NLS
NATIONAL
LAND SURVEY
OF FINLAND

Higher accuracy for smartphone positioning

Post-processing, centre points and repetition

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Background

- Smartphones are widely spread and cheap to manufacture
- Public and private sectors are interested in the positioning capabilities of devices
- NLS is interested in their application from the crowdsourcing point of view
- Pyykkijahti smartphone game by projects of the National Land Survey of Finland
  - Luore 2021, Matko 2022-2023
- Master's Thesis (Tech.) 2023

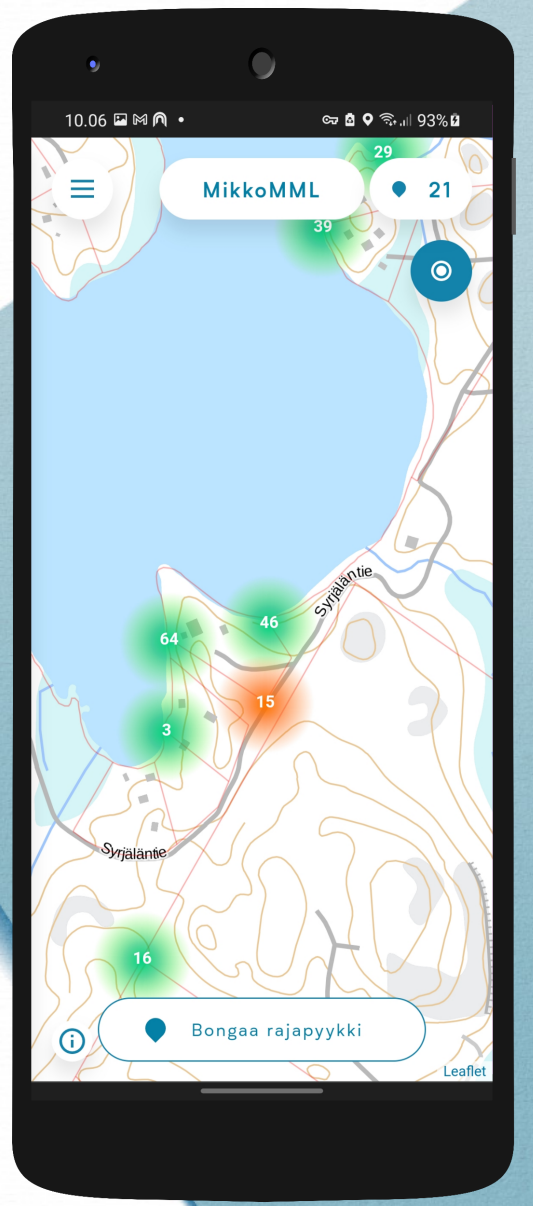
Objectives

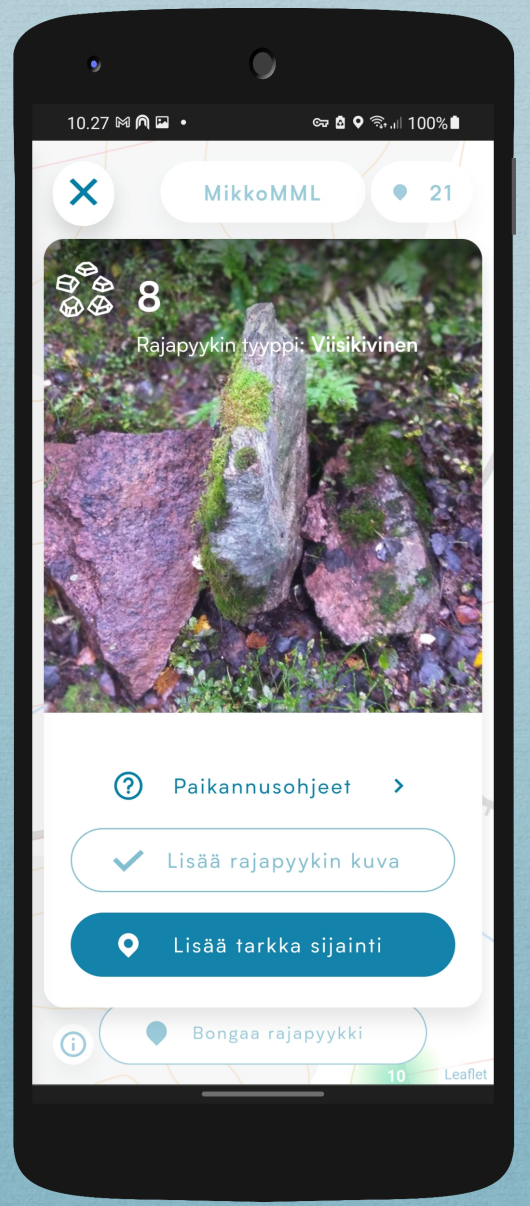
- Study the positioning accuracy of common smartphones using **real-time and post-processing** positioning techniques
- Improve accuracies using **centre points** of measurements
- Study how positioning accuracy changes when the **number of measurements** increases

Pyykkijahti

Marker Quest

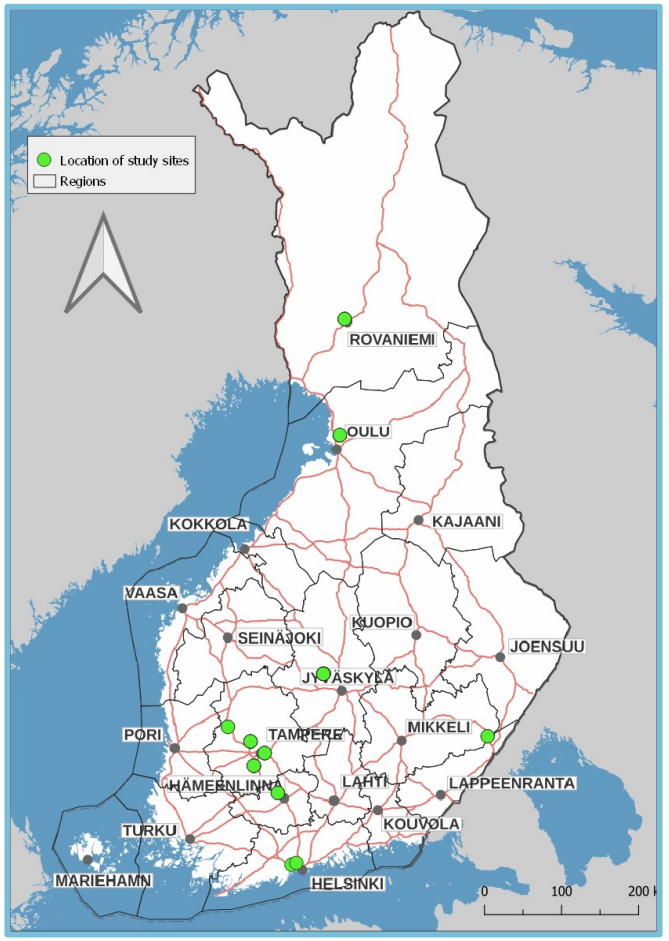
- Web-based mobile game for enhancing location accuracies of border markers in the Finnish cadastral index map by crowsourcing.
- Players measure inaccurate markers in the terrain or mark them missing.





Measurements

- Study areas in different parts of Finland
- Simulated crowdsourcing environment
  - NLS employees
  - Different kinds of environments
  - Most commonly used smartphones
- Border markers of the cadastral index map
  - Smartphone measurements
  - RTK reference measurements

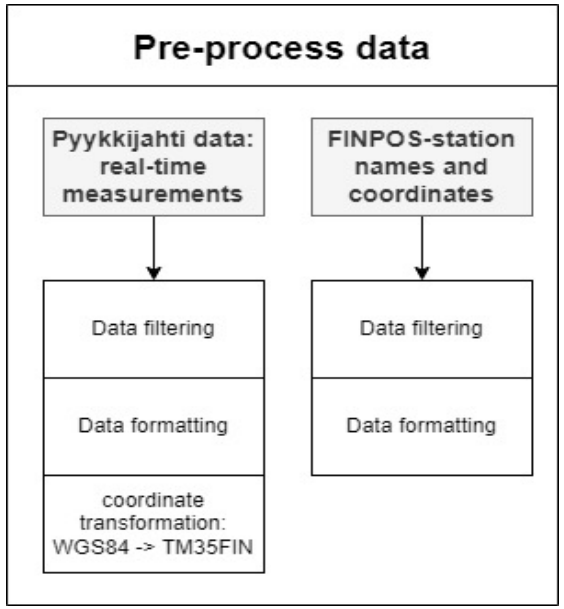


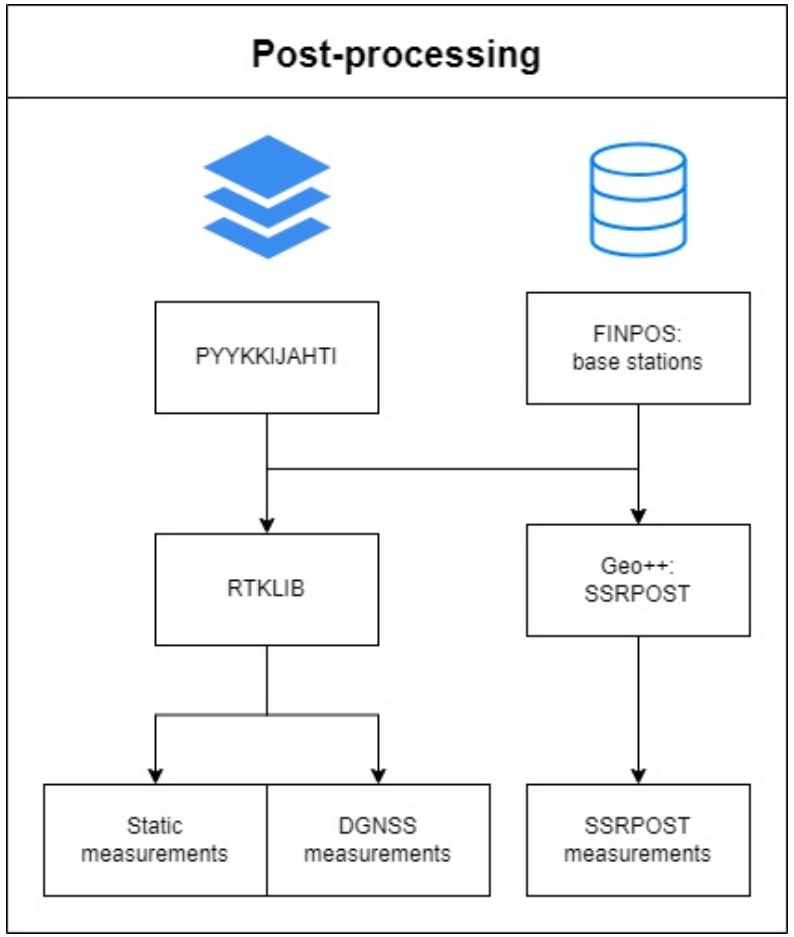
Statistics of data collection

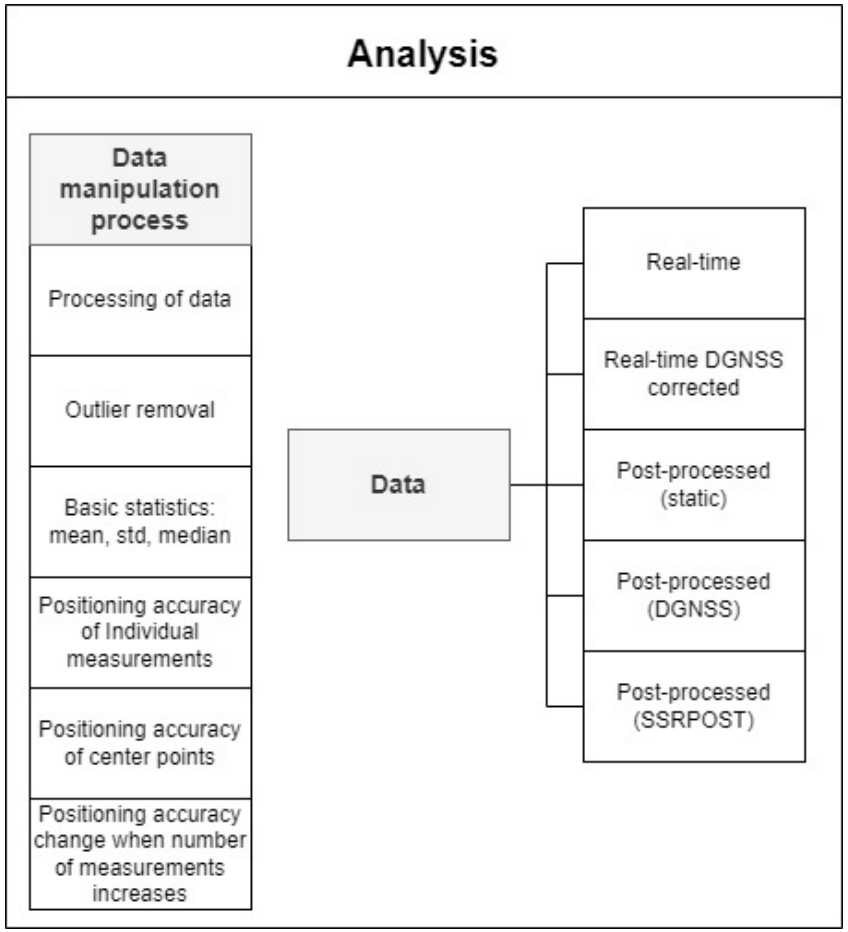
- Before filtering of data
  - 41 border markers
  - 1889 measurements
  - 12 smart devices

Smartphone types	Measurement count
Google sdk gphone	1
Motorola Moto G(60)	100
Samsung SM-A202F	7
Samsung SM-A326B	494
Samsung SM-A405FN	279
Samsung SM-A526B	162
Samsung SM-A528B	97
Samsung SM-A750FN	163
Samsung SM-G398FN	443
Samsung SM-G960F	3
Samsung SM-G970F	22
Wheatek RT1	118

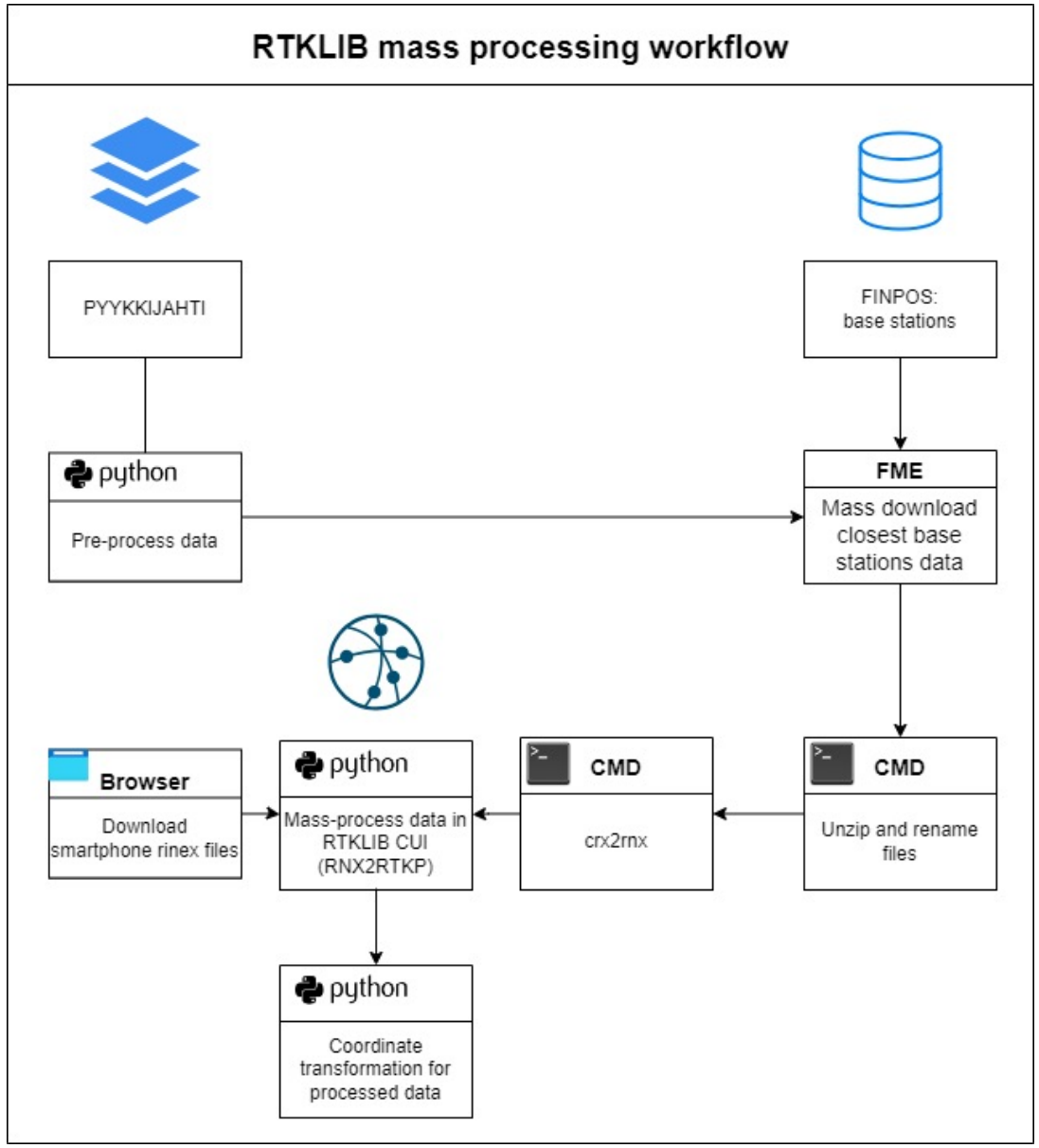
Process workflow





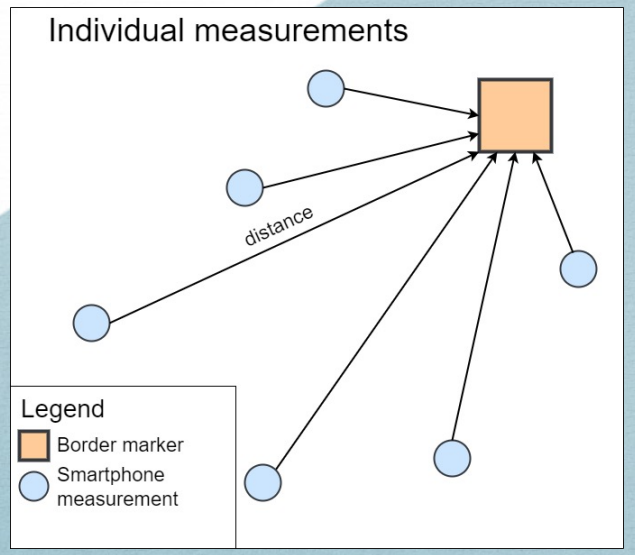


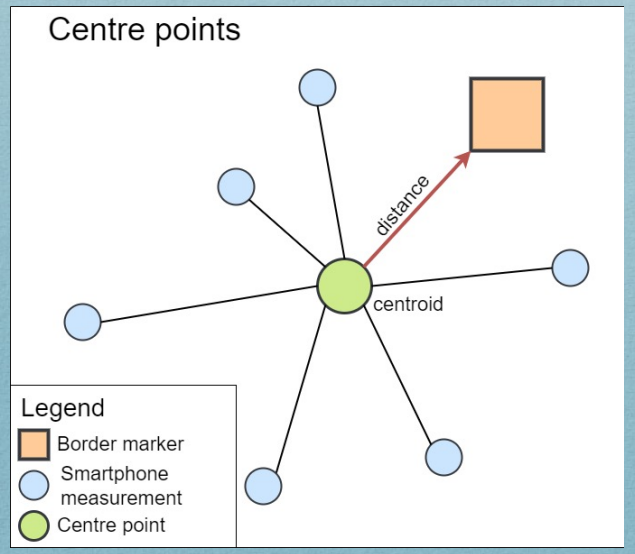
RTKLIB workflow



Positioning accuracy

1. Individual measurements
2. Center points
3. Increasing number of measurements

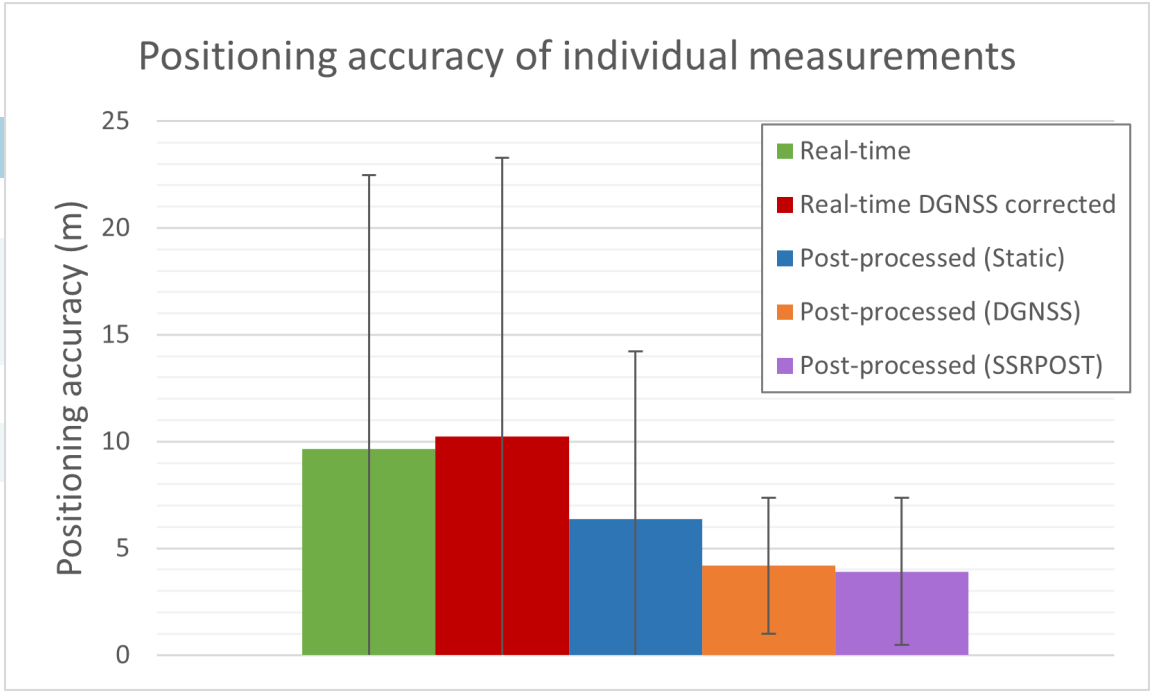




RESULTS
Positioning accuracy of individual measurements

Positioning accuracy of positioning techniques

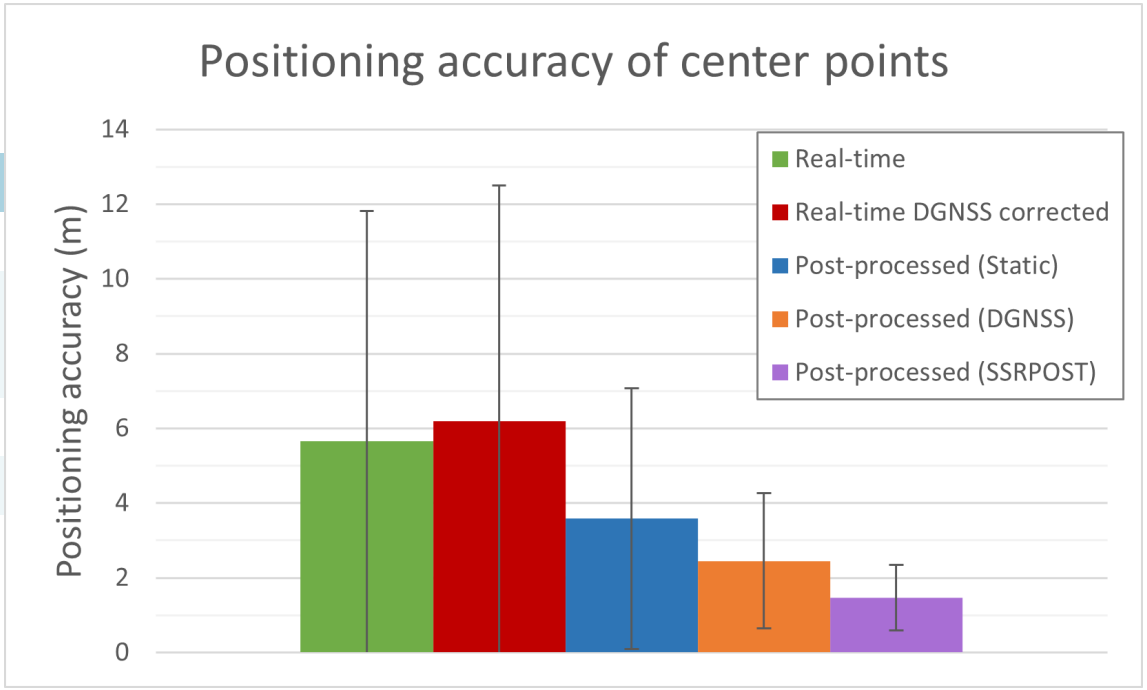
	mean (m)	st dev (m)	median (m)
Real-time	9,66	12,81	4,85
Real-time DGNSS corrected	10,24	13,03	5,27
Static	6,38	7,85	3,96
DGNSS	4,19	3,18	3,47
SSRPOST	3,92	3,44	2,95



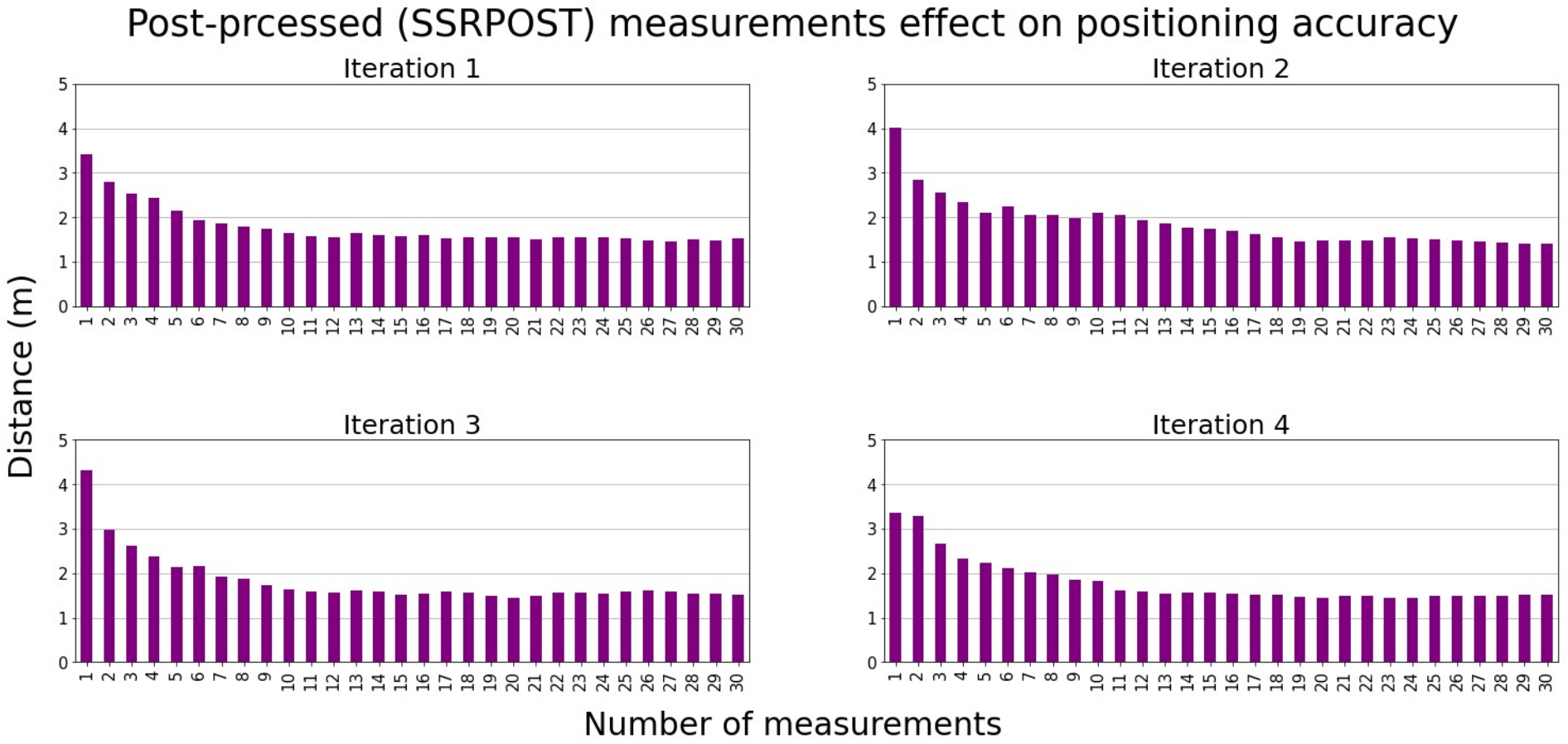
Positioning accuracy of centre points

Positioning accuracy of positioning techniques

	mean (m)	st dev (m)	median (m)
Real-time	5,66	6,15	3,18
Real-time DGNSS corrected	6,19	6,31	3,76
Static	3,58	3,49	2,31
DGNSS	2,45	1,81	2,09
SSRPOST	1,46	0,88	1,34



Increasing number of measurements



Conclusions

- The results show the potential of crowdsourcing applications in improving positioning accuracies of measurement points
- SSRPOST post-processing produced the most accurate results at 1.46 meters
- Above 10 measurements per position ensure the highest accuracy
- Issues with the smartphone measurement: variation in accuracy, phone types, variation of the environment, etc.
- Further research: optimization of workflow, longer field measurement time, study most commonly available smartphones

Publications about Pyykkijahti

Kontiokoski A (2022) Enhancing Location Accuracy of Boundary Markers by Crowdsourced Smartphone Positioning (in Finnish). Bachelor's Thesis, Land Surveying, Lapland University of Applied Science. https://urn.fi/URN:NBN:fi:amk-202202252860

Kettunen P, Rönneberg M (2022) Accuracy Enhancement of Cadastral Boundary Marker Coordinates with Smartphone Crowdsourcing. In Krisp JM, Meng L, Kumke H, Huang H (eds) Proceedings of the 17th International Conference on Location-Based Services, pp 154–155. http://hdl.handle.net/10138/350768

Jussila A (2023) Positioning accuracy of smartphones in crowdsourcing context. Master's thesis, Department of Geoinformatics, Aalto university. http://urn.fi/URN:NBN:fi:aalto-202305213319

Rönneberg M, Kettunen P (2023) A gamified map application utilising crowdsourcing engaged citizens to refine the quality and accuracy of cadastral index map border markers. International Journal of Digital Earth, 16(2), 4726–4748. https://doi.org/10.1080/17538947.2023.2279673

Advancing together

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