

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Mikhail Kurenkov

PhD Program: Engineering Systems

Title of Thesis: Neural field-based optimal motion planning method for differential drive robots with nonholonomic constraints, robots in dynamic environment and swarm of robots

Supervisor: Associate Professor Dzmitry Tsetserukou

Name of the Reviewer:

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	Date: 02-11-2024
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The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

The thesis investigates the issue of optimal motion planning, a critical problem in mobile robotics. It introduces the Neural Field Optimal Motion Planner (NFOMP), a novel approach designed to augment optimization techniques through the creation of an obstacle neural field model that accurately assesses collision costs. NFOMP is further tailored to navigate dynamic environments and to robot swarms. The thesis is structured in a coherent and accessible manner. The proposed methodologies are grounded in the latest advancements in robotics and have demonstrated promising outcomes in addressing complex motion planning scenarios. Consequently, the findings carry significant scientific value. The author's contributions include outstanding publications, with first-authored articles in RA-L and ROBIO, as well as several co-authored works in prestigious journals and conferences. Below is a summary of the issues for the author to address.

Major comments:

1. What is the loss function for training ONF? It appears that Chapter 4.2 does not provide an explanation for this.
2. The second to last sentence on page 41 says "... calculated using the following formula". However, there is no formula presented. Please add the missing formula.
3. It is unclear where the loss defined in eqn. (4.6) is used. Additionally, please explain why the loss uses *BCELossWithLogit* function.
4. Please explain why choosing eqn. (5.4) to deal with dynamic environment. What is the use of this function? Besides, should it be a minus sign in eqn. (5.4), or should it be a summation sign?
5. Please comment on the scalability of the proposed method in multi-robot path planning. Has the proposed method been tested for a larger number of robots?

Minor comments:

1. Chapter 4.1 explained the objective function in CHOMP. Yet, it does not mention the name "distance loss" until before eqn. (4.1). It is therefore unclear whether "distance loss" refers to the loss in CHOMP. I suggest that the name "distance loss" be mentioned in the sentence "The main part of its loss function consists of ..." to avoid ambiguity.
2. P24, the first sentence in the second to last paragraph, i.e., "There have been also introduced ...", is incorrect in grammar. An alternative way is "There have also been several improvements introduced to the encoding methods used in NeRF."
3. Three lines below eqn. (5.5): "sequential" should be "sequential"

Provisional Recommendation

I recommend that the candidate should defend the thesis by means of a formal thesis defense

I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report

The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense