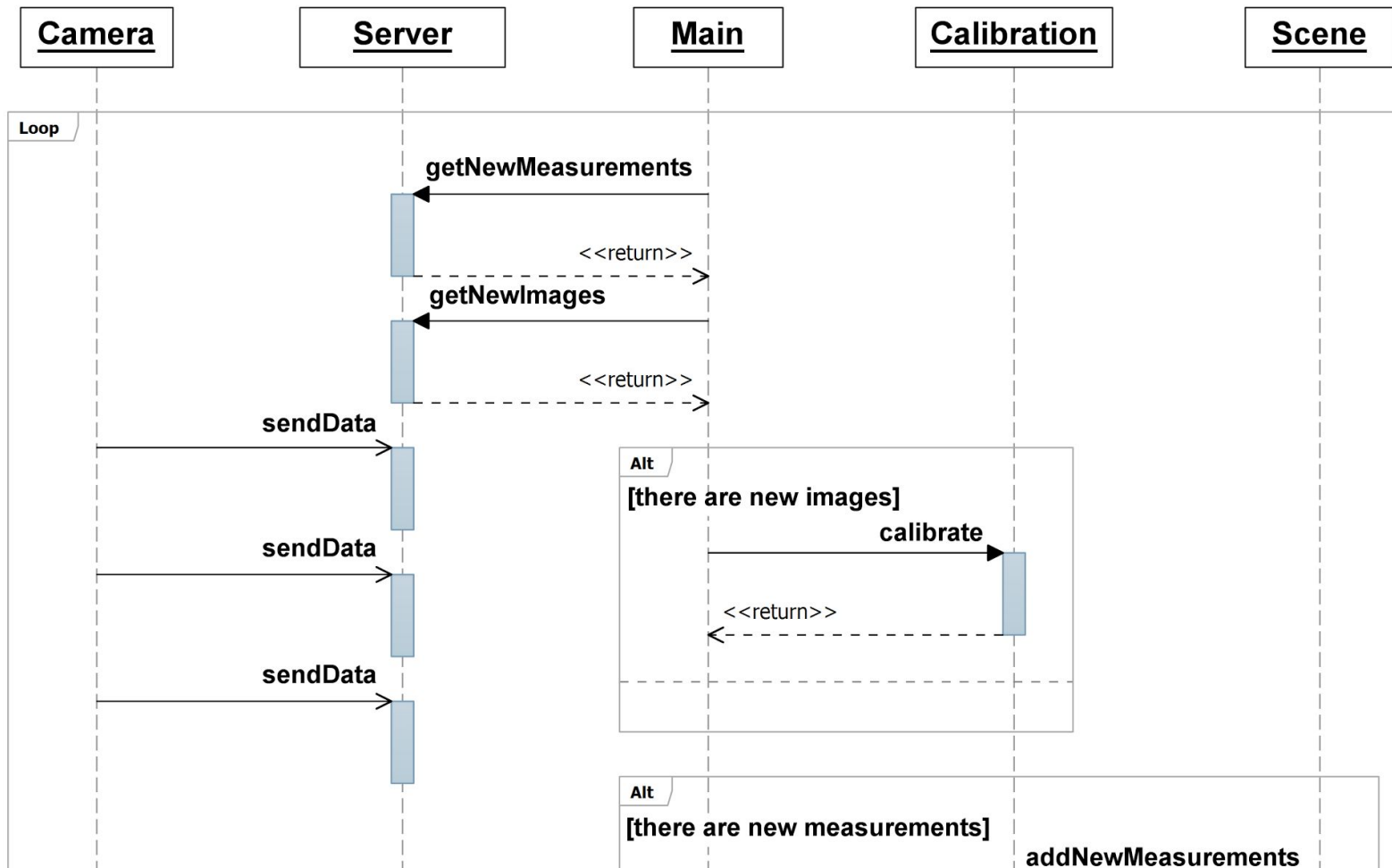
- Scoping and Planning - Original Project Plan



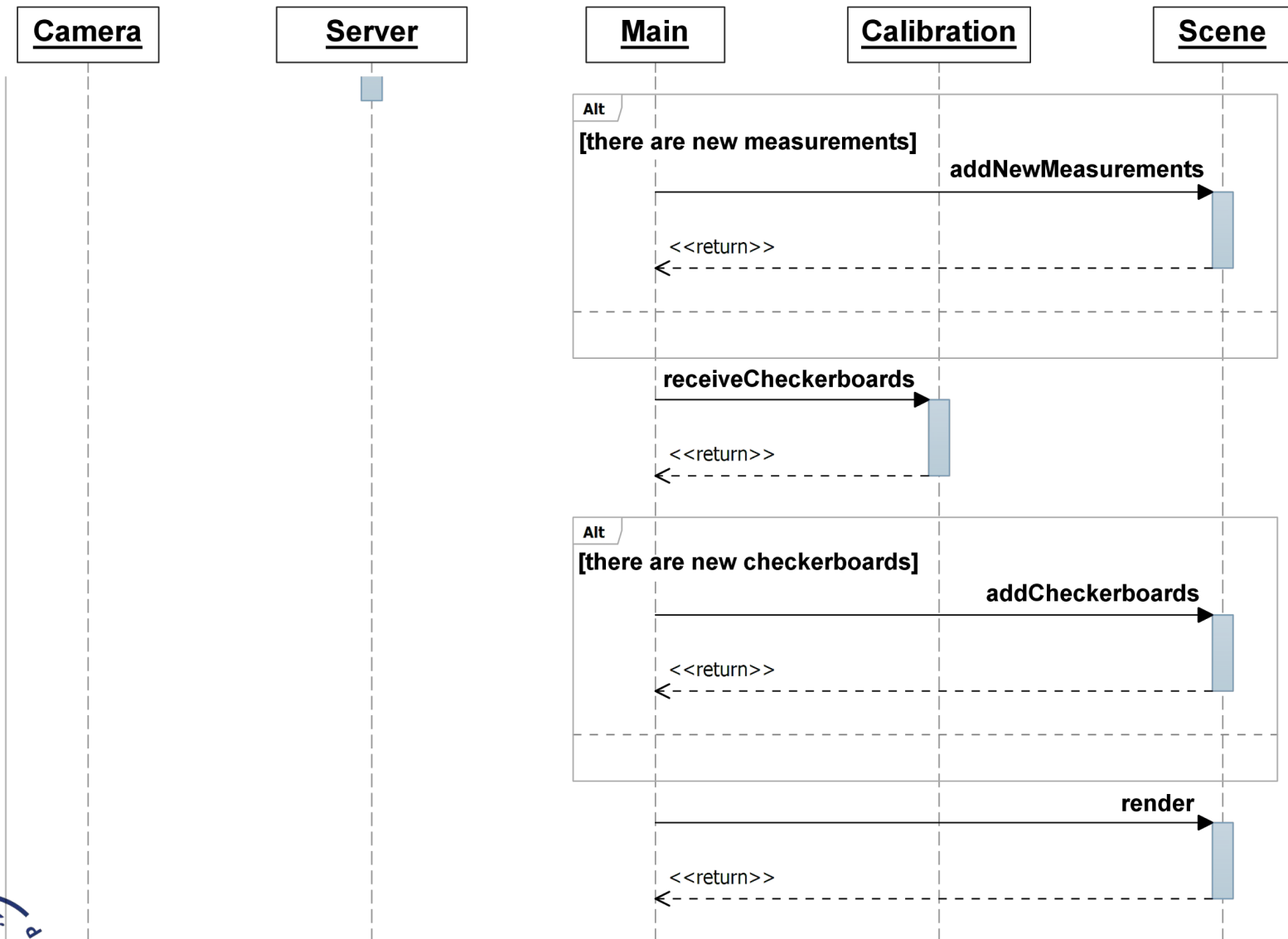
Software Design UML Use Case Diagram



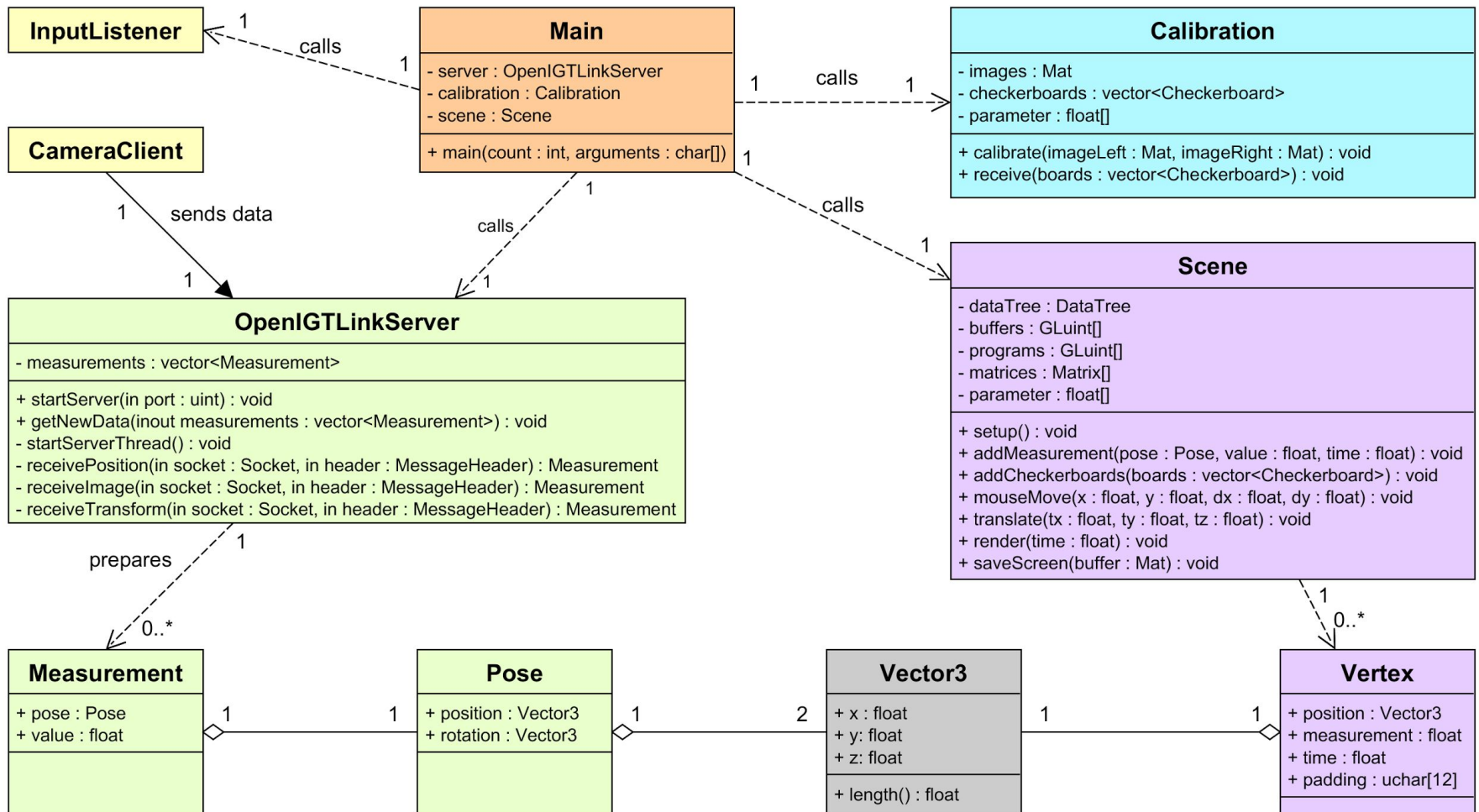
Software Design UML Sequence Diagram



Software Design UML Sequence Diagram



Software Design UML Class Diagram



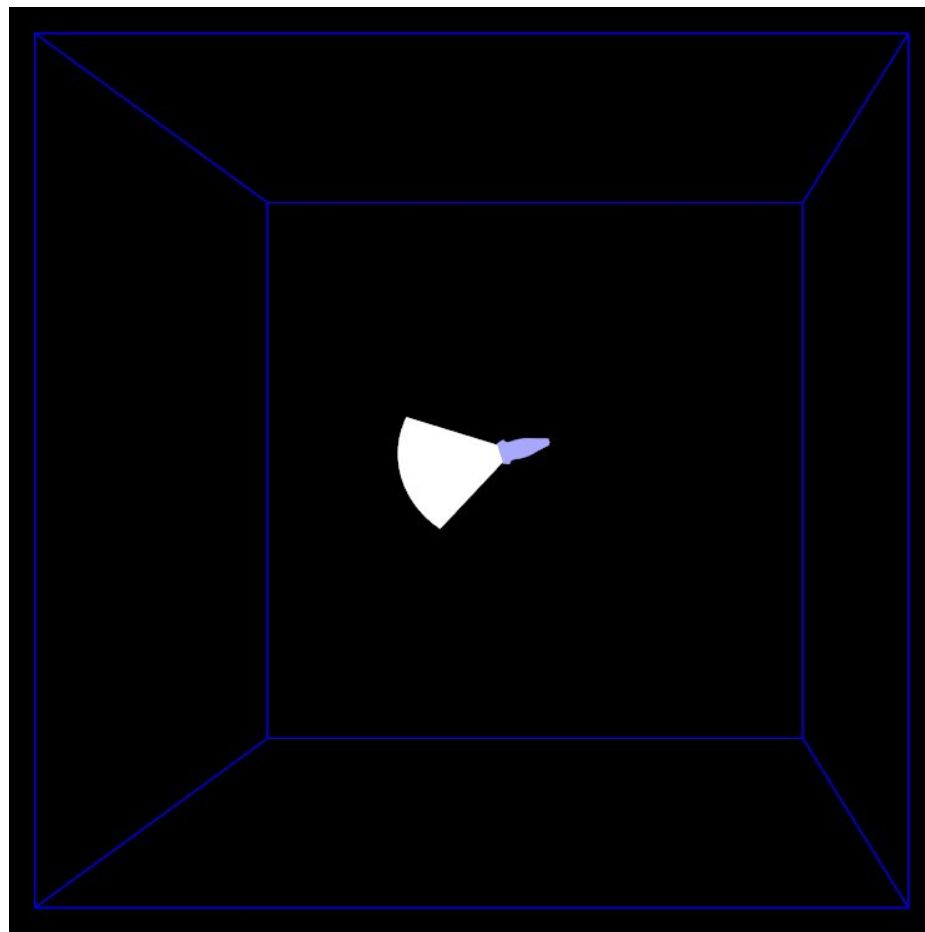
Software Design

- Strategies
 - GUI / rendering: bottom-up implementation
 - Server-Client: top-down
- Server-Client Communication
 - OpenIGTLink protocol, using Position Message / Image Message
- Separate threads (server, calibration, GUI)
- Design Patterns
 - Creational patterns: RAII
 - Concurrency patterns: Monitor Object (for server)

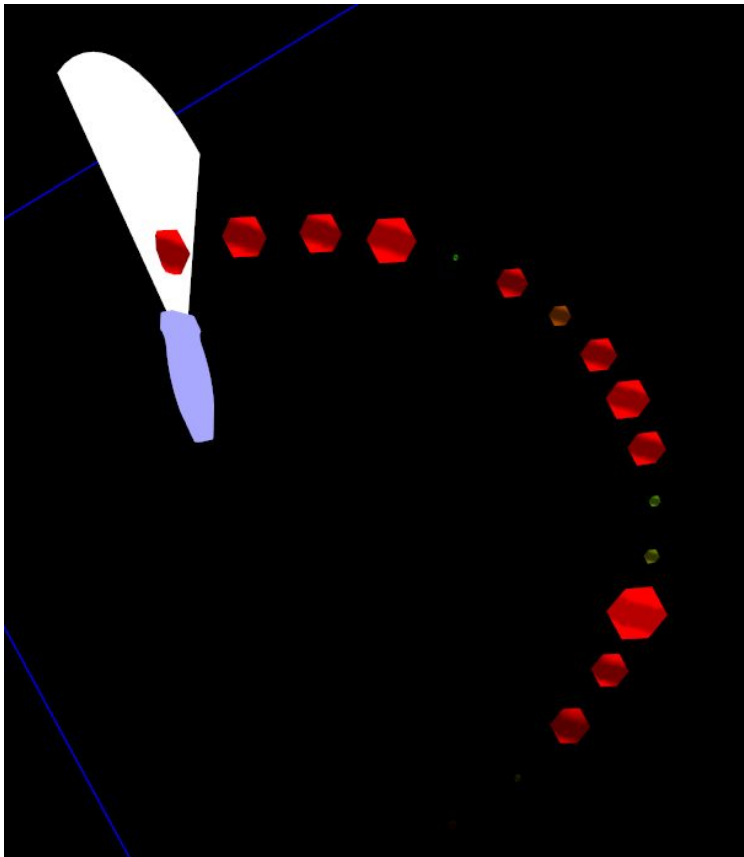
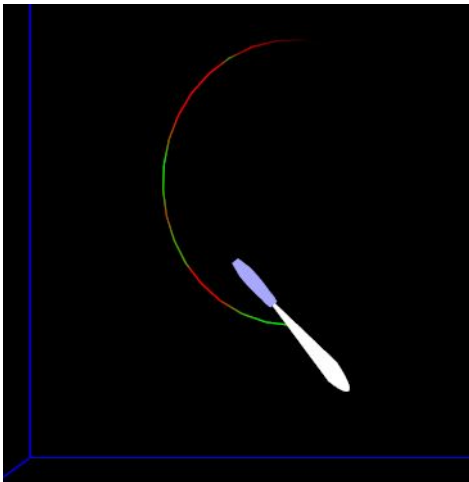
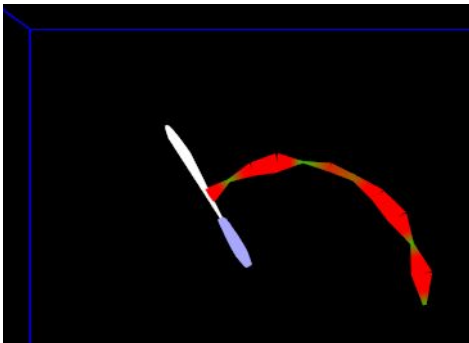
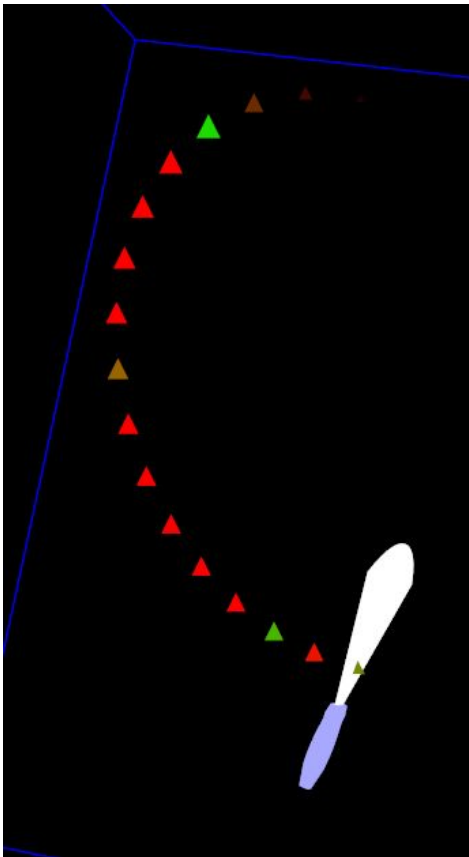


Project Results

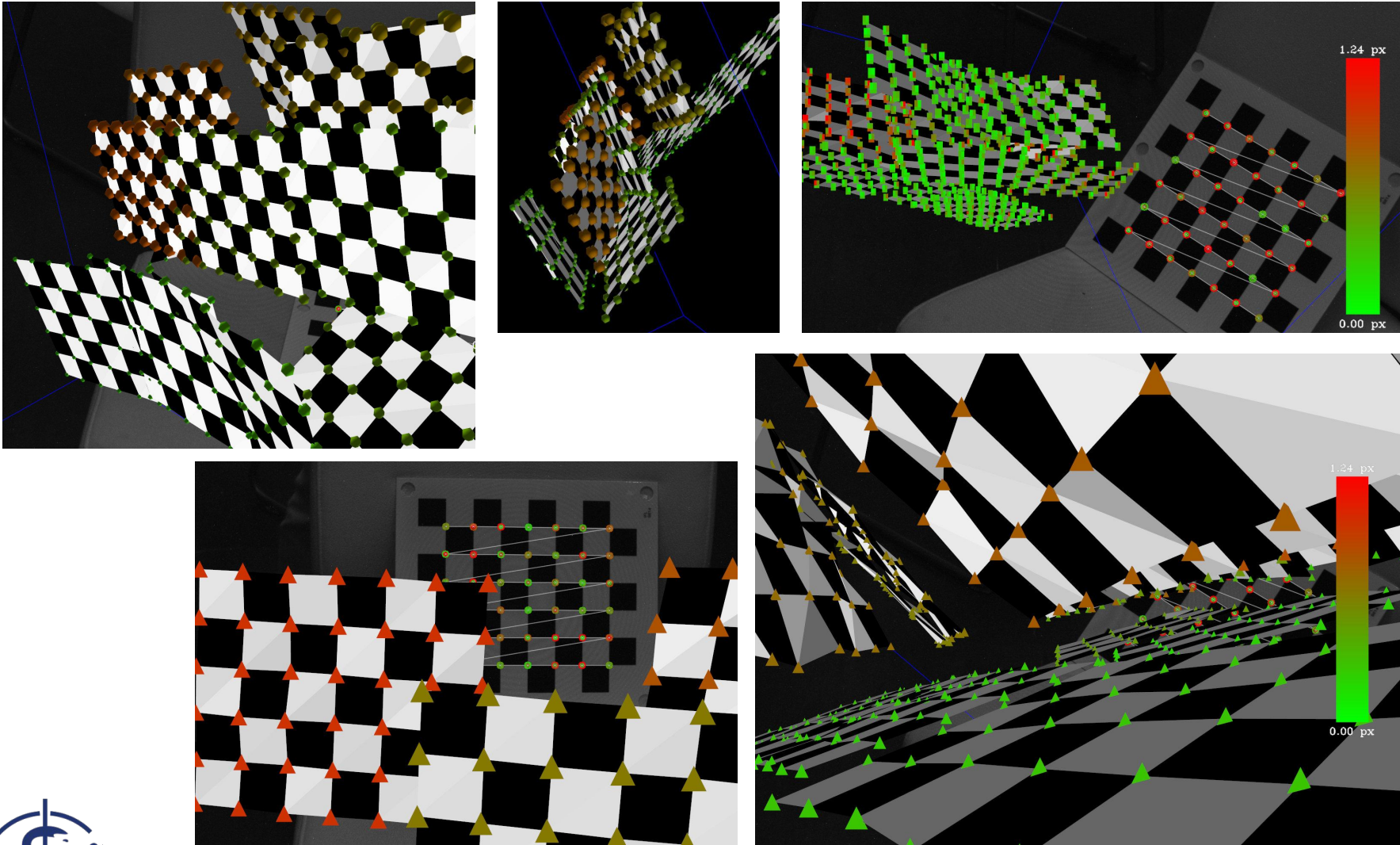
- Questions
 - How useful is old data ?
 - Postprocessing
 - What if paths cross ?
 - Show latest data
- Approach
 - Show **recent** positions
 - Use **color** for accuracy
 - Use **size** for accuracy
 - Show **reference frame**
 - Show additional **devices**
 - Let measurements **fade out**
 - Show **checkerboards**
 - Show **reprojection error**



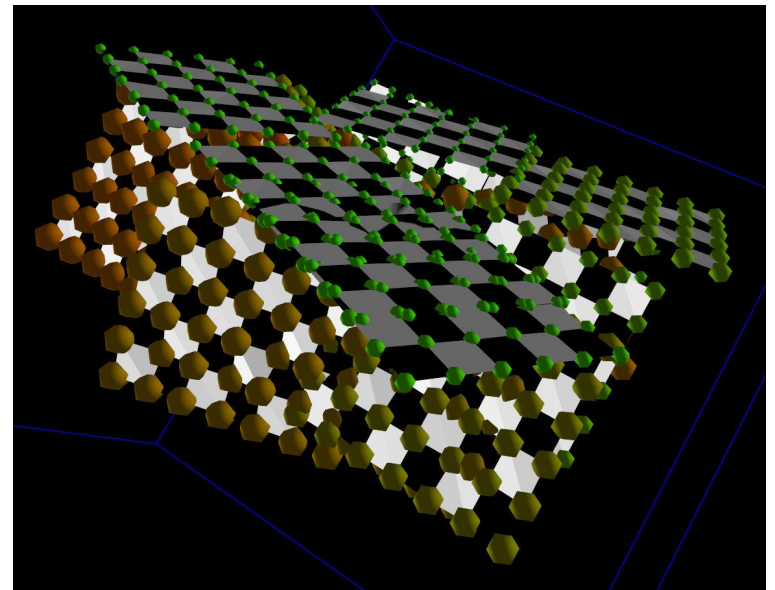
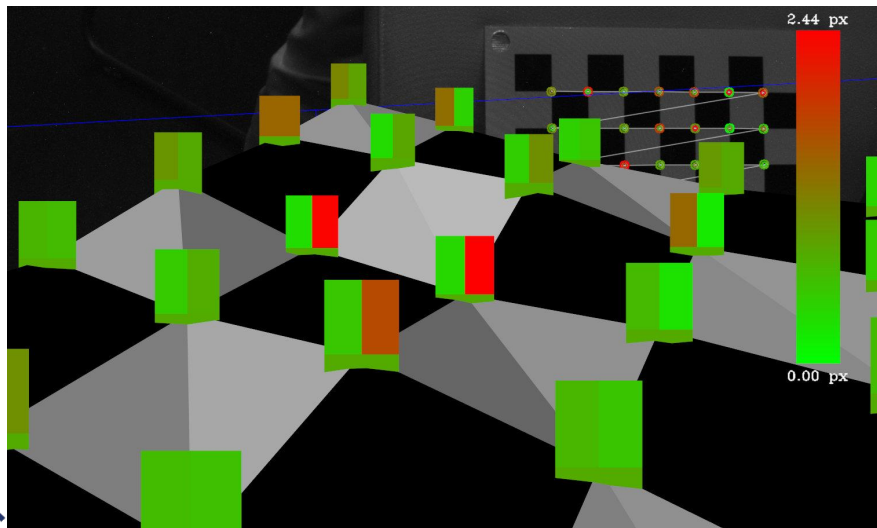
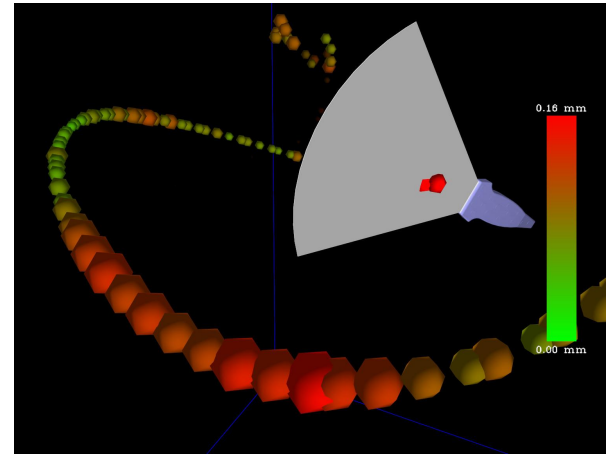
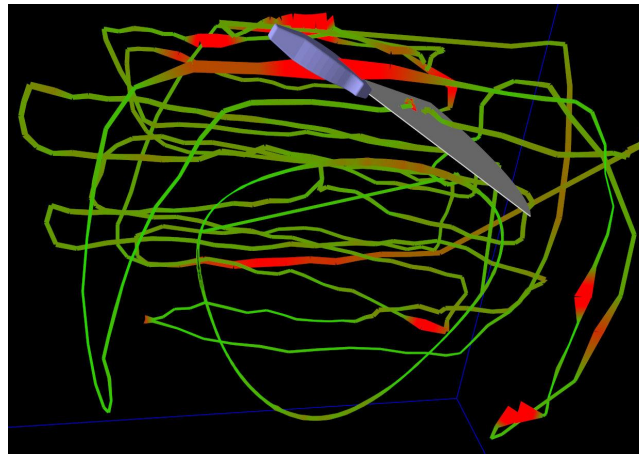
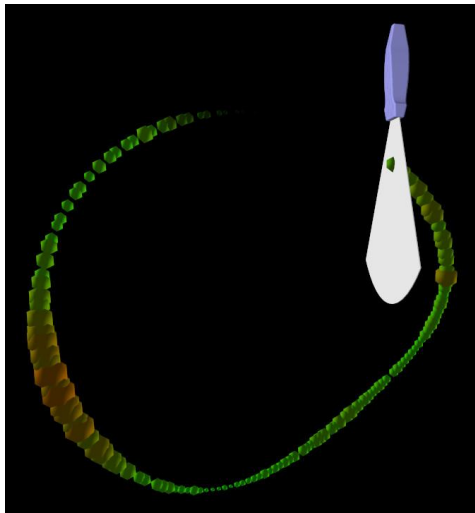
Project Results - Demo - Poses



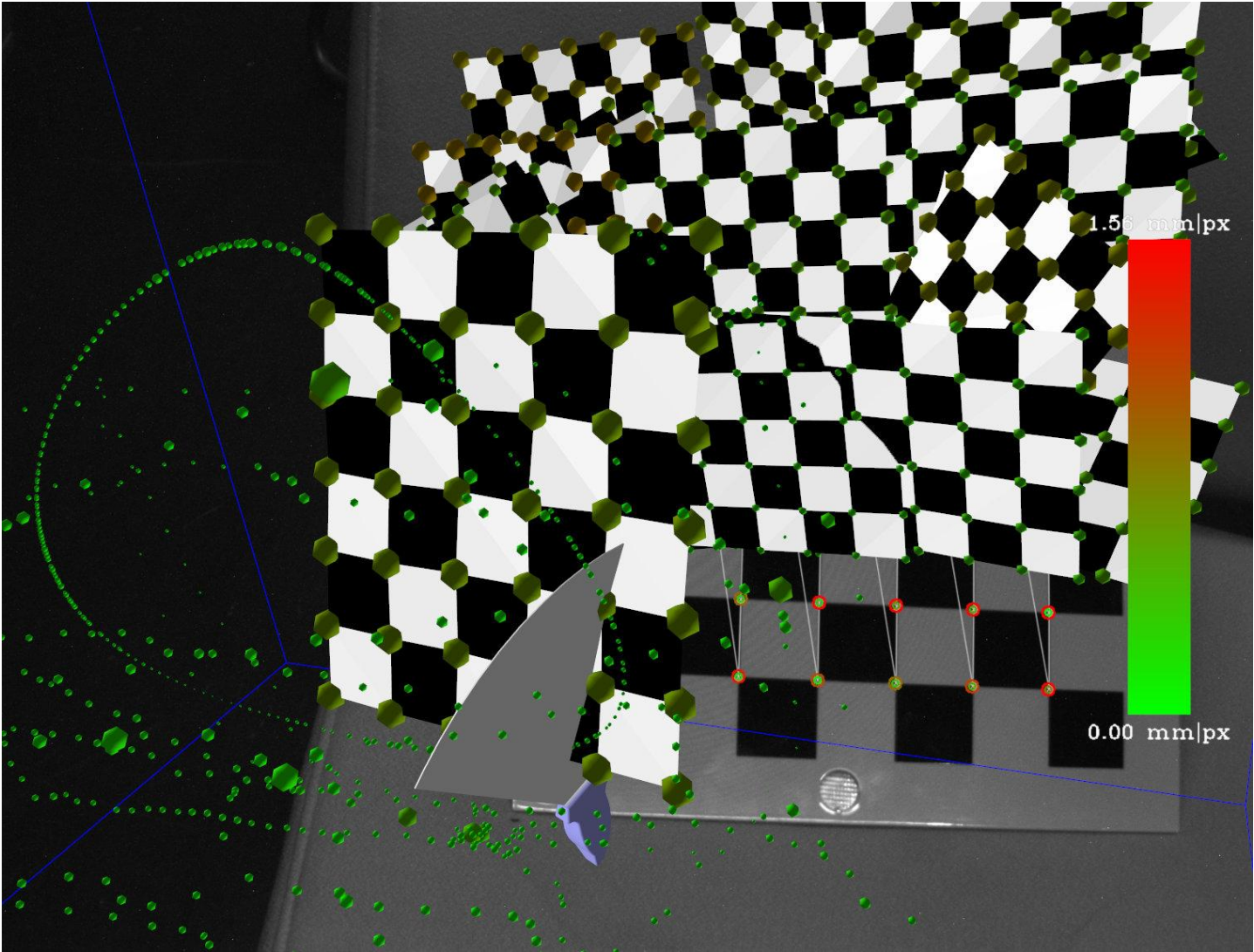
Project Results - Demo - Checkerboards



Project Results - Demo

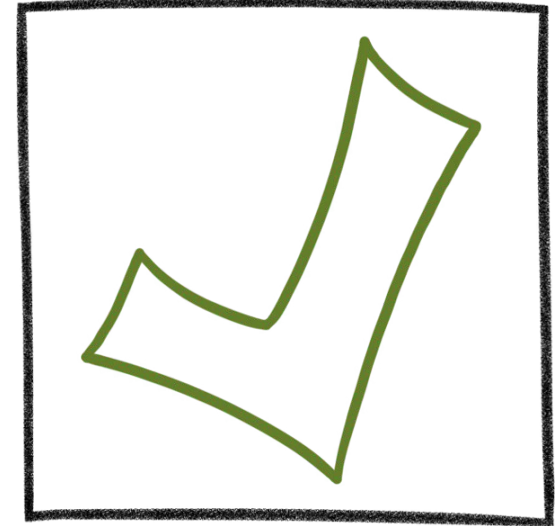


Project Results - Demo - Combination



Project Outlook

- Completed Tasks and Subtasks
 - Six different visualizations
 - Displaying reference frame
 - Displaying US probe mesh
 - Navigation (mouse, keyboard)
 - Server implementation
 - OpenIGTLink integration
 - Customization of visualization (color, size, legend)
 - Calibration (Mono and Stereo) with OpenCV on 38 image pairs (10 rejected)
 - Visualization of checkerboards (8 x 7 test board)
 - Visualization of reprojection error per corner and board (0.29 ~ 0.75 px)
 - Connection with FRAMOS framework
(directional communication via OpenIGTLink packages)



Project Outlook

- Possible Future Work
 - Advanced error measurements
 - More tests / evaluation
 - Heatmap for postprocessing
 - Include partial checkerboards
 - Suggest next position for checkerboard



Project Retrospective

- Main challenges
 - Integration of OpenIGTLink (reason: library)
 - Calibration with OpenCV (reason: documentation)
- Tasks: all mandatory tasks are done
- Stereo calibration / reconstruction
- PMSD presentations provided interesting insight into typical topics



- Questions

- Comments

- Ideas

