THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Multiagent path planning with kinematic constraints**
Author's name:	**Adam Beckert**
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Computer Science
Thesis reviewer:	RNDr. Jiří Švancara, Ph.D.
Reviewer's department:	Department of Theoretical Computer Science and Mathematical Logic, Faculty of Mathematics and Physics, Charles University

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment — **ordinarily challenging**

How demanding was the assigned project?

The task of the thesis was to modify the implementation of well-known MAPF algorithms to be able to deal with kinematic constraints. To this extent, the student was provided with an existing implementation of these algorithms. That being said, the changes needed were non-trivial and the student had to familiarize themselves with an existing code, which proposes different types of challenges.

Fulfilment of assignment — **fulfilled**

How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.

The student familiarized themselves with the algorithms, and their implementations, modified them to be able to handle the kinematic constraints of real robots, and performed experiments to compare all proposed algorithms, thus fulfilling all specified tasks.

Methodology — **correct**

Comment on the correctness of the approach and/or the solution methods.

The methodology used is correct. The student started with the existing algorithms and identified the differences and insufficiencies that needed to be changed in order to be able to handle kinematic constraints.

Technical level — **B - very good.**

Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?

The technical level of the thesis is adequate. It contains formal definitions, pseudocodes, and a presentation of experimental results. There are some minor oversights such as a missing definition of collision for the classical MAPF. Most importantly, I would appreciate a deeper explanation of the measured results to better understand the behavior of the algorithms (see below for detailed comments). Also, as the submitted code is based on a public repository, it would be nice to clearly distinguish which parts were written by the student and which are taken from the original repository.

Formal and language level, scope of thesis — **B - very good.**

Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?

The thesis is written in excellent English with only a few mistakes and typos. There are some typographical mistakes and incorrect labels (there are references to algorithm lines that do not exist). Overall, the thesis is easy to read with many illustrative examples.

Selection of sources, citation correctness — **A - excellent.**

Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the

standards?
The student uses relevant and novel publications that are the current state-of-the-art in the field of MAPF.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.

The thesis focuses on multi-agent pathfinding (MAPF), which is the task of navigating a set of mobile agents in a shared environment without colliding. Such a task is often found in robotics, thus it makes sense to modify the solving algorithms to deal with kinematic constraints during the planning phase rather than as a post-processing phase.
The student modified a well-known pathfinding algorithm SIPP and its two variants SIPPS and SIPP-IP to be able to both handle the kinematic constraints (SIPP-IP) and be able to deal with soft collisions (SIPPS), producing a new algorithm SIPPS-IP. This pathfinding algorithm is then used in the MAPF-LNS2 algorithm. To this extent, the student had to familiarize themselves with several state-of-the-art algorithms and make non-trivial changes to them.
Based on the measured results, the LNS2 with SIPPS-IP can find a solution faster than the compared LNS with SIPP-IP, however, the found solution is of worse quality (i.e. higher cost). The measured results could be better explained to understand why this sort of behavior happens. Also, it is a pity that the experiments ran on a laptop that was used during the experiments, as this could skew the results.
I would also appreciate a comparison with the classical LNS2 algorithm that uses some sort of post-processing to map to the kinematic constraints (such as MAPF-POST). It would better highlight the importance of SIPPS-IP and the comparison between LNS and LNS2. However, such a comparison was not part of the assignment, so I am not holding this against the student.

My question for the defense is if it is necessary to define the edge collision in the kinematic MAPF since the agents have non-zero size and always occupy 2 vertices during movement. Are all possible conflicts not covered by the vertex collision? Do you even implement a check for edge collisions in the code?

The grade that I award for the thesis is **B - very good.**

Date: **29.5.2024** Signature: