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IntCDC
CLUSTER OF EXCELLENCE

Robotic Platform for Cyber-Physical Assembly of Long-Span Fiber-Composite Structures - Geodetic Perspective

Overall Project Goals

- Development of cyber-physical on-site construction platform (CPC) for automation of material handling and on-site assembly
- Human-machine interaction by haptic feedback through haptic user interfaces
- Development of real-time robotic total station (RTS) network for seamless CPC positioning
- **Project partners:** Research project within the Cluster of Excellence IntCDC at the University Stuttgart: Institute of Engineering Geodesy (IIGS); Institute for System Dynamics (ISYS); Haptic Intelligence Department
  (MPI HI), Max Planck Institute for Intelligent Systems

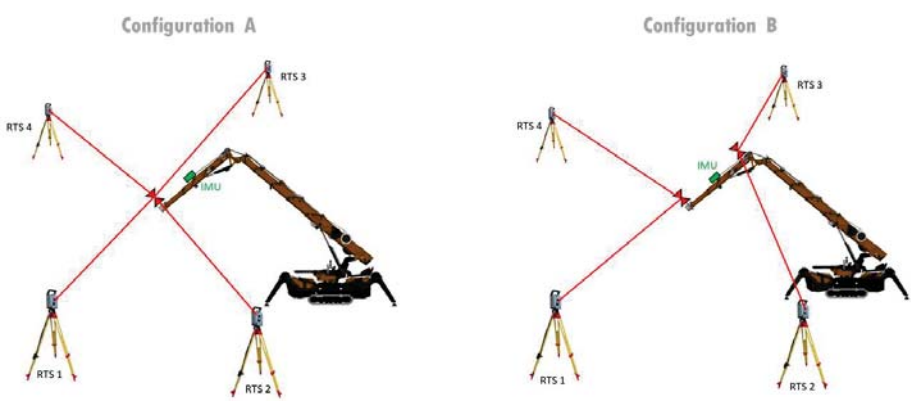
Geodetic contribution

- Absolute 6-DoF pose determination for the guidance process of the CPC with highest possible accuracy and reliability/ robustness
  - Development of RTS-network for pose determination
  - Optimization of geometric network configuration w.r.t. accuracy and reliability

Approach

- Establishment of the geodetic reference frame (with

- Configuration for CPC pose determination
- RTS network control



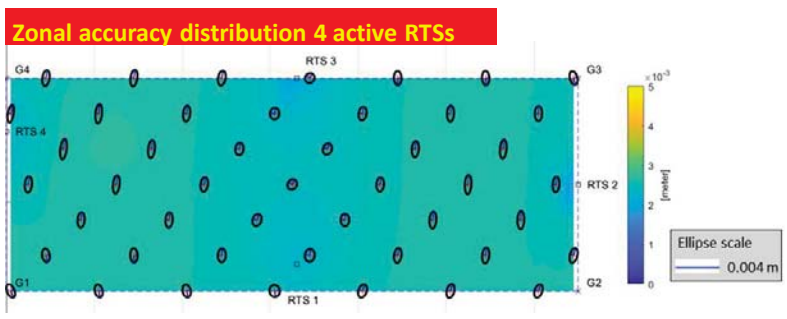
Methodology

- Data fusion and pose determination by Gauss-Markov-Model
- Definition and determination of quality parameters
  - Accuracy: standard deviations, error ellipses/hyperellipsoids
  - Reliability: minimal detectable error ∇_{l_i}, impacts of ∇_{l_i} on positions and orientations
- Analysis of geometric on-site arrangement of RTSs w.r.t. CPC platform using geodetic network analysis

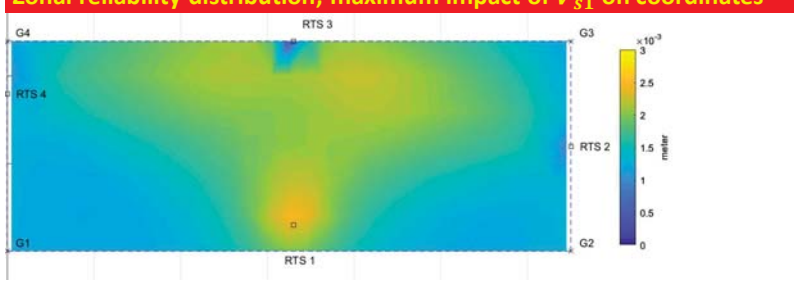
Results

- Accuracy
  - for positions between 2.1 mm and 3.3 mm
  - for orientations between 0.05° and 0.1°
- Reliability
  - impact of minimal detectable error ∇_{li} on coordinates between 0.42 mm and 1.32 mm
  - impact of minimal detectable error ∇_{li} on orientations (yaw, pitch) between 0.001° and 0.054°
- Analysis of geometric on-site arrangement of RTSs w.r.t. CPC

Zonal accuracy distribution 4 active RTSs



Zonal reliability distribution; maximum impact of ∇_{s1} on coordinates



Selected publications

Lerke, O., & Schwieger, V. (2021). Analysis of a kinematic real-time robotic total station network for robot control. Journal of Applied Geodesy, 15(3), 169--188. https://doi.org/doi:10.1515/jag-2021-0016

Lauer, A. P. R., Lerke, O., Gienger, A., Schwieger, V., & Sawodny, O. (2023). State Estimation with Static Displacement Compensation for Large-Scale Manipulators. Proceedings of the 2023 IEEE/SICE International Symposium on System Integrations (SII 2023).

Lauer, A. P. R., Lerke, O., Blagojevic, B., Schwieger, V., & Sawodny, O. (2023). Tool center point control of a large-scale manipulator using absolute position feedback. Control Engineering Practice, 131, 105388. https://doi.org/10.1016/j.conengprac.2022.105388

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