Chair of Architectural Informatics
TUM School of Engineering and Design
Technical University of Munich

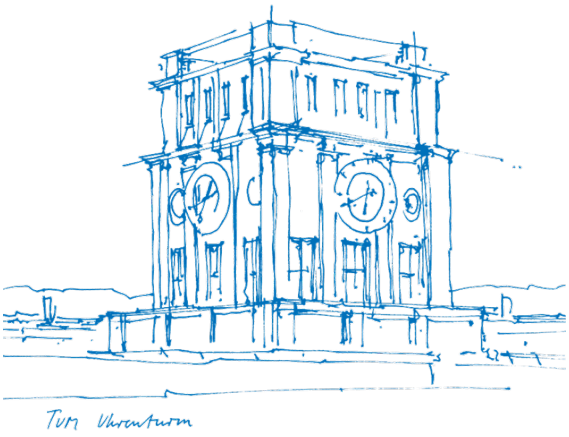
Algorithmic Design

Final Presentation

Fabian Danisch, Eric Esch

Chair of Architectural Informatics
TUM School of Engineering and Design
Technical University of Munich

August 28th, 2022

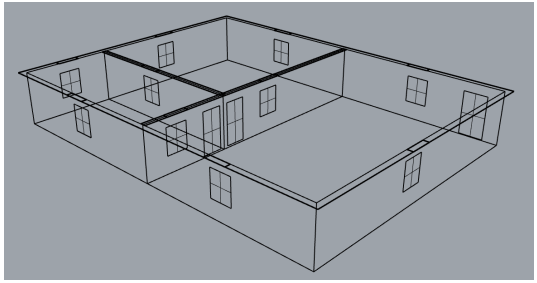


Outline

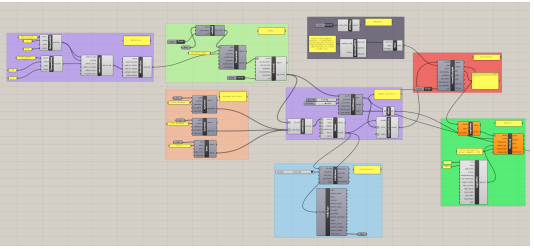
Concept

- Help architects at constructing floor plans of office buildings.
- Real-time simulation of illuminance via AI.
- Efficient and fast feedback from AI instead of simulating the whole floor model.

Original Workflow



(a) Wireframe that has to be build in Rhino



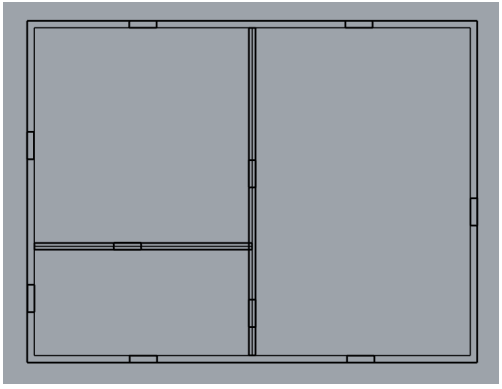
(b) Calculation has to be made in Grasshopper

Outline

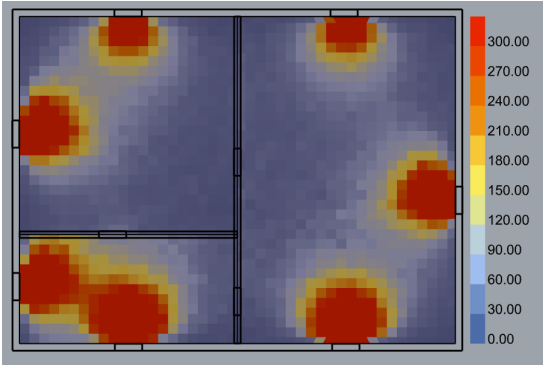
Structure

- Office buildings need 300 lux on desks for computer work. [2]
- Office surface equals to 300 square meters and a height of 3 meters. [6]
- Simulated data will be capped at 300 lux to facilitate training our network.
- Fixed definitions for the building such as white walls and standard window size. [3][4]
- Lux is measured about 0.9 meter above floor level to simulate the eye level of a sitting person. [5]

Structure

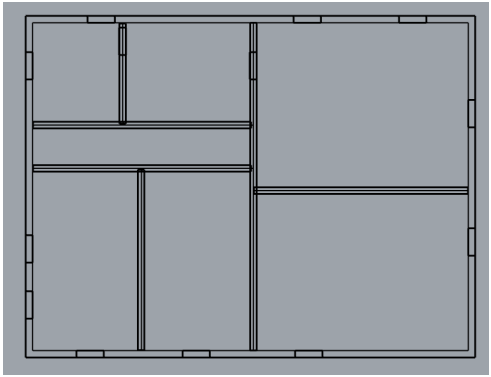


(a) Layout 1 wireframe

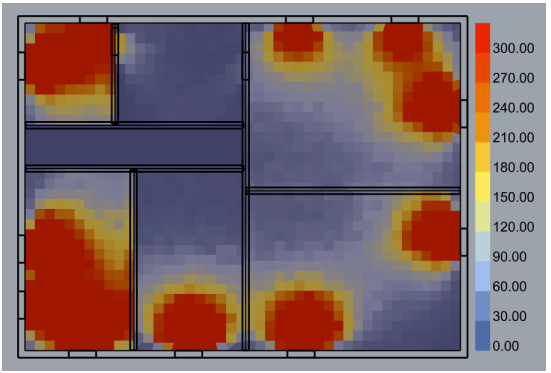


(b) Layout 1 simulated data

Structure



(a) Layout 2 wireframe

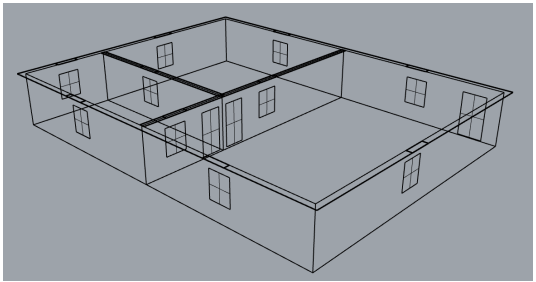


(b) Layout 2 simulated data

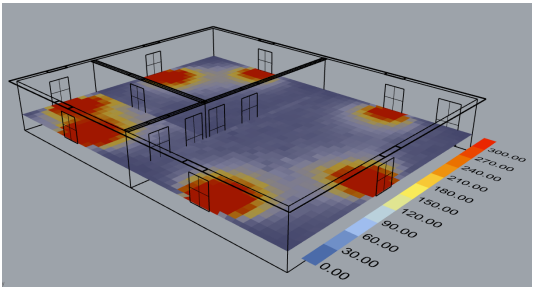
Source

- Self made dataset.
- Only small base set of 64 models.
- Rhino/Grasshopper to create buildings.
- Honeybee plugin to simulate annual daylight studies.
- Simulated images are annotated and used to train our network. [1]

Source - Layout 1

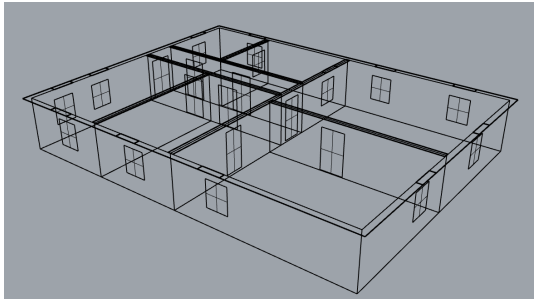


(a) Layout 1 wireframe in perspective

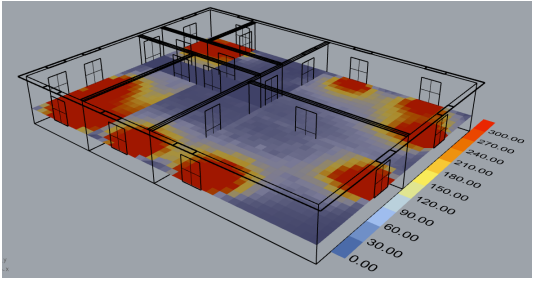


(b) Layout 1 simulated data in perspective

Source - Layout 2

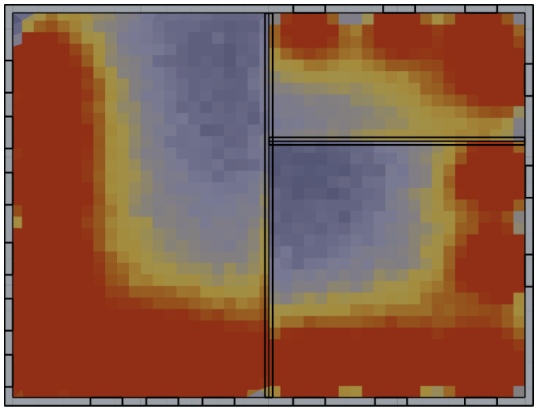


(a) Layout 2 wireframe in perspective

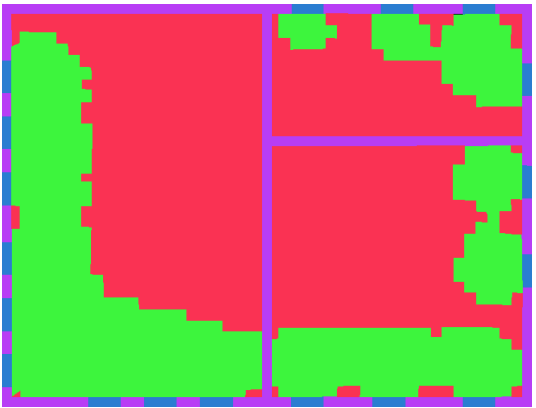


(b) Layout 2 simulated data in perspective

Source - Annotation



(a) Simulated illuminance



(b) Annotated simulation

Outline

Image Segmentation

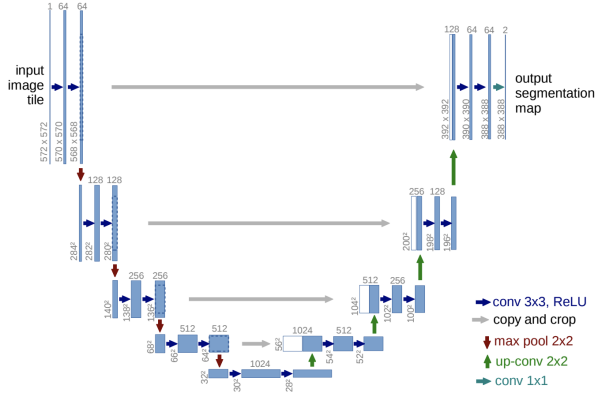


Figure 7 Source: *https://paperswithcode.com/method/u-net*

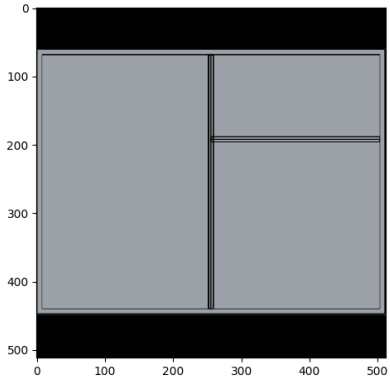
Structure

- Multilayer UNET model with 8 million+ trainable parameters.
- 5 convolutional blocks up to 512 filters.
- 4 upsampling blocks.
- ReLU activation and Softmax at the end.
- 5 classes and batch size of 8.
- ADAM and Sparse Categorical Crossentropy.

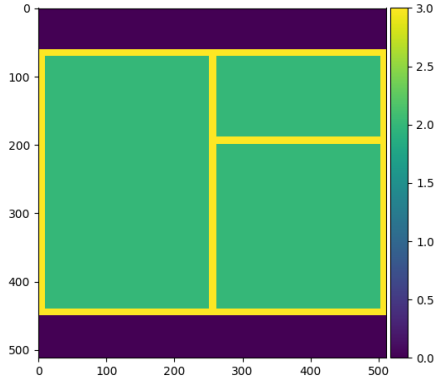
Results

- Good results with a model accuracy of 97.4%.
- Small perturbations on the inner walls due to trickier training data.

Results: Empty Room

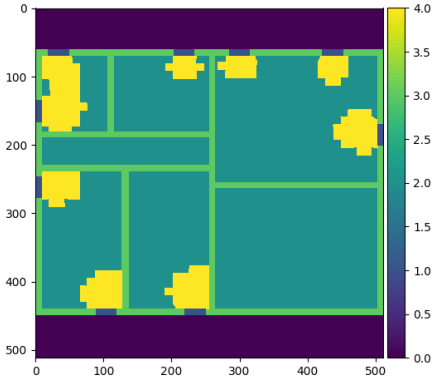


(a) Input image

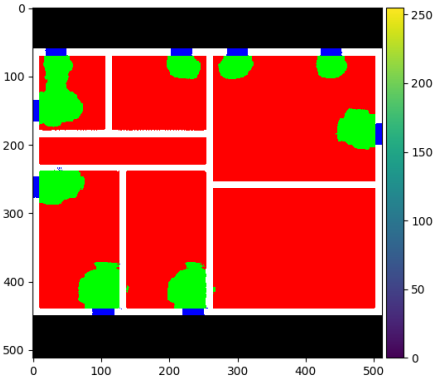


(b) Illuminance Prediction

Results: Room with some windows

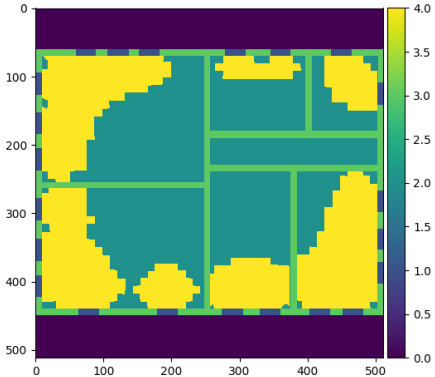


(a) Input ground truth

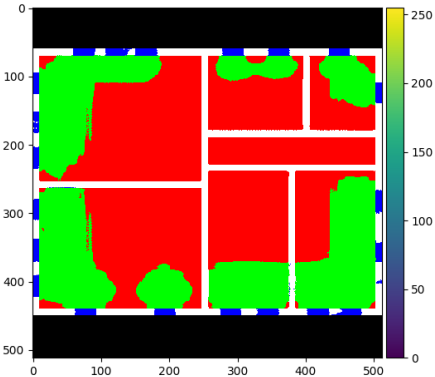


(b) Illuminance Prediction

Results: Room with a lot of windows

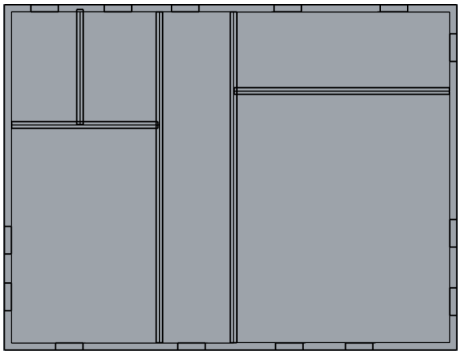


(a) Input ground truth

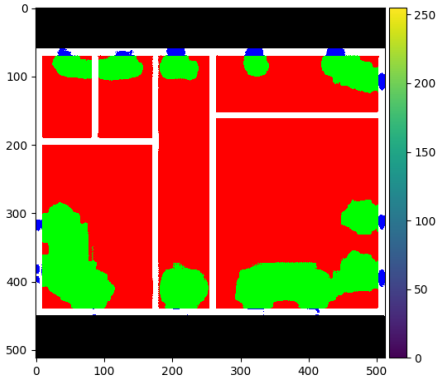


(b) Illuminance Prediction

Results: Untrained room layout



(a) Input image



(b) Illuminance Prediction

Cvat.

Archtoolbox.
Recommended lighting levels in buildings.
2021.

CIAL.
Light reflectance.
2011.

Fensterversand.com.
Fenstergrößen.

First in Architecture.
Average heights / dimensions of person sitting.
2014.

Haufe Online Redaktion.
Arbeitsstättenverordnung büro: Mindestgröße und raumhöhe.
2022.