THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Comparison of Mapping Algorithms for Deployment Onboard Robots with Uncertain Pose**
Author's name:	**Msalha Omar**
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Cybernetics
Thesis reviewer:	Martin Pecka
Reviewer's department:	Department of Cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment — ordinarily challenging

How demanding was the assigned project?

The assignment required that the student finds and evaluates several existing occupancy mapping algorithms. An evaluation scheme for precision of these methods should also be proposed and verified.

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 has examined three existing occupancy mapping frameworks, integrated them into the MRS framework and used them to generate and evaluate map data. An evaluation scheme was also proposed and used to compare the mapping methods under varying uncertainty of pose.

Methodology — correct

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

The data collection procedure that generates ground truth data for mapping framework comparison seems to be fair and makes it possible to evaluate various algorithms on the exact same data. The three proposed metrics give a good insight into the way how the algorithms work and how are they influenced by pose uncertainty.
I do not, however, support the idea that each voxel containing even the smallest part of an obstacle should be reported as occupied by the mappers (this implies from eqs 2.15 and 2.16). All the voxel-based mapping frameworks discretize the space and as such, each voxel should represent what the majority of its volume represents. There may be special cases requiring the chosen approach (like safety bumper controllers), however, the reasoning for this choice is not present in the thesis.

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 approach used in the thesis is valid and suitable. The student has attached the software framework used for evaluation and data generation, as well as documentation on how to run it.
I would only like to see more complex geometry present in the evaluated terrains because the primitive shapes used to construct the worlds are not a very good approximation of real-world obstacles (in general).
There are also minor problems with the attached source code. All ROS metadata files (package.xml) contain nonsense data (non-existing maintainer email addresses, license called TODO, version 0.0.0 and so on). Some of the provided scripts use hard-coded paths that will not exist on any other computer than the student's one. These paths are not exposed as parameters. The C++ source code is an unexpected mixture of modern and historical C++ (e.g. it requires C++17 support, but uses the historical BOOST_FOREACH to iterate over collections). The attached readme file contains information on how to run the code, but not information on how to install it and its dependencies.

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Formal and language level, scope of thesis	A - excellent.

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 formal part of the work is good. English language is properly used. The work is easy to read and understand.

Selection of sources, citation correctness	F - failed.

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 work cites a large number of relevant publications.
The student failed to clearly mark figures copied from other publications. At least figures 1.2 and 1.4 are copied and their labels do not suggest the reader that these are not original figures created by the author. Citations (bracketed numbers) of the relevant works are present in these labels, but it is very unclear whether the citation only relates to the presented idea, or if it means that the whole image was taken from the publication.
In the list of references, there are some nonsenses, e.g. [23] and [25]. Also, [6] has wrong diacritics in the 1st author's name (it only carries half of it).
Capitalization of some words in the list of references is wrong.

Additional commentary and evaluation (optional)

Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.

Technical comments:

- p. 6: hash table does not have asymptotic lookup complexity of O(1). This is only true for the average amortized complexity.
- p. 11: footnote points to a webpage of reseller instead of original manufacturer
- Chapter 2.4: There is very distracting mix of meanings of the word "node". It is used both to denote a ROS node and to denote an octree node. However, in many places, just "node" is used.
- Figure 3.1: Subfigures c, f, i apparently use a different color scheme than the others. However, the figure label states that all subfigures use the same color scheme.
- Chapter 4.4.2: "The results show that the number of incorrectly classified voxels is decreased when using lower resolution in all of the methods". Lower resolution usually means coarser, less detailed. It seems the author wanted to express the other direction.

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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 student has fulfilled the tasks given in thesis assignment. Several existing occupancy methods were integrated, evaluated and tested for the purpose of UAV mapping. Several improvements of the methods were proposed and also evaluated.

The chosen approach is valid and suitable, even though I think the classification of voxels could be set up in a better way.

The weakest part of the thesis is citations. Several figures do not clearly state they are copied from other works. And the list of references has also some non-trivial issues.

Questions for thesis defense:

1. How would the comparison change if a different definition of occupied/unoccupied cells would be used (the one based on majority of volume)? Did you test for this?
2. What were the CPU and memory requirements of each of the methods? Was the latency significantly different for some of the methods?
3. Would the 0.5 m resolution presented as algorithm improvement be actually practically usable for some use-case?
4. Do you know if any of the occupancy mapping frameworks has support for loop-closures? How does (could) that work?

The grade that I award for the thesis is C - good.

Date: 05.06.23

Signature: