

FORSCHUNGS MODULE

5CP

RESEARCH MODULES

INTRO & SIGN-UP

8 NOVEMBER 2016, 14:00

MACHINE LEARNING FOR DIGITAL FABRICATION

A.I. PLAYS GAMES

DRAG&DROP GAME PROTOTYPING IN UNITY

A ROBOT PLAYS MINECRAFT

FROM VOXEL TO REALITY

BENDING/BUNDLING SIMULATIONS

2.5D PRINTING OF HOUSES

PROGRAMMING TEXTILES VIA 3D PRINTING

FILLING SPACE: GEOMETRY & CNC HOTWIRE CUTTING



Digital Design Unit — Digitales Gestalten

DIGITAL DESIGN UNIT (DDU)
EL-LISSITZKY-STR. 1, ROOM 333
CAMPUS TU LICHTWIESE
www.ddu-research.com



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FILLING SPACE: GEOMETRY & CNC HOTWIRE CUTTING 5CP

THE RESEARCH MODULE (5CPS) AT FB ARCHITECTURE OFFERS INTERDISCIPLINARY RESEARCH WORK AND IS OPEN TO STUDENTS FROM TU DARMSTADT AND H_DA IN ALL FACULTIES

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RESEARCH QUESTION

IS IT POSSIBLE TO DEVELOP A "VOLUMETRIC" DESIGN APPROACH, BY COMBINING THE STUDY OF SPACE-FILLING GEOMETRIES WITH CNC HOTWIRE CUTTING?

SCOPE OF THE RESEARCH

- RESEARCH SPACE-FILLING PATTERNS AND THEIR USE IN ARCHITECTURE
- DEVELOP COMPUTATIONAL TECHNIQUES TO GENERATE SPACE-FILLING PATTERNS (2D/3D)
- OPTIMIZE THE CURRENT CNC HOTWIRE CUTTING WORKFLOW IN THE WORKSHOP
- DEVELOP AN INSTALLATION BASED ON SPACE-FILLING MODULES PRODUCED WITH CNC-CUT FOAM
- OPTIONAL: DEVELOP A ROBOTIC PROCESS TO ASSEMBLE THE MODULES

REQUIRED SKILLS / GEFOREDERTE FAHIGKEITEN

- GOOD KNOWLEDGE OF 3D MODELLING IN MCNEEL RHINOCEROS
- BASIC/INTERMEDIATE KNOWLEDGE OF MCNEEL GRASSHOPPER
- OPTIONAL: PREVIOUS EXPERIENCE WITH CNC MACHINES (LASERCUTTER, 3D PRINTERS, ETC.)



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A ROBOT PLAYS MINECRAFT — 5CP

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RESEARCH QUESTION

CAN ROBOTICALLY FABRICATED MODELS MADE OF BLOCKS BE USED FOR EMPIRICAL STRUCTURAL VERIFICATION OF DESIGNS?

SCOPE OF THE RESEARCH

- USING A ROBOT ARM TO BUILD MODELS OUT OF WOODEN BLOCKS
- TESTING VARIOUS GLUE TYPES AND BLOCKS SIZES
- TESTING THE MODELS ON STRUCTURAL LOADS AND DOCUMENTING THE FAILURES
- OPTIONAL: USING SENSORS TO AUTOMATE THE PROCESS AS MUCH AS POSSIBLE

REQUIRED SKILLS

- ANYONE CAN DO THIS MODULE



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DRAG&DROP GAME PROTOTYPING IN UNITY — 5CP

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RESEARCH QUESTION

CAN UNITY BE USED BY NON-CODERS TO VISUALLY DEVELOP GAME PROTOTYPES?

SCOPE OF THE RESEARCH

- USING OUR IN-HOUSE PROTOGAME TOOLKIT FOR UNITY TO PROTOTYPE SAMPLE GAMES
- CREATING A SIMPLE, ONLINE HOW-TO-USE GUIDE FOR THE TOOLKIT
- OPTIONAL: EXTENDING THE FEATURES OF THE TOOLKIT USING C#
- OPTIONAL: SETTING UP AN OPEN SOURCE VERSION CONTROL IN GITHUB

REQUIRED SKILLS

- KNOWLEDGE IN C# OR JAVASCRIPT
- BASIC UNDERSTANDING OF GAME DESIGN CONCEPTS

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2.5D PRINTING OF HOUSES — 5CP

A 3D-PRINTED INHABITABLE LANDSCAPE

The landscape is 3D-printed by crowd-operated robots. It has variable material properties and patterns.

The vertical components are 3D-printed horizontally. They can have the same variety of material properties and patterns as the landscape.

Suitable for gardening

Watertight or porous

Variable softness allows the range from walk-on to sit on and sleep on

The vertical components are lifted up and fixed in place by crowd-operated machines.

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A pet-like 3D-printing robot with reservoir for material, printing nozzle, lifting hooks and large all-terrain wheels.

RESEARCH QUESTION

IS IT POSSIBLE TO USE 3D PRINTING TO FABRICATE INSITU, FLAT, UNFOLDABLE FRAMEWORK FOR A HOUSE?

Nature, structure and infrastructure are merged into a coherent whole. Capillaries are printed into the surface and used to collect and redistribute water.

SCOPE OF THE RESEARCH

- DESIGN AND 3D PRINT SCALE MODELS OF AN UNFOLDABLE HOUSE
- EXPLORE THE USE OF 3D PRINTING FOR PRODUCING ONSITE LOADBEARING AND ENCLOSING WALL PANELS
- COLLECT PRECEDENTS OF THE USE OF 3D PRINTING FOR BUILDINGS

REQUIRED SKILLS

- BASIC KNOWLEDGE OF 3D PRINTING
- GOOD 3D MODELLING
- SOME BACKGROUND IN EITHER ARCHITECTURE OR PRODUCT DESIGN OR MECHANICAL ENGINEERING



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A.I. PLAYS GAMES

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and for buying more blocks

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RESEARCH QUESTION

WHICH MACHINE LEARNING OR GENETIC ALGORITHM IS SUITABLE TO SIMULATE GAME PLAYERS?

SCOPE OF THE RESEARCH

- PLAY THE IN-HOUSE, MINECRAFT-BASED, CITY BUILDING GAME 20,000 BLOCKS
- SIMULATE COMPUTATIONALLY THE BASIC GAME OUTCOMES

REQUIRED SKILLS

- FAMILIARITY WITH MACHINE LEARNING OR GENETIC ALGORITHMS
- PROGRAMMING



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FROM VOXEL TO REALITY — 5CP

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RESEARCH QUESTION

WHICH DIGITAL FABRICATION TECHNIQUES ARE SUITABLE FOR TURNING MINECRAFT MODELS TO REAL STRUCTURES?

SCOPE OF THE RESEARCH

- BUILD 3-5 MODELS
- USE MESH-RECONSTRUCTION TECHNIQUES
- EXPLORE DIGITAL FABRICATION TECHNIQUES SUCH AS 3D-PRINTING AND LASER-CUTTING TO MATERIALIZE MINECRAFT MODELS

REQUIRED SKILLS

- EXPERIENCE WITH LASERCUTTING
- OR EXPERIENCE WITH 3D PRINTING
- RHINO/GRASSHOPPER KNOWLEDGE



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MACHINE LEARNING FOR DIGITAL FABRICATION 5CP

```
function p = predict(Theta1, Theta2, X)
%PREDICT Predict the label of an input given a trained neural network
% p = PREDICT(theta1, theta2, X) outputs the predicted label of X given the
% trained weights of a neural network (Theta1, Theta2)
% Useful values m = size(X, 1); num_labels = size(Theta2, 1);
% You need to return the following variables correctly
p = zeros(size(X, 1), 1);
h1 = sigmoid([ones(m, 1) X] * Theta1');
h2 = sigmoid([ones(m, 1) h1] * Theta2');
[dummy, p] = max(h2, [], 2);
% =====
end
```

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RESEARCH QUESTION

ARE MACHINE LEARNING ALGORITHMS SUITABLE FOR FINDING ROBOTIC TOOLPATHS?

SCOPE OF THE RESEARCH

- REFINE A ROBOTIC ASSEMBLY PROCESS
- RESEARCH AND DOCUMENT MACHINE LEARNING ALGORITHMS FOR MOTION TASKS
- PROGRAM A MACHINE LEARNING ALGORITHM IN PYTHON / OCTAVE / MATLAB /

REQUIRED SKILLS

- PROGRAMMING SKILLS (E.G. PYTHON, C#, C++, MATLAB ...)
- OPTIONAL: SIX-AXIS ROBOT PROGRAMMING EXPERIENCE

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BENDING/BUNDLING SIMULATIONS 5CP

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RESEARCH QUESTION
HOW TO LINK ENGINEERING SIMULATIONS OF BENDING/BENDING TO A 3D MODELLING SOFTWARE LIKE RHINO?

SCOPE OF THE RESEARCH

- RESEARCH COMPUTATIONAL REALTIME PHYSICS ENGINES
- RESEARCH TOOLS FOR GRAPHIC STATICS
- DEVELOP A MATERIAL SIMULATION FOR MATERIAL SYSTEMS OF ACTIVE BENDING AND BUNDLING
- BUILD AN INSTALLATION FOR COMPARISON BETWEEN PHYSICAL AND SIMULATED MATERIAL SYSTEM

REQUIRED SKILLS

- MODELLING SKILLS WITH A 3D-SOFTWARE



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PROGRAMMING TEXTILES VIA 3D-PRINTING 5CP

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RESEARCH QUESTION

WHAT ARE THE FABRICATION PARAMETERS FOR TEXTILE HYBRIDS INFORMED VIA 3D PRINTING TO BUILD BENDING-ACTIVE STRUCTURES?

SCOPE OF THE RESEARCH

- RESEARCH SELF-TRANSFORMING STRUCTURES
- DOCUMENT THE FABRICATION PARAMETERS FOR 3D PRINTING TEXTILE HYBRIDS
- DESIGN A BENDING-ACTIVE STRUCTURE

REQUIRED SKILLS

- 3D PRINTING EXPERIENCE
- 3D MODELLING SKILLS

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