OPPONENT'S REVIEW OF MASTER THESIS

Erasmus Mundus Joint Master Degree Programme

Copernicus Master in Digital Earth

Specialization Track Geovisualization & Geocommunication

Title of the thesis: **DIGITAL TWINS IN THE CONTEXT OF DISASTER PREPAREDNESS: FUSION OF GIS AND GAME ENGINES**

Student: **Anatole DELIGANT**

A1 Methods, techniques, and procedures of processing (data handling)

The thesis presents a workflow integrating GIS outputs into a game engine within a case study focusing crisis management. The pilot case study captured flooded buildings in the cities of Prague and Brno using the open-data sources of the respective municipalities. Data was processed in order to convert the scene containing 3D building models and a basemap into the Unity game engine. Finally, simple user testing was performed.

A2 Literature review

The literature review of 5 pages (13–17) contains necessary background for described topics, including game engines, floods, extended reality and digital twins approach. Despite the fact that the literature review is quite brief, it contains relevant sources. However, the structure seems a bit chaotic and difficult to orient for readers. I would expect the paragraph about digital twins to be in the very beginning instead of on the last-but-one page. Classifying reality types could be in the appropriate chapter related to Extended realities. Chapters describing Floods and The use of game engines for visualising geospatial data should follow afterwards.

A3 Theoretical and application difficulty

The thesis' theoretical difficulty is on an average level. However, the application difficulty is high. Student had to orient himself in the functionality od game engines and practical use of VR equipment, which was out of the scope of attended university courses.

B1 Thesis structure

The general structure of the thesis is well designed. It describes the whole workflow in a logical way. I only see reserves in the literature review structure.

B2 Formal and graphic level (editing, stylistics, grammar, tables, graphs, maps)

The work is formally very successful with only minor typos and inappropriate stylizations. Figures and tables are well prepared and appropriately commented in the text.

B3 Poster

The poster describes shortly objectives, implementation and results achieved within the thesis. The graphical design have limitations and could have been designed in a more uniform and attractive way.

B4 Website

The website is well designed and includes all necessary content and links. The level of web graphics is high and matching up-to-date trends. The website also includes interactive pseudo-3D visualisation of the mapped area.

C1 Quality of outputs and results

The main output is the description of the technical implementation of a scene from ArcGIS environment into Unity game engine. Achieving this goal is well documented and described within Chapter 4 on two examples of urban areas capturing the cities of Prague and Brno. Additionally, alternative software solutions were suggested and a user testing was done. The testing consisted of a simple experiment of perceiving percentage of flooded buildings and elevation of defined markers. From my point of view, the experiment could have contained more complex evaluation with tasks defined better to examine the research hypothesis.

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C2 Interpretation of results, discussion

Interpretation of the results is well done in the case of the technical workflow. However, the assumptions from the user experiment results seem to be not much relevant. The task to choose which cylindrical marker shows the highest peak when the elevation difference is only 5 meters while the cylinder diameter 200 meters, especially when the markers are located few kilometers from each other, seems to be indistinguishable within this visualisation style. Therefore, I expect this task to be mostly guessed by the respondents providing close-to-random results. That is probably why the correct answer was the most frequent in one study area while incorrect in the second area, as well as why better assumption of flooded area was achieved using VR in one study area while using ArcGIS online in the second area. For such difficult tasks, the number of 15 respondents seems insufficient to me in order to conclude from its results.

C3 Applicability of achievements

The described workflow can be directly applied in subsequent research as well as in designing cartographic outputs in Unity game engine. The description is also well documented by multiple digital files stored on the SD card attached to the thesis. However, I would not recommend to use the results of the user testing without further examination of their validity.

C4 Thesis aims and their fulfillment

The student worked in accordance with the thesis objectives and the aims were completely fulfilled.

D Final comments, questions for the defense

Questions:

For what other tasks (than distinguishing flooded buildings and comparing elevation) similar visualisations could be used in the field of floods and crisis management generally?

How would you explain why users' assumption of flooded area were much more precise when using ArcGIS online in one case study (Brno) while when using VR in the second one (Prague)?

Is there any set of open-source softwares which could be used to produce virtual 3D visualisations of similar quality as the presented ones?

E Overall summary and evaluation

The submitted work of Anatole Deligant is a good-quality experimental thesis. The author applied modern technologies and presented a workflow applicable in further studies. The thesis is well written and structured. Even though there are some minor misconducts, I clearly recommend this thesis for defense.

In Olomouc 23 May 2022

Radek BARVÍŘ

opponent

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