

Opposition Report

MARTIN SVATON

August 24, 2016

General Overview

Thesis Title: Performance of Map Matching and Route Tracking depending on the quality of the GPS data

Thesis performed by: PROKOP HOUDA

Thesis Structure

The Thesis is well structured. All chapters are in the correct order (except the discussion and conclusion) and they are mutually connected. It creates coherent and read-friendly document on professional level. I would switch the chapter Discussion and Conclusion to have the conclusion at the last place in the text. In addition, the text formatting should be justified to increase the coherency impression.

All the chapters are well structured and introduced. Author holds the defined approach over the whole work and I do not find any deflections from the defined field. The Title of the Thesis perfectly reflects the content of the thesis.

Figures and Equations are well described and titled. Sometimes there are missing the linkage to the figure or reference from the text (Especially in Chapter 4 - Results).

Methodology and goal

All chapters and sections are understandable, but the chapter describing the system description needs a bit more focus to get into principals of developed algorithms. Used methodology of definition and testing several scenarios by different map matching methods achieve the goal defined in the Introduction chapter in specified range.

The goal definition in the introduction should be more highlighted and the general questions, which leads to achieve the goal could be defined.

Thesis Strengths/Weaknesses

I think the main strength of the thesis is the potential for further development and implementation. The weakness is that developed algorithms for map matching performance analysis is available only in MATLAB and there are no suggestions or examples of usage of that algorithms on another platform (JAVA, C++).

Language

The language is used in very good and manner. Author used a varied words and there are no redundant words or repetitions.

Used References

Author use a very varied and reliable references, which are well addressed in the text. Also the number of used references reveal a good quality of the theoretical sections.

Individual Chapters Assessment

Chapter 1 – Introduction

The introduction Chapter is well written and easy to read. The initial part of the Introduction provides a good approach from wide topic of Global Navigational Satellite systems to concrete problematic of map matching. A reader is well informed in the beginning part of the report to which area is the thesis oriented. I would appreciate separate Aim Section to make it easier to find the main objective of the report. A good statement is that the thesis is oriented to creates a detailed comparison between several map matching methods and their performance, which creates a base for next development of the map matching devices. I would also point out the fact that the thesis does not propose any HW implementation of the examined map matching methods and their results in the real application.

From a structural point of view, I would prefer to make the Outline section more structured (highlight individual chapters). Nevertheless, the Introduction chapter contain all necessary parts, which state the general field of interest.

Chapter 2 – Theoretical Background

The Theoretical Background chapter follows the brief Introduction chapter and describes elementary parts of the areas, from which the main part of map matching performance evaluating is composed. I appreciate the order of individual parts, which begin with brief description of GNSS systems, their effectiveness, performance, and error analysis. Detailed description of Geodetic systems and particular map matching methods follow these. The Section describing the Projection systems points out the basic projection methods with a brief and clear description. However, as stated in the text, the Mercator Projection is used for evaluation of map matching performance analysis. I would like to find this information somewhere in the Introductory chapter or Abstract since I assume that it is one of the key information for potential developers. The Map Matching section nicely describes methods of map matching from a simplest method to the sophisticated curve matching methods. I welcome the supplementing of each method description by the general equation, which helps to understand each map matching method. I found interesting the last section of this chapter, which describing even more sophisticated map matching methods, together with an assumption of inapplicability of these methods to the main performance analysis.

I do not feel anything missing in the background chapter and all described parts corresponds to the main chapter 3, which proposes the map matching performance analysis methods. The background chapter creates relevant base for understanding of the following performance analysis system design.

Chapter 3 – System Description

The former part of the main chapter describing the initial data preparation and methods of collection for next application of map matching algorithms. The first data identification is done in very good manner and gives idea about the range of measurement. A very good research was done to find own GPS error distribution, which is done on adequate professional level and provides new useful comparison. In addition, the problematic of error vectorization could be described in more details to have a deeper idea how is it done. While reading the text I get confused because of some terms such as Ground truth or true points. This term Ground truth is used very frequently and sometime it refers to measuring of error magnitude (in the error research) and sometimes to map ground truth. I think it would be good to create some summary of used terms with brief description of each.

The latter part of this chapter describes the individual methods of used map matching algorithms in details. This part is quite easy to read, but some sections need a deep focus to understand the principal. Nevertheless, in total, all the described methods are possible to understand. The used methodology of using several map matching methods follow the simple and understandable principal. Also I find the flowchart diagrams very useful to find differences between methods. Chosen methodologies are in accordance with initial background chapter, where the method choice was justified. I think the method is adequately described with balanced level of details together with advantages, disadvantages, and necessary assumptions. The performed methodologies of map matching performance estimation are relatable to defined goals in the beginning.

Things I miss in this section are the evaluation of theoretical performance of individual methods and how the complexness of the evaluated network affects the algorithm execution.

Chapter 4 – Results

The fourth Chapter describes the results collected by designed algorithms in previous chapter in clear and organized manner. I find all figures readable and the color scale division contributes to easy understandability. One think to recommend is to be careful about automatic linkage to the reference. Especially Word can replace the link by unnoticed warning.

Some parts of the figures description also contain a reasons of the of eventual errors and the way to treat this errors. I would expect these thoughts in discussion chapter. Also I would welcome some guide how to orient in appendices, which includes all the presentable results and involve the appendices in the result section or in the discussion (e.g. This can also be observed in Appendix...).

I welcome the section, which evaluates the usage in the ITS. Author mention several ITS application and connect them to the proper scenario. I find this consideration very useful for potential project development. It can help to decide which matric should be more useful for specified project.

Chapter 5 – Conclusions

The Conclusions chapter seems to be quite long. Some thoughts and sentences should be (in my opinion) in Discussion section. I would like to see some numbers regarding to resulting summarization of the results and make some brief comparisons. However, aside of mentioned shortcomings, the conclusion chapter is credible, reflects the methodology and results in a good manner, and well summarize the job done in the thesis. In addition, the last sentence should be more deep to leave the readers with something to thing about.

Chapter 6 – Discussion

I think, the discussion chapter is very brief. It should be longer and focus more on the problems faced in the performed work. It would be nice to make it more structured with accordance to chapters and individual problems faced on. In addition, discuss possible alternatives or solutions to resolve the problems. (This is mainly done in the work itself, but it should also discussed here). I like the paragraph describing the future development. It is a nice approach, of which the future development of map matching performance analysis can head out.

Questions

1. Do you think it is possible to implement an inertial sensors and accelerometers to the developed algorithms? How it would be difficult?
2. Did you try to find another sources of GPS measurements to create a wider comparison of different areas (internet)? Or did you try to measure your own data?
3. Did you thing about gathering the ground truth data by different method?
4. You chose only one measurement for estimation of error distribution. Based on what? Were there any differences between measurements?
5. In section **Generation of Route Scenarios**, you mention that true position are always just estimates, and some minor manual changes are possible. Can you describe once more the difference between true point position and Ground truth position? Which kind of manual adjustments you mean?
6. How did you determine the initial hexagon size in P2C and C2C?
7. Why it is necessary to compute the network density at the end of each cycle?
8. Why you decided to use CEP67 for accuracy estimation? Are there any special reasons for using a 67% confident level?
9. How about the performance of the algorithms? Did you observe any effects of the network complexity influence the system performance? Are there possibilities for optimization of the algorithms?
10. How did you find the connection between defined scenario and real application?