

## I. IDENTIFICATION DATA

Thesis name:	Cooperative path planning for a team of mobile robots
Author's name:	Tomáš Novák
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Control Engineering
Thesis reviewer:	M.Sc. Jana Jost
Reviewer's department:	Fraunhofer Institute for Materialflow and Logistics IML

## II. EVALUATION OF INDIVIDUAL CRITERIA

### Assignment

**challenging**

*Evaluation of thesis difficulty of assignment.*

The thesis topic to develop an algorithm for a real warehouse scenario as well as the multi-robot path planning are challenging tasks. There are just a couple of previous achievements on which the work can be based on.

### Satisfaction of assignment

**fulfilled with minor objections**

*Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.*

The student has discussed current approaches to collision-free path-planning for a team of cooperating robots and has presented the state-of-the-art algorithm Push and Rotate. For presenting the state-of-the-art more information about other complete algorithms except the Push and Rotate method is expected and missing here. He has developed algorithms to overcome the problem of multi-path planning for robots with previous defined simplifications. Also, the real warehouse scenario was the basement for evaluating the algorithms. The comparison between the developed algorithm and the described Push and Rotate method was just done theoretically and not simulated and evaluated. Instead he has compared two different ways of his algorithm (sequential and standard) which is important but for assessing the developed algorithm with the state-of-the-art it is not enough.

### Method of conception

**correct**

*Assess that student has chosen correct approach or solution methods.*

The student has thought about and explained the requirements for a real warehouse scenario and according to that made his assumptions about the consideration of these issues in his algorithms.

### Technical level

**B - very good.**

*Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.*

The state-of-art of path planning algorithms is very short. Although the task emphasizes on the Push and Rotate algorithm other algorithms should have been explained and compared to one another more in detail. Especially since there are other existing complete approaches. Maybe some ideas and some combination between those and the Push and Rotate algorithm would have been good for the development of the thesis.

### Formal and language level, scope of thesis

**C - good.**

*Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.*

There are minor mistakes regarding the language arrangement like using "we" and "I" instead of third person. Further on, the position of some figures should have been changed as well as some figures are used twice (3.10) although there should have been a difference. There are different fontsizes used in the figures. The division into (sub-)subchapters is too detailed



this somehow influences the reading of the thesis. There is a mixture between agent and robot. In the beginning of the work the term agent is used later on mainly robot and sometimes agents. There should be a consistent use or the words should be used synonymous but still the formal notation should be the same.

**Selection of sources, citation correctness**

**B - very good.**

*Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.*

The citation style in the bibliography is not strict. There are assumptions made which need confirmation by sources e.g. picking time, number of robots at charging station. Further on, the citation convention for figures differs from standards. Usually it has to be clarified if the graphic is made according to the source or if it is copied. The listed sources for a figure aren't listed in and linked to bibliography. Some assumptions are not correct. The fourth industrial revolution doesn't aim at warehouses without any humans instead it aims at helping the human worker with his tasks through new technologies e.g. AR and the adaptation of systems to the worker.

**Additional commentary and evaluation**

*Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.*

The chosen evaluation criterion suit the task. Besides evaluating two varieties of the developed algorithms an evaluation regarding the state-of-the-art what have been useful. Further on, the real warehouse scenario is just based on the layout. It doesn't become clear if real data from the warehouse management system is used. More important the behavior of the two types of robots (with and without rack) is not differing as much as it would in the real world. For example especially the stopping and starting movement would be different since the acceleration of a robot with a rack cannot be that fast concerning safety reasons.

**III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION**

*Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.*

I evaluate handed thesis with classification grade B - very good.

Date: **17.1.2018**

Signature:

