THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**A coupled approach to Watchman Route Problem**
Author's name:	**Štefan Trusina**
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Computer Science
Thesis reviewer:	Ing. Jindřiška Deckerová
Reviewer's department:	Department of Computer Science

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	**challenging**

How demanding was the assigned project?

The thesis should deal with the solution of the Watchmen Route Problem (WRP) and the underlying Traveling Salesman Problem with Neighborhoods (TSPN), where the neighborhoods are of a hybrid - polygoncircle - shape.

The student should familiarize himself with a variant of the TSP with disk-shaped neighborhoods referred to as the Close Enough TSP (CETSP) and the state-of-the-art methods in the solution of routing problems. Then propose a method to find the shortest path between two points and the polygoncircle neighborhoods. The proposed method then should be utilized in the GLNS solver to address the studied problem. Furthermore, the student should design and implement an algorithm that generates a set of polygons covering a given polygon with holes. Lastly, the student should combine the implemented method that generates polygons and the proposed method solving the TSPN to solve the WRP and empirically evaluate the proposed method.

The assignment is challenging since the student is required to study the literature regarding two well-known problems, design and implement two solvers, and empirically evaluate the proposed methods.

Fulfilment of assignment	**fulfilled with major objections**

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 significant parts of the assignment have not been fulfilled nor addressed.

It is not clear that the student has familiarized himself with a variant of the TSP with disk-shaped neighborhoods (CETSP) since there is no overview of the state-of-the-art methods and related work regarding the CETSP and the studied problem at all.

The student proposed a method to solve the shortest path between two points and polygoncircle that is based on the existing method of solving the shortest path between two points and a polygon. And the proposed method is utilized in the GLNS solver to address the herein studied TSPN as required.

The requirement to propose and implement an algorithm to generate polygons covering a given polygon with holes has not been fulfilled. The student did not implement a solution; only utilized the existing solver Face 2D together with another existing solver to find the shortest path. However, the literature overview of the literature and state-of-the-art methods nor the discussion to support the utilization of the existing solver is missing.

Furthermore, it is not clear how the modified GLNS method and polygon generating algorithm are combined to solve the WRP since it is not explicitly described in the thesis.

The proposed method is empirically evaluated; however, the reasons for selecting the baseline methods [1,2] are not elaborated. Furthermore, the difference between the baseline methods and proposed methods is unclear.

[1] J. Mikula and M. Kulich, "Towards a continuous solution of the d-visibility watchman route problem in a polygon with holes," IEEE Robotics and Automation Letters, vol. 7, no. 3, pp. 5934–5941, 2022.
[2] J. Faigl and L. Přeučil, "Inspection planning in the polygonal domain by self-organizing map," Applied Soft Computing, vol. 11, no. 8, pp. 5028–5041, 2011.

Methodology	**partially applicable**

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

The method proposed in the solution of the TSPN in the thesis is correct; however, the overview of the studied problems and their solutions is not sufficient. It is not clearly stated the difference between the state-of-the-art methods and the proposed method and why to use the proposed method. Furthermore, the contribution of the thesis is not well defined. Besides, the empirical evaluation of the proposed method is not sufficient. It is not clear why the student selected the framework from [1] for the comparison and why using the SOM method [2] as a reference solution.

The replicability of the proposed method and results is low since the crucial parts of the method, such as parameter settings, are not described at all.

[1] J. Mikula and M. Kulich, "Towards a continuous solution of the d-visibility watchman route problem in a polygon with holes," IEEE Robotics and Automation Letters, vol. 7, no. 3, pp. 5934–5941, 2022.
[2] J. Faigl and L. Přeučil, "Inspection planning in the polygonal domain by self-organizing map," Applied Soft Computing, vol. 11, no. 8, pp. 5028–5041, 2011.

Technical level	**E - sufficient.**

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 crucial parts of the research that support the student's expertise in the field are missing. Such as the overview of the state-of-the-art methods in the solution of the herein studied problems and the motivation. It is not explicit why the student is solving the TSPN in the polygonal domain, why the proposed method is better than the state-of-the-art methods such as [1], and the contribution of the thesis.

The particular chapters of the thesis are not very well processed. The expected structure of the thesis is not followed. With the aforementioned missing motivation and overview of the state-of-the-art methods, there is no conclusion to the thesis. Overall description of the proposed method is vague.
Furthermore, the student is comparing his method to arbitrarily selected reference rather than the best-known solution, and these untypical metrics are not sufficiently explained.

Overall, the technical level of the thesis is poor.

[1] J. Faigl and L. Přeučil, "Inspection planning in the polygonal domain by self-organizing map," Applied Soft Computing, vol. 11, no. 8, pp. 5028–5041, 2011.

Formal and language level, scope of thesis	**F - failed.**

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 overall quality of the text is poor. Expected parts of the thesis are missing, such as the overview of the state-of-the-art methods and conclusion. The contribution of the thesis is not clear, and its motivation is not discussed.

The notation in the thesis contains significant inconsistencies, e. g., in section 3.1.1, the focal points are denoted as A and B, and suddenly the focal points are referred to as F1 and F2 in the next paragraph.
Figures are not sufficiently described, e. g., Figure 2.2 and Figure 3.10, and titles of subfigures are missing, e. g., Figure 3.7 (a) and Figure 3.7 (b).
Furthermore, it is hard to follow students' ideas and workflow since the cross-referencing is missing, for instance, in section 3.1.5 and the parts with examples.

The thesis is not well-presented. Moreover, the thesis does not follow the official requirements as the Czech abstract is missing.

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 thesis has an insufficient number of citations, only seven. The student may not have adequately studied the related work, e. g., the crucial citations for the well-known WRP such as [1,2,3], or the TSPN such as [4,5,6,7] are missing.

The citation of "Fade2D" software [5 - in the thesis] is wrong as it does not comply standard way of citing software/web pages.

[1] Chin, W. P., & Ntafos, S. (1986). Optimum watchman routes. In Proceedings of the second annual symposium on Computational geometry (pp. 24-33).
[2] Carlsson, S., Jonsson, H., & Nilsson, B. Finding the Shortest Watchman Route in a Simple Polygon. Discrete Comput Geom 22, 377–402 (1999).
[3] Dumitrescu, A., & Tóth, C. D. (2012). Watchman tours for polygons with holes. Computational Geometry, 45(7), 326-333.
[4] Arkin, E. M., & Hassin, R. (1994). Approximation algorithms for the geometric covering salesman problem. Discrete Applied Mathematics, 55(3), 197-218.
[5] De Berg, M., Gudmundsson, J., Katz, M. J., Levcopoulos, C., Overmars, M. H., & Van Der Stappen, A. F. (2005). TSP with neighborhoods of varying size. Journal of Algorithms, 57(1), 22-36.
[6] Gudmundsson, J., & Levcopoulos, C. (1999). A fast approximation algorithm for TSP with neighborhoods. Nordic Journal of Computing, 6(4), 469-488.
[7] Gentilini, I. & Margot, F. & Shimada, K. (2012). The travelling salesman problem with neighbourhoods: MINLP solution. Optimization Methods & Software.

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.
The assignment and the problem that should be solved in the thesis are interesting, and if appropriately solved and described, the proposed solution can be expected to have a scientific value.

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 thesis focuses on the solution of the well-known WRP, mainly the solution of the TSP with convex neighborhoods. Even though the thesis's topic sounds promising, the execution fails. The crucial parts of the assignment are not fulfilled. Overall, the quality of the thesis is poor. The expected parts of the thesis are missing, such as the motivation, the related work, and the conclusion. The description of the utilized methods is vague.

Furthermore, it is not clear what is the thesis's contribution to the field of the study. Besides, the work with literature and citations is dire. Only seven citations on such well-studied problems as the WRP and TSPN are highly insufficient. The metrics used for the empirical evaluation are poorly used and commented on. The selected baseline methods, reasons for their selection, and the differentiation of the proposed method from them are not elaborated upon.

During thesis defense, I propose to ask the following questions:

- The results indicate that the proposed method should perform better for instances with a small number of regions than the state-of-the-art method. Is there any intuitive explanation for such performance?

- It is stated that the point P* found by the PPCP algorithm is optimal, see section 3.1.3. Is it guaranteed that the P* is optimal? Moreover, is the solution of the TPCP optimal?

The grade that I award for the thesis is **F - failed.**

Date: **3.6.2022**   Signature: