ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

REVIEWER'S OPINION OF FINAL THESIS

I. IDENTIFICATION DATA

Thesis name:	**Motion planning for seabed monitoring by Autonomous Underwater Vehicles**
Author's name:	**Robert Pěnička**
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Katedra kybernetiky
Thesis reviewer:	David Oertel
Reviewer's department:	Institute for Anthropomatics and Robotics (IAR) – Intelligent Process Control and Robotics (IPR), Karlsruhe Institute of Technology - KIT

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **challenging**

Evaluation of thesis difficulty of assignment.

The scope of this work is quite sophisticated since it required designing planning algorithms on a rather wide range of abstraction levels.

Satisfaction of assignment **fulfilled**

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 thesis submitted covers all the tasks and goals provided by the supervisor.

Method of conception **correct**

Assess that student has chosen correct approach or solution methods.

Several methods and approaches were discussed in the theoretical part and then some of them, based on RRT, were implemented in the practical/evaluation part of the thesis. The selection for the latter part was well justified. For the last part of the thesis, a mission planning system for multiple AUVs/robots, a well designed new algorithm was proposed which combines several well known robust algorithms from other planning systems. Other options are available but focus in this part was on practical feasibility rather than optimality as was desired by the supervisor.

Technical level **A - excellent.**

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

The professional level is well within the state of the art of robotics (motion planning) research.

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

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

The language level can be considered good. There are several minor mistakes in grammar and spelling. However, most of these can be corrected „automatically" by the reader. Above that, most aspects are explained clearly and comprehensible.

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

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.

Most relevant literature was considered. Since part of the thesis covers a partly new topic of research, there is not much literature available for this part. According to best knowledge of the opponent reviewer, the use of citations and references is according to general scientific standards.

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 thesis' author has submitted a work of high quality regarding both theory and evaluation. Parts of the thesis should be published and/or continued for further publications.

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 **A - excellent.**

The thesis covers a wide range of challenges in dynamically constraint motion and mission planning. Starting with schemes to relatively low-level motion plans for non-holonomic vehicles, the work is gradually extended up to a high-level mission plan suitable for an entire team of AUVs with recurrent recharging at a sea-bed station.
The scope of these diffferent levels of abstractions is quite impressive and almost extends the scope of a single diploma thesis.
It was shown, that suitable motion plans for AUVs can be found using RRT with either a direct control input or motion primitives based on Dubin's paths. The generated motion plans were then evaluated in simulation, using a dynamic modell and depth/heading controllers.
In the opponent's option, the most imporant and scientifically most sophisticated part is covered in chapter 5, where a high-level mission planner for multiple AVUs is combined with the motion planning derived in the previous chapters. By smart use of adapted well-known algorithms, a sub-optimal but practically feasible mission planner was derived for an actual NP-complete problem, which is one of the core competences in algorithmic research.
All in all, the thesis covers all aspects desired by the supervisor with excellent results.

Questions:

1) Do you think it is absolutely necessary to evalute every generated Dubin's path using the Simulink model and controllers? Should it not be enough to evaluate some basic characteristic Dubin's paths (LSR, LRL, ...) once with the modell and controller and then assume all generated paths using these primitives will be feasible?
2) What would be the main advantage/disadvantage of the adaptations proposed in question 1?
3) Explain why the algorithm in chapter 5 is currently limited to at most 3 AUVs and under which circumstances and adaptations it could be expanded to more AUVs?
4) Do you know an (easy) way to adapt the proposed mission planning to several docking-stations and e.g. 3 AUVs per docking station?

Date: **25.1.2016** Signature: