THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	Fúze radiačních a hloubkových měření pro bezpilotní helikoptéru
Author's name:	Zribko, Tadeáš
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Computer Graphics and Interaction
Thesis reviewer:	Ing. Jan Mrkos
Reviewer's department:	Department of Computer Science

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **extraordinarily challenging**

How demanding was the assigned project?

The assignment covers both the development of algorithmic methods with the application of these methods to the hardware and real-life evaluation with said hardware. As such, I would rate the assignment as extraordinarily challenging.

Fulfillment of assignment **fulfilled with minor objections**

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.

The student has fulfilled the assignment in all parts. However, due to the extraordinarily challenging nature of the assignment, many aspects of the solution appear to be superficial.

Methodology **correct**

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

Methodologically, I have one major objection regarding the simulated radiation sources. It is not discussed in the thesis how the size of the radiation sources impacts the methods used and whether background radiation would be an issue for detection with smaller sources.
Using simulated environments with obstacles goes a long way toward showcasing the viability of the approach, but it's not clear whether the obstacles interact with the emitted radiation or whether they only hinder visual detection.

Technical level **C - 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 thesis is overall sound, but many decisions seem to be insufficiently explained or not covered with the depth they would warrant.

The section on radiation seems to me a bit alarmistic and simplifying. While I understand that a description of radioactivity is not the main focus of the thesis, highlighting certain types of radiation as "the most deadly" is inappropriate for scientific work (at least without any foundation). Also, while the section distinguishes different kinds of radiation as alpha, beta, and gamma, it then mixes them up again, such as using x-rays in the examples, which are another kind of ionizing radiation. One paragraph then overly focuses on the deadlines of the general "radiation" without quantification, qualification, or citation (e.g., "… animals exposed to radiation … leads to the collapse of the food chain…"). This seems to me unfounded. The Compton camera description then mentions only "radiation photons", implying that the whole work focuses solely on photon radiation and not on particle radiation.

Is the cone description described in 3.1. the output of the camera? If it is, it's not clear from the text why an alternative cone description of the Compton cone is needed; the coordinate transformation from the succinct cone variables into xyz is poorly motivated, and it seems to me the points on the cone could be easier to sample using the original description of the cone. Also, it's not clear why the sampling is needed at all; any cone is fully defined by its origin, point on its axis, and point on a surface. If the camera outputs data in some other form, then the "Sampling" chapter should start with that. If

the goal of the sampling is to get the point cloud out of the cone that will intersect with the point cloud from the depth measurement, that too should be mentioned, but that sounds like a problem solved by ray tracing algorithms.

Regarding the clustering of the particle filter output, unsupervised clustering with an unknown number of classes is a problem with large sota, maybe some established algorithm would work better?

For the simulated detection experiments, I would be interested in results showing the dependence of the distance of the aerial circle navigated by the drone from the radiation source; flying over the source seems to overly simplify the task. However, the simulations done in complex environments alleviate these concerns.

Other notes:

- The equation 2.1 does not have the meaning of the variables explained.
- The meaning of "depth" within the Compton camera sensor is not clear.
- The Compton cone seems to be just a cone.

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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 thesis is well-structured and appears to be free of typos. However, many sentences use non-English idioms, non-English structures, or incorrect words. For example, in the introduction, consider the sentence "A discovery which has fatally improved medical diagnoses…", "… potential possible sources of radiation", "on the other side" instead of "on the other hand". The most glaring issue with the text is the lack of cohesion within the paragraphs; the text could be improved by joining sentences with adverbs (therefore, however, …) to guide the reader through paragraphs. However, all these issues do not significantly hinder the readability of the text, which is quite easy to follow and of generally high quality.

Selection of sources, citation correctness **B - very good.**

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 state-of-the-art section appears to be one of the weakest sections. It's not clear whether the algorithms discussed pertain only to UAV-based search for radiation sources. The gradient ascent is also an iterative method, unlike what the text implies. Overall, the focus of the work is not clear from the state-of-the-art section. Is the main innovation in the developed search algorithm, is it the use of a novel sensor, or sensor fusion, or is it the integration and testing of the whole system, and what is the state-of-the-art in each? However, the rest of the introduction makes it clear that it's the integration and testing of the whole system.

The references seem to superficially cover a large breadth of the knowledge, but this is understandable with such a complex assignment. The references seem to be ordered randomly.

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.

Please insert your comments here.

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III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

The student managed to fulfill the extraordinarily challenging assignment set out for this thesis. While I have many objections regarding the low depth of the work in many aspects of the assignment, this is to be expected with a bachelor thesis attempting such a large undertaking, and I commend the student for managing so many different aspects of this work successfully.
Nevertheless, the presentation of the work in the thesis suffers from a lacking motivation in many sections. Methodologically, I see the biggest issue in the simulated nature of the radiation; it's not clear whether the proposed solution would work at all in the presence of smaller radiation sources and background radiation.

Questions:

1. Why is cone sampling needed? Would it be possible to calculate the intersection between the analytical description of the cone and the point cloud description of the 3D scene directly, without sampling the cone surface?
2. In the simulations, are the environmental obstacles between the source and the detector assumed to shield parts of the radiation intensity? How would the detection rates be impacted when trying to detect partially shielded radiation sources that emit beams of different intensities in different directions?
3. The work mentions using Cs-137 as the radiation source. What was the radioactivity of the source (meaning its intensity)? How sensitive would you assess the proposed detection methods to be regarding the different levels of source radioactivity and background radioactivity?

The grade that I award for the thesis is **B - very good.**

Date: **12.6.2023** Signature: