Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Feras Alsaggaf
Student number	5591031

Studio		
Name / Theme	Design Informatics	
Main mentor	Dr. Michela Turrin	Design Informatics
Second mentor	Dr. Martijn Lugten	Environmental Technology and Design (Urbanism)
Argumentation of choice of the studio	The demand for dementia care in the Netherlands is expected to nearly double by 2050. Current understanding of what makes a dementia-friendly architecture is well-documented and can be leveraged to creating an AI-driven assessment tool to support early-stage design to respond to the increased demand for high-quality residential care in the Netherlands and worldwide.	

Graduation project	
Title of the graduation project	Dementia-Inclusive Design: Machine Learning Assessment Tool for Evaluating Indoor Wayfinding Quality of Dementia Care Spaces
Goal	
Location:	The Netherlands
The posed problem,	Assessing soft criteria for dementia-friendly spaces is a complex, multi-variable problem with many decision points that can influence the health and wellbeing outcome for a very vulnerable user group. As dementia care demand continue to increase, there is an ever-greater need to directly respond to the unique user requirements through a human-centered design approach that can be measured and validated in the early stages of design prior to involving dementia care professional/specialist validation. The design of residential care facilities require deep understanding on how spatial layout supports occupants

| | to be independent in their own environment and foster social integration. Without a dementia care professional with a design background in the early stages, the project run the risk for incompliant designs and costly design changes at later project stages.

There is a gap for early-stage digital assessment models on dementia design principles criteria to support the design of dementia-friendly architecture. |
|---|---|
| research questions and | The following research aims to answer the primary question:

How can artificial intelligence support the design of dementia-friendly architecture during the early stages?

Sub questions that were developed in conjunction with the literature review:
- What are the essential qualitative spatial design features that promote wellbeing for people living with dementia?
- How can digital tools for assessing floor plan geometry be implemented to measure ease of wayfinding based on dementia design principles?
- What are the prerequisite data needed to build a machine learning model that predicts the wayfinding quality from floor plan design representation?
- To what extent can a machine learning model predict wayfinding quality from floor plan information?
- In what way can the AI model be deployed in the design process? |

design assignment in which these result.	Objectives: • Investigate the state-of-the-art review of the design of dementia care facilities, and in parallel investigate AI-enabled tools that might be relevant to the research question. • Define wellbeing in this thesis by selecting a specific user group and building typology, and propose a method for measuring it. • Develop a computational framework for generating and/or obtaining data through Grasshopper software package for the purpose of training the AI model. • Develop the code environments on programming language, Python, for handling the data and experimenting with different AI models through machine learning libraries such as SKLearn and TensorFlow. • Evaluate the performance of the model with validation and test sets.

Process

Method description

Literature review was done in 3 steps:
1. Define occupant wellbeing and identify relevant dementia design principles critical for early-stages of design.
2. Research current machine learning methodologies that use visual perception data in its training, such as isovist and visibility graph analysis.
3. Research machine learning methods and techniques for developing a proof-of-concept model.

The goal is to give the most up-to-date literature on what makes a dementia care facility good for supporting wayfinding. And in conjunction, simulation tools and AI methodologies are explored to discover parallels where we can re-purpose a similar methodology for assessing dementia design criteria.

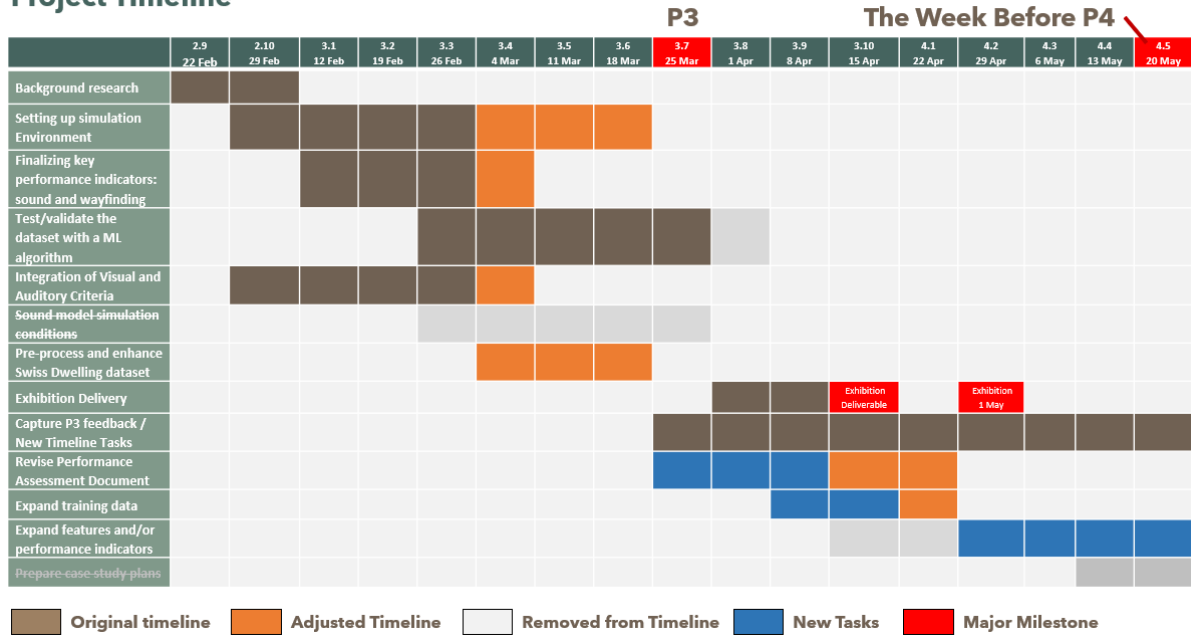| Dataset collection, simulation data, and machine learning	
Week 3.1 – 3.10: **Data and simulations**	**Week 4.1 – 4.5:** **Research by design**
• Collect floor plans that can be used to perform assessment algorithm on • Define and capture dataset requirement needed from the simulation results • The simulation data to the defined soft criteria • Setup the machine learning algorithm to train on the simulation results.	• Fine tuning the machine learning model to fit the design exercise • Apply the tool on a case study

The simulation tools will be set up to create a training set. In conjunction with simulation setup, a scoring system will be developed to assess compliance with the dementia design principles in order to quantify the overall alignment with the soft criteria.

Preliminary Project Timeline:

	2.9	2.10	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10	4.1	3.2	4.3	4.4	4.5
Background research	■	■															
Setting up simulation data	■	■	■	■													
Finalizing key performance indicators			■	■	■	■	■										
Test/validate the dataset with a ML algorithm				■	■			■	■	■	■	■					
Fine tuning										■	■	■	■				
Research by Design Case										■	■						
Evaluation and Reflection														■	■	■	■

Project Timeline

	2.9 22 Feb	2.10 29 Feb	3.1 12 Feb	3.2 19 Feb	3.3 26 Feb	3.4 4 Mar	3.5 11 Mar	3.6 18 Mar	3.7 25 Mar	3.8 1 Apr	3.9 8 Apr	3.10 15 Apr	4.1 22 Apr	4.2 29 Apr	4.3 6 May	4.4 13 May	4.5 20 May
Background research																	
Setting up simulation Environment																	
Finalizing key performance indicators: sound and wayfinding																	
Test/validate the dataset with a ML algorithm																	
Integration of Visual and Auditory Criteria																	
Sound model simulation conditions																	
Pre-process and enhance Swiss Dwelling dataset																	
Exhibition Delivery												Exhibition Deliverable		Exhibition 1 May			
Capture P3 feedback / New Timeline Tasks																	
Revise Performance Assessment Document																	
Expand training data																	
Expand features and/or performance indicators																	
Prepare case study plans																	

Original timeline   Adjusted Timeline   Removed from Timeline   New Tasks   Major Milestone

Literature and general practical references

Preliminary (P2) reference list added at the end of this document. The work cited is included at the end of the project report under 'References.'

Reflection

1. This graduation topic relates to the field of design informatics and digital simulation/assessment tools. The graduation topic combines architectural design consideration with dementia design principles criteria to respond to a real need for high-quality residential care communities specifically tailored to enhance livability of people living with dementia.
2. This project puts the spotlight on the soft criteria integration in architectural projects, raises awareness on the need for high-quality dementia care facilities in the near future, and reflects on current state-of-the-art of dementia-friendly architecture and AI-driven spatial design analysis tools while aiming to provide a meaningful contribution of a machine learning approach to support the designs of dementia care facilities.

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