Recenzja spełnia wymogi formalne
Przewodniczący Rady Dyscypliny
Inżynieria Lądowa, Geodezja i Transport

Review of Muhammad Fawad's Doctoral Thesis

Thesis title: BIM-based Framework of Bridge Health Monitoring Supported by Immersive and 3D Reconstruction Techniques for Analytical and Asset Model Updates

I was provided with this thesis as part of the preliminary review process in the doctoral procedure. This allowed me to propose modifications that could be considered and evaluate the Candidate's responsiveness to critical feedback, as reflected in the acceptance or rejection of the suggested revisions. I had previously submitted a detailed, annotated version of the thesis for the preliminary discussion, and the current version has been prepared following the Candidate's incorporation of my comments and suggestions, along with feedback from that initial discussion.

In the following, I will assess the doctoral thesis based on a general set of criteria I have deemed appropriate, as no specific guidelines have been provided to me.

1. Timeliness

The thesis is timely, with a very modern choice of topic and subsequent scientific research and development. It is, therefore, of interest to academics and professionals.

2. Structure

The thesis is a comprehensive work of 103 pages, using a bibliography of 243 items. In contrast to the effectively book-like 7-page table of contents of the preliminary material, we now have a 2-page list of substantial scientific rigor. The total 139 thesis pages, including the bibliography and appendices, are now acceptable, i.e., a significant revision and 'condensation' of the preliminary material. The structure of the thesis has also been improved to a large extent by the Candidate, who has accepted and applied most of the improvements I had indicated in the preliminary material. Chapter summaries can still be found in the thesis; I feel this is redundant (as with the ones marked in the preliminary material).

3. Literature Review

The processing and incorporation of 243 literature sources over 12 pages into the thesis, in coordination with the Candidate's research and development work, is a considerable achievement. The only omission is that the own publications are not separated, making it difficult to extract the Candidate's work in this area.

4. Methods

The methods used in the R&D activities are modern, forward-looking, and have great potential for further development. The combination of methods used will further enhance these potentials. Having posed the problems, the Candidate has made an excellent choice of measurement, analysis, and processing methods and has skillfully identified and included the necessary background of tools. The presentation and evaluation of the results obtained are also good.

5. Original Contributions

Compared to the paper prepared for the workshop discussion, the final version of this paper presents the new scientific results in a much more structured and understandable way. (I will refer to the new scientific results as theses.) The Candidate has abandoned the distinction at the sub-thesis level and has summarized his scientific results in three distinctive and defensible theses. My only complaint is that these could have been presented in the appropriate chapters, not just in the summary chapter at

the end of the thesis. In support of the theses, it is the practice of our Doctoral School to cite one's publications. For Thesis 1 and 2, there is a reference in the text, but for Thesis 3, there is no reference at all.

6. Detailed Review and Questions

Page 14: MEMS systems are usually based on electromechanical solutions rather than electrochemical ones, although chemical solutions are not far from their world. They follow their mechanical roots in their design.

Page 21: Terrestrial and airborne photogrammetry can be combined, and it is even advisable to opt for a hybrid solution because of the problems described by the Candidate. I interpret drone (UAV) photogrammetry here as part of aerial photogrammetry.

Page 22: In laser scanning, both aerial (ALS) and terrestrial (TLS) solutions are mentioned in a similar way, and the drone solution (ULS) also seems to be spreading nowadays.

Page 24: Visual Programming is not, in my opinion, part of AI; it can be used independently of AI and is even being used. The inclusion of AI will obviously make VPL systems more efficient.

Page 44: The phrase "as proposed in this research paper" was presumably a term used in a separate publication; it just happened to be left as it is.

Page 46: Wouldn't the temperature load range be +60/-20 °C (as opposed to the reverse in the thesis)?

Pages 66-67: DHT22 and MPU6050 are not wireless sensors! They can be connected to a platform as a simple digital or I2C output, which becomes wireless thanks to the onboard device or additional shield. So, I prefer to suggest the term "wireless sensor node", e.g., for the Kurow bridge, where the horizontal distance between MET and ACC points is 56.80 m (see Fig. 4-13). However, a single board can handle several sensors; the term node can also treat these.

Page 70: It is unclear from the text what the geometric dimensions of the "lab-scale bridge" are. What was the planned measurement scenario since some periodic motion is assumed based on the gyro data?

Page 72: The Visual Studio setup details are exaggerated compared to the other chapters of the paper (sln, builds, and IP address setup are deeper technical than in the other places - unjustified)

Page 74: The difference between traditional and MR-based SHM is not solely due to visualization, contrary to the Candidate's claim, as he assigns the application of the IoT solution to the latter only. In fact, I think there are three basic cases: basic SHM, SHM + IoT and SHM + MR. Traditional SHM is actually far inferior in visualization to the MR version (it would have been really "cool" if the result from the software Axis was incorporated into the mixed reality, not a simple dashboard representation.)

Pages 85-86: Were the temperature measurements simple read-outs, or was there any calibration before they were taken? Calibration is also an essential issue for the other sensors.

Pages 97-99: I think the Final conclusion chapter is also unjustified in a PhD thesis because of its specificity.

Page 99: Probably the most important chapter, as this is where the thesis, the Candidate's own independent scientific results, appear. These should (as I have written before) have been brought in the appropriate chapters and proved by a series of his own publications.

7. Language and Presentation

The technical-scientific text in this thesis follows precise, readable wording. With a few negligible exceptions, the difficulty of approach and the comprehensibility of the chapters are homogeneous; I emphasize this especially because English is a foreign language for both the writer and the reader. The terminology is used appropriately (at least in the subfields with which I am familiar).

The appearance, layout, and illustrations of the thesis are appropriate and follow the standard used in scientific papers.

8. Overall Evaluation

I consider the thesis in its present form to be suitable for public discussion and, pending the outcome, recommend that the Candidate be awarded the PhD degree. I can accept all three theses of the Candidate as independent scientific results without any changes.

Considering the assessment of the doctoral dissertation, I believe that it is an original solution to a scientific problem and demonstrates the general theoretical knowledge of the PhD student in the conduct of scientific work. It also confirms the ability to conduct scientific work. It thus meets the requirements of the Act of July 20, 2018, Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended). I request that it be accepted and allowed for public defense.

Budapest, 13 September 2024.

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