FACULTY OF ELECTRICAL ENGINEERING CTU IN PRAGUE

THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis Title:	**Adaptive Local Binarization to Improve the Performance of the UVDAR-COM System**
Author's Name:	**Marlon Rivera Muñoz**
Type of Thesis:	master's thesis
Faculty/Insititute:	Faculty of Electrical Engineering, Czech Technical University in Prague
Department:	Department of Cybernetics (13133)
Thesis Reviewer:	Ing. Martin Zoula
Reviewer's Department:	Department of Computer Science (13136)

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment: **ordinarily challenging**

How demanding was the assigned project?

The goal was to improve the performance of an existing UAV onboard subsystem for tracking UV beacons wielded by another vehicle with adaptive thresholding of grayscale images. As the field deployment was optional, the whole assignment may be deemed ordinarily challenging.

Fulfilment of assignment: **fulfilled with minor 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?

The student reviewed existing approaches to adaptive thresholding, which were, however, not compared to the proposed methods, even if in a discussion. Apart from the method implementation, the submitted files contained around 1000 lines of supporting code, indicating a major effort was spent integrating the component into the existing system. A significant part of the thesis concerns field deployment, which is marked optional in the thesis assignment. Given the presented results, the effort might have been invested in rigorous off-line evaluation of the proposed methods in more challenging scenarios rather than field deployments. Although the proposed methods do not always improve over the baseline, the task may be seen as fulfilled.

Methodology: **correct**

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

The methodology is sound, and the proposed methods seem applicable to the solved task.

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 statistical significance of the presented data is questionable; it seems only a single UAV flight per investigated setup was used. Conclusions are often based on ad-hoc observations; proper hypothesis testing by established methods is absent. Evaluation metrics are not properly defined, ambiguous and inconsistently used. Evaluation is also limited to simple scenarios with no further sources of UV radiation like the Sun, which neglects one of the prime motivations of the work. Characterization or discussion of the experiment setup or computational demands is very vague. The thesis contains multiple fuzzy sections, such as the description of the localization system used in field deployment. Some Figures like 3.19 or 5.9 are meaningless or do not support related statements. The proposed methods are not inventive but off-the-shelf verified baselines applied to novel settings. Further, the student claims he implemented the *Otsu's* method, yet he merely used the OpenCV implementation. Although the thesis leaves a lot of room for questions, the presented evaluation was sufficient to prove certain features of the proposed solution.

Formal and language level, scope of thesis:	**E — sufficient**
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, correct and understandable?	
The thesis is hard to follow, with poor structure, many typographical issues, grammatical mistakes (missing verbs, sentence stubs), and typos. Notably, the existing methods summary spans Section 1.2 ("Related works"), Chapter 2 ("Preliminaries") and even Chapter 3 ("Problem statement"). Some abbreviations are not introduced at all ("SVM"), some are introduced twice ("CDF", "RTK"), and others are used inconsistently ("w.r.t."). Figures are disruptive and sometimes even missing mentioned data. (E.g., Figure 3.4 misses the 10 000 µs bar or Figure 5.12 lacks highlighting of data collection distances.) The proposed methods would greatly benefit from illustrations of the probability distributions. Formal mathematical language is scarce and completely absent in problem statement or method evaluation. The problem statement mentions only "one of the goals". Math notation is abused, e.g., in Section 3.1, where a threshold T is defined constant despite the rest of the thesis requiring $T(x, y)$. Listed algorithms do not follow any single convention. The author uses the letter "u" instead of "μ" and disregards any conventions on typesetting physical units, switching between "meters" and "m". Words like "few", "certain" or "seems to have" are often used instead of exact numbers. Not even the abstract is free of mistakes; both the Czech and English versions contain a sentence stub and an unexplained abbreviation. The thesis extent may be considered adequate. Overall, a significant effort is required to digest the thesis.	

Selection of sources, citation correctness:	**E — sufficient**
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 draws from a number of relevant sources, both from the worldwide community and the MRS team. Student's contribution is distinguished from such foreign works. In Chapter 2, the author uses foreign illustrations heavily, marking the figure sources possibly ambiguously. This leaves room for doubt if illustrations like Figure 2.2 or Figure 2.9 are indeed the author's work or if the author forgot to declare their source. The term "L12-P0.500000" is referred to be used [4], but the paper does not contain such a string. I cannot see any pattern in the reference ordering: The first references appearing in the thesis are [46] on page xii and [34] on page 1; those are not alphabetically first in any listed fields. Formally, the references suffer from numerous inconsistencies: Some include the Digital Object Identifier URL, but some have an ad-hoc URL. Some references have downgraded letters in the work titles ("qos" instead of "QoS"), some works have the list of authors shortened by the "et al." but others not, etc.. Miscellaneous references like GitHub repositories lack the "cited on" note, which is against applicable guidelines. Some sources like [11] do not include page ranges in the proceedings and other information provided in other similar references.	

III. SUMMARY, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

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 clearly needs to improve on many issues, spanning the quality of presented results, fluency or formal delivery. However, the presented conclusions, mainly the possibility of using a shorter exposition time, are justified enough and, therefore, admissible. Likely, the student invested a major effort in method integration into the existing system, which might have left less time for the thesis itself or for a more thorough method evaluation. I ask the following for the defense.

1. The camera effectively samples the transmitted signal. What are the requirements for the camera frame rate with regard to the frequencies present in the transmitted message?

2. In the thesis you use a measures called "presence" and "error rate". (E.g., in Table 5.1 or Figure 5.2, respectively.) Please formally define the terms. How are the two terms related to each other?
3. Why did you choose particularly the signals 0, 1 and 3 for the evaluation? In Figure 5.17, what is the reason the "Presence rate" of signals 1 and 3 was tightly correlated?
4. Please provide illustrations and formal definitions of how you construct the distributions Q_b and Q_f. Does the KL divergence method introduce noise in its own right, or is it rather susceptible to the existing noise?
5. What is the key limitation of the presented system for achieving communication ranges of 60 or even 300 m as with the referenced state-of-the-art methods?

I suggest to award the thesis with classification grade **E — sufficient**.

Date: June 5, 2024 Signature: