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Skolkovo Institute of Science and Technology

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: Jianke Zhu

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Jianke Zhu** **Date: 26-10-2024**

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

This thesis entitled as “Neural Field-Based Optimal Motion Planning Method for Differential Drive Robots with Nonholonomic Constraints, Robots in Dynamic Environment and Swarm of Robots” aims to develop a motion planning system that is able to deal with challenging obstacle with U-shape, movable objects and swarms.

The key contributions of whole thesis can be summarized into three aspects:

1) an obstacle neural field model to estimate collision loss by introducing Lagrange multipliers. A series of experiments have been conducted on the several benchmarks, which demonstrate the proposed model is quite effective;

2) the temporal information is taken into consideration to enable the neural field motion planner for dealing with dynamic scenarios. The simulation results on BeamNG.tech driving simulator show that the derived model can handle the movable objects;

3) the proposed model is adapted for the swarms of robots, including drones and warehouse robots.

Contribution 1 has already been published in RAL, which is thoroughly evaluated both quantitatively and qualitatively. However, the empirical studies on contribution 2 and 3 are a bit weak. In particular, there is lack of quantitative comparisons against the related methods for motion planner of swarm robots.

Some minor issues need to be fixed:

Chapter 1: discussions on relation between three key contributions are missing.

Chapter 2: a table to summarize different kinds of motion planners would be useful to understand the background. Moreover, the most recent studies are missing.

Chapter 3: Figure 3-1 is related to Sec. 3.1, suggest to move into the page 27.

Chapter 4: Table 4-1 needs to be moved before the last page of Chapter 4.

Chapter 5: The detailed descriptions on Figure 5-1 (a) (b) (c) (d) are missing. The font size of Figure 5-2 is too small.

Chapter 6: the comparisons against the related approach are missing.

The whole thesis could be improved by better illustration and reorganize the structures. More comparative studies are needed to validate the effectiveness of proposed models on various tasks.

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*