THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Map Management System for Visual Teach and Repeat Navigation**
Author's name:	**Vivek Punia**
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Cybernetics
Thesis reviewer:	Ing. Petr Štibinger
Reviewer's department:	Department of Cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment — challenging

How demanding was the assigned project?

The goal of the thesis is to develop and integrate a map management system for Visual Teach and Repeat (VT&R) navigation of mobile robots. The work includes metadata extraction from the maps obtained during the teaching process, spectral analysis to discover periodic patterns in the data, implementation of a database to hold the data and the creation of a planning heuristics for the repeat process. The work is research-oriented with the goal of applying VT&R methods for long-term deployment of autonomous robots.

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.

All tasks given in the assignment have been fulfilled.

Methodology — outstanding

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

The author has chosen a scientific approach to the given problem. The chosen methodology is well explained, and the challenges of a real-world deployment of mobile robots are taken into consideration. The author observes that there are several criteria that can be optimized in the used approach, and discusses the necessary trade-off between fast and robust navigation needs. The theoretical assumptions are backed up by results from several real-world experiments.

Technical level — A - excellent.

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 thesis combines state-of-the-art concepts from multiple domains of robotics. I would appreciate a slightly more detailed description of the core concepts and the framework which the work is extending. It is clear that the author has a deep knowledge of the topic, but several concepts are only mentioned by keywords followed up by a reference. This approach is common in short scientific articles, but breaks the flow of a longer thesis.

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 text is well structured and mostly easy to follow. The work contains an appropriate number of accompanying illustrations and graphs. The extent of the work is adequate for a master's thesis. There are minor formal inconsistencies in references to parts of the thesis itself. Both lowercase and uppercase letters are used when a figure is referenced (e.g. section 4.1.2). Given the same numbering style for sections, figures and equations, it is always necessary to clarify, which

one is being referenced. Notably, there are several references to "(3.3)" and from the context it is sometimes not clear if the author references "equation 3.3" or "section 3.3".

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 author presents a thorough review of the state of the art, and the core concepts of the work are backed up by recent publications in respected scientific journals. The style of the bibliography and the number of references are adequate for a master's thesis.	

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 author has developed a map management system for use in VT&R techniques for mobile robots. The work includes the design of a map database, and metadata extraction from the raw map inputs. Spectral analysis of the data is performed with the goal of exploiting periodicity in the measurements in both short-term and long-term horizons. The author has established several criteria to select a suitable reference from the database during for the robot's navigation. The presented methods have been demonstrated in experiments conducted on real-world data gathered by two different robotic platforms operating in various outdoor environments.

The grade that I award for the thesis is A - excellent.

Questions for the defense:

In Section 3.1, you are advocating for a centralized data storage on a powerful server that all robots can pull the data from. The server should perform all the heavy computation and provide the robot with only the most suitable map from the database.

1) How large are the files that the robots are working with? What kind of data does the robot send out and what is the server providing as a response?
2) How often does the robot need to call the database and pull new data during its mission?

Date: **1.6.2023** Signature: