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Positioning Techniques and Algorithms for a Commercial Bicycle Tracker (Summary)

Master's thesis

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PhD

Co-Supervisor: Stemo Ojavee

MSc

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Positsioneerimise meetodid ja algoritmid jalgratta jälgimisseadmele (Kokkuvõte)

Magistritöö

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Author's declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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Abstract

Bicycle trackers often rely on Global Navigation Satellite Systems (GNSS) to obtain their position and form a trace of their movement. However, continuous GNSS tracing, without sufficient postprocessing, often ends up unrepresentative of true movement due to various reliability problems. One such tracker developed by Comodule OÜ, *Track & Trace*, suffered the same issue; which compelled the development of a software postprocessing layer for the input coming from its GNSS receiver module (the Quectel BG96) as an enhancement to the tracker's firmware.

This development involved the design and implementation of a set of parsing and processing algorithms for GNSS location messages based on existing research, including measures to identify and eliminate corrupt data, dynamically select different sources of truth, reduce fluctuations of reported position, and improve idle accuracy, among other improvements, resulting in a reliable, accurate and smooth trace to the extent allowed under the given constraints of software architecture and hardware.

Alongside the main algorithms, a set of complementary mechanisms for local position spoofing and remote debug were also implemented in the firmware in order to allow more convenient and thorough testing, which accelerated overall development of the postprocessing layer by allowing easier reproduction and tracing of rare bugs.

The developed algorithms were extensively tested and had their efficacy verified by a dedicated team operating across multiple countries, and enabled a level of tracking performance comparable to that of current commonly used commercial trackers. This work also allowed finding out that improvements in some edge cases could still be made, and a number of impassable constraints are identified that could be avoided with different design decisions in future projects.

This thesis is written in English and is 92 pages long, including 7 chapters, 19 figures and 4 tables.