CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE

THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	Multi-Goal Path Planning for Spray Writing with Unmanned Aerial Vehicle
Author's name:	Arseniy Tkachev
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of electrical power engineering
Thesis reviewer:	RNDR. Miroslav Kulich, Ph.D.
Reviewer's department:	Czech Institute of informatics, robotics and cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment — ordinarily challenging

How demanding was the assigned project?

The thesis addresses a variant of the Generalized Traveling Salesman Problem, which is known to be NP-hard and state-of-the-art methods generating good-enough solutions in a reasonable time are not trivial. To model a behavior of a real hexarotor, a curvature-constrained Dubins vehicle is employed. Finally, one of the goals is to develop a new font suitable for the multi-goal planning. This can be a standalone topic for a bachelor thesis if done honestly.

Fulfillment of assignment — fulfilled

How well does the thesis fulfill 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.

Formally, the student fulfilled all the tasks specified in the assignment. He got familiar with multi-goal planning methods, developed a new font, presented a method for spray writing and experimentally evaluated its performance. The presented work, nevertheless, is very minimalist. It looks like the student tried to fulfill the assignment with least possible effort.

Methodology — partially applicable

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

I see the approach to the planning problem valid. The formulation of the spray writing problem as GTSP and determination of distances between nodes as lengths of Dubins curves is interesting and feasible. On the other hand, I have doubts about the developed font. I would expect that the student will study font design more deeply so he can vindicate the font he designed. The designed font is very primitive and it is questionable, whether the student followed the rules and recommendations for a proper font design. Moreover, the whole alphabet is not presented so it is not clear, whether (and how) all characters were actually designed. For example, were lowercase letters also considered to be designed?

Technical level — D - satisfactory.

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 code is written in Python and third party libraries are used for Dubins paths generation and the GTSP solver. It is thus questionable, what the contribution of the student is and how much effort he dedicated to the implementation. Moreover, the description of the the algorithms is very shallow and it does not provide the evidence that the student understands their principles.

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Formal and language level, scope of thesis	D - satisfactory.

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 written in English. Although grammar and style could be improved, it is well readable and understandable. My main objections are to the level of detail the algorithms are described and the relevance of the description of geometrical representation of fonts. Instead of the current text, I would expect a discussion about font design, font families, whether to use serif or sans serif, etc. It is also not clear to me, why Bezier curves cannot be used for spray writing. For example, could it be possible to represent the "C" character with several Bezier segments and consider them as a single segment in the GTSP solver?
The experimental section is written very economically. It only shows that the planning algorithm works, but without any detail about its properties. For example, it will be interesting to see dependence of trajectory length and time to traverse the planned path on the turning radius. What is the complexity of generating Dubins paths in the experimental scenarios? The student claims that the experiments showed that the UAV precisely followed the planned trajectories, but this is not supported by any data. What is this precision in dependence on UAV speed?

Minor issues:

- Table 3.2 should contain also Node "f"
- It looks like the sequence of nodes in Figure 3.4 is visualized for distances determined as lengths of Dubins paths, although it is referenced in the paragraph describing Euclidean distance.

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 number of references is more than enough. All references are relevant and the citations meet the publication standards.

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.

I have many complaints to the text and doubts about the amount of work done. The student, nevertheless, fulfilled all assigned tasks and I recommend to accept the thesis.

The grade that I award for it is D - satisfactory.

Date: 06/10/20 Signature: