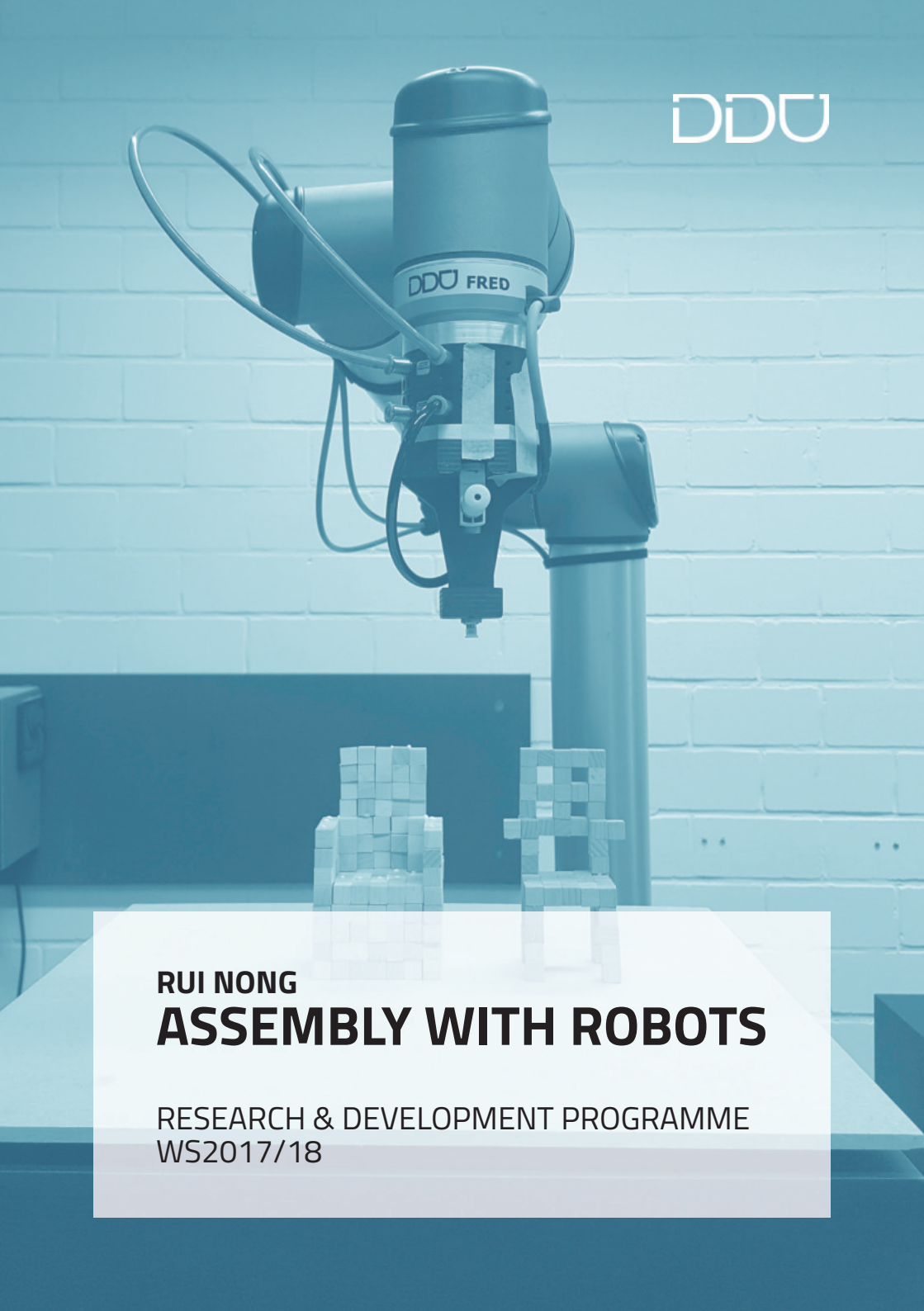

RUI NONG

ASSEMBLY WITH ROBOTS

RESEARCH & DEVELOPMENT PROGRAMME
WS2017/18

TECHNISCHE
UNIVERSITÄT
DARMSTADT

ASSEMBLY WITH ROBOTS
- AN UPDATE FOR "20.000 BLOCKS"
BY RUI NONG

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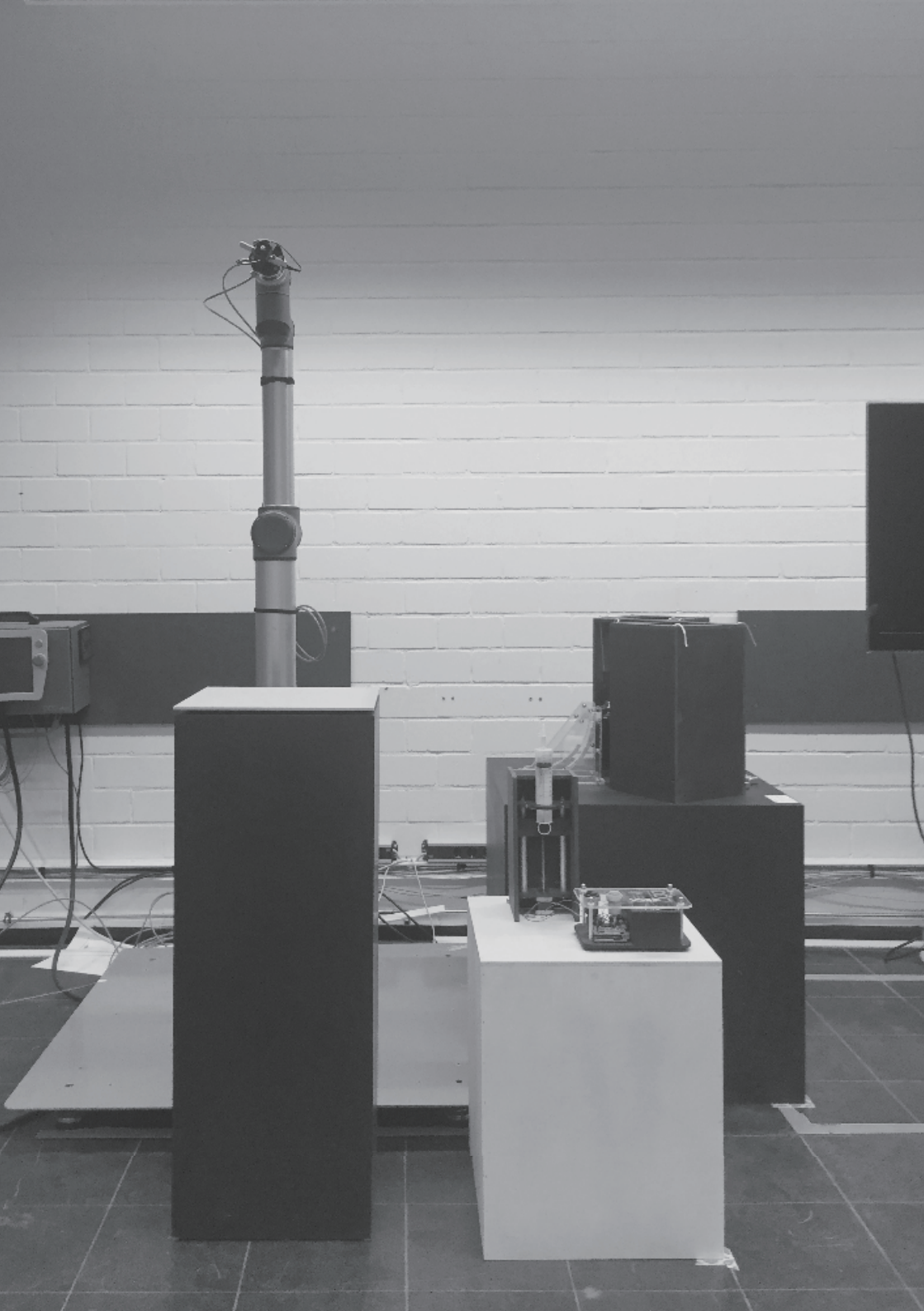
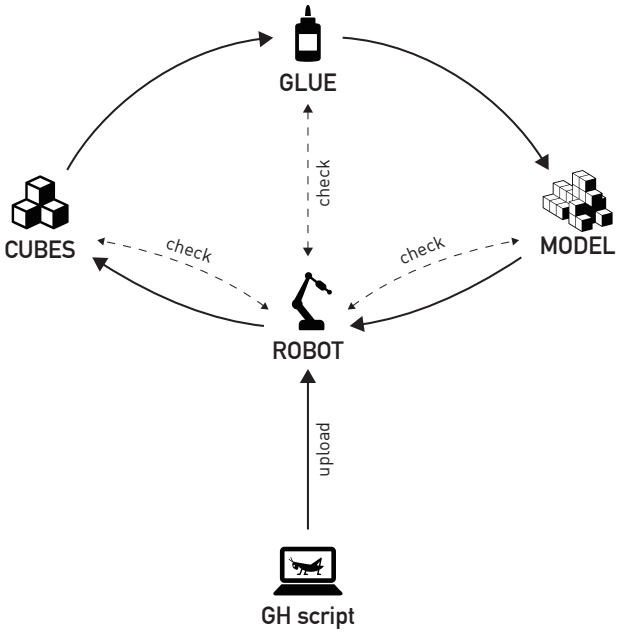
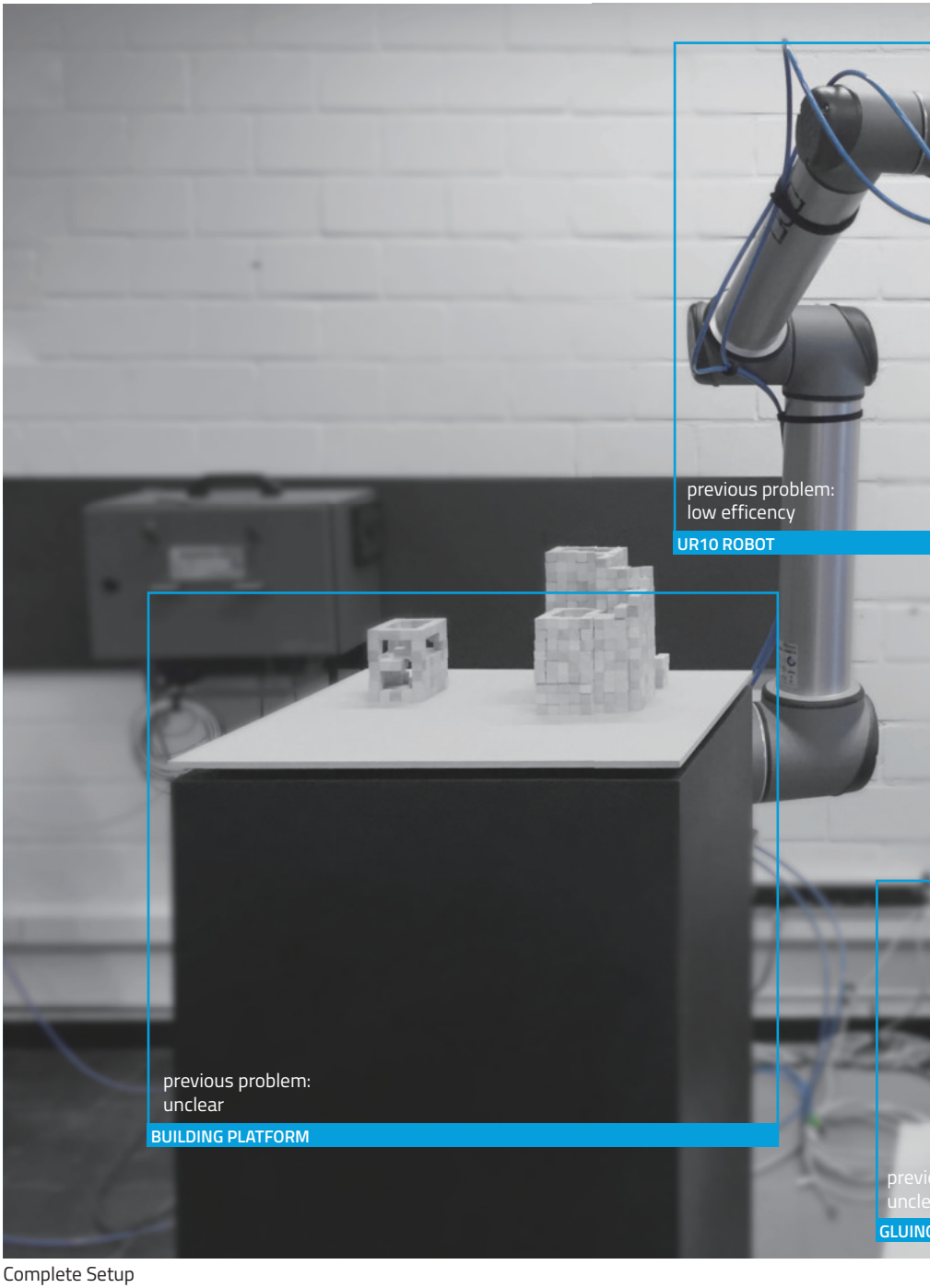
IDEA





ABSTRACT

This research and development project is based on the robotic assembly part of the previous research project "20.000 Blocks". In previous project, low efficiency and gripping failures were the main problems of the assembling process, which became the main focus of the current project. The current setup includes a PC, a UR10 robot with suction gripper, two material dispensers, a gluing station, a placing platform, and other electronic parts. The whole assembly process can be concluded as: robot receive commands from grasshopper - robot pick up block - robot glue the block - robot place the block.
Problems described above occurred at the former two process - the efficiency of codes and picking up. That is to say, tools related to these two process has to be reexamined, namely the code, gripper and dispenser. Finally, the goals of this project lie in two aspects - hardware and sofware. In hardware level, the design of material dispenser and suction gripper are to be improved. In software level, the code efficiency is to be enhanced.

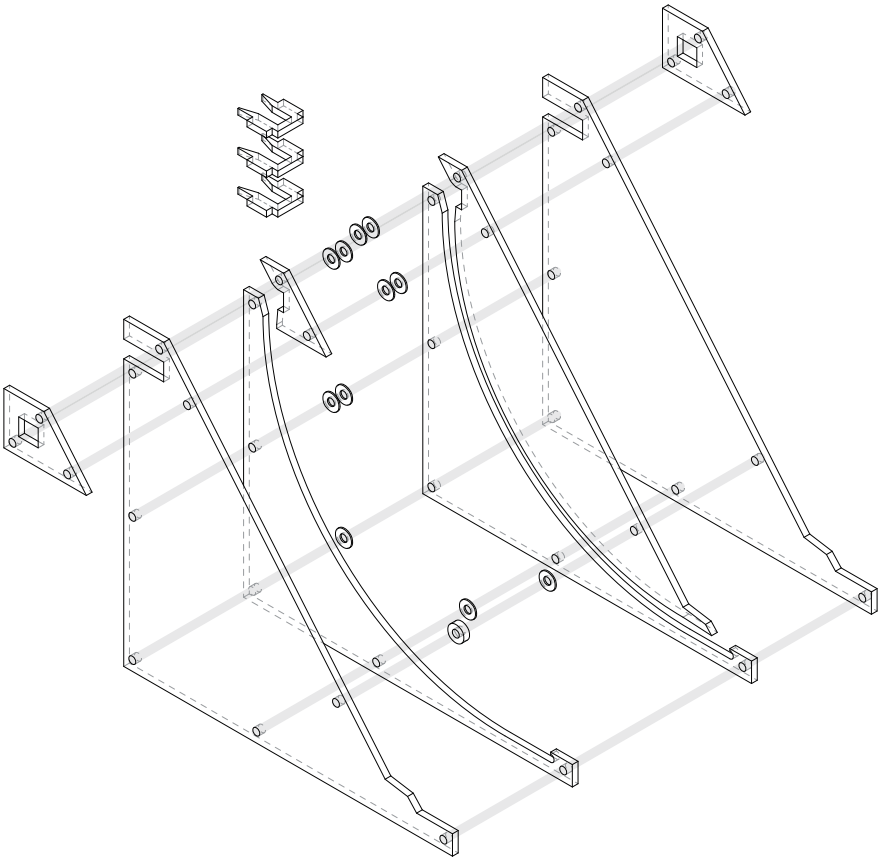


Complete Setup

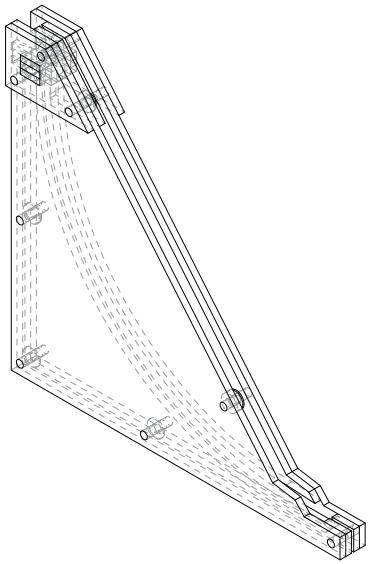

FRED
MATERIAL DISPENSER
previous problem:
frequent material stuck
ous problem:
ar
G STATION

HARDWARE

FEEDER REDESIGN



To gain better performance, the new feeder is fixed with screws. So that the width of tunnel can be adjust – wider opening, more precise ending position.



FEEDER

Due to occasional pick-up failure, the previous feeder design was examined. Friction is mainly the reason of wooden blocks being stuck. As the frictional force can be expressed as

$F_f = \mu N$

where

F_f = frictional force

μ = frictional coefficient

N = normal force between the surfaces

so the frictional force can be reduced by decrease either friction coefficient or normal force between surfaces. In addition, frictional force changes according to the position or movement of wooden blocks. But in this case, what matter the most is the gravity of the block itself and pressure from other blocks behind, and also the frictional coefficient of the feeder material and wood. Consequently, choosing a material with smaller frictional coefficient and reducing blocks in the feeder would be a reasonable solution.

Original Design

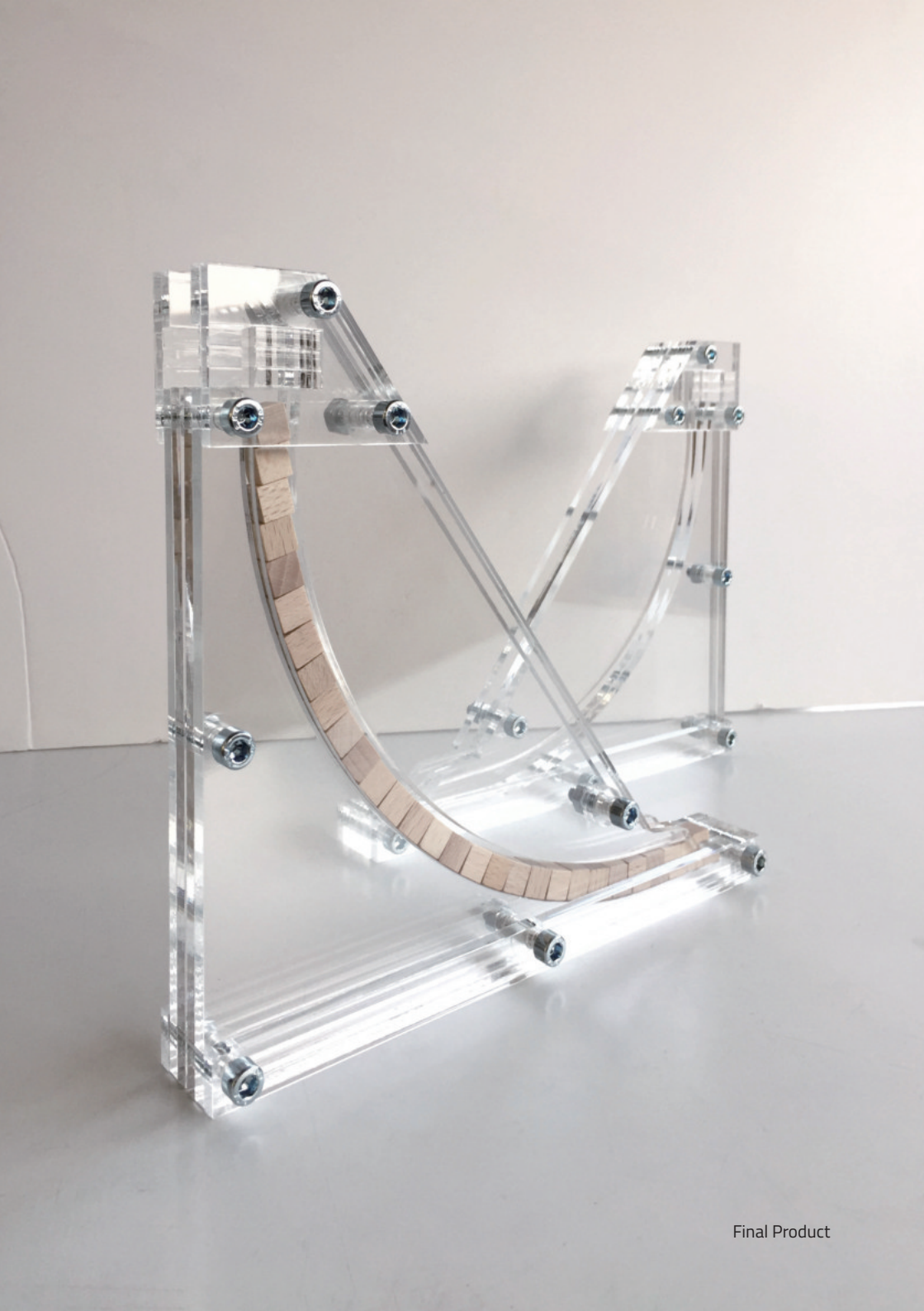
- wood
- long tunnel
- more capacity
- solid

Prototype A

- plexiglas
- long tunnel
- more capacity
- see-through

Prototype B

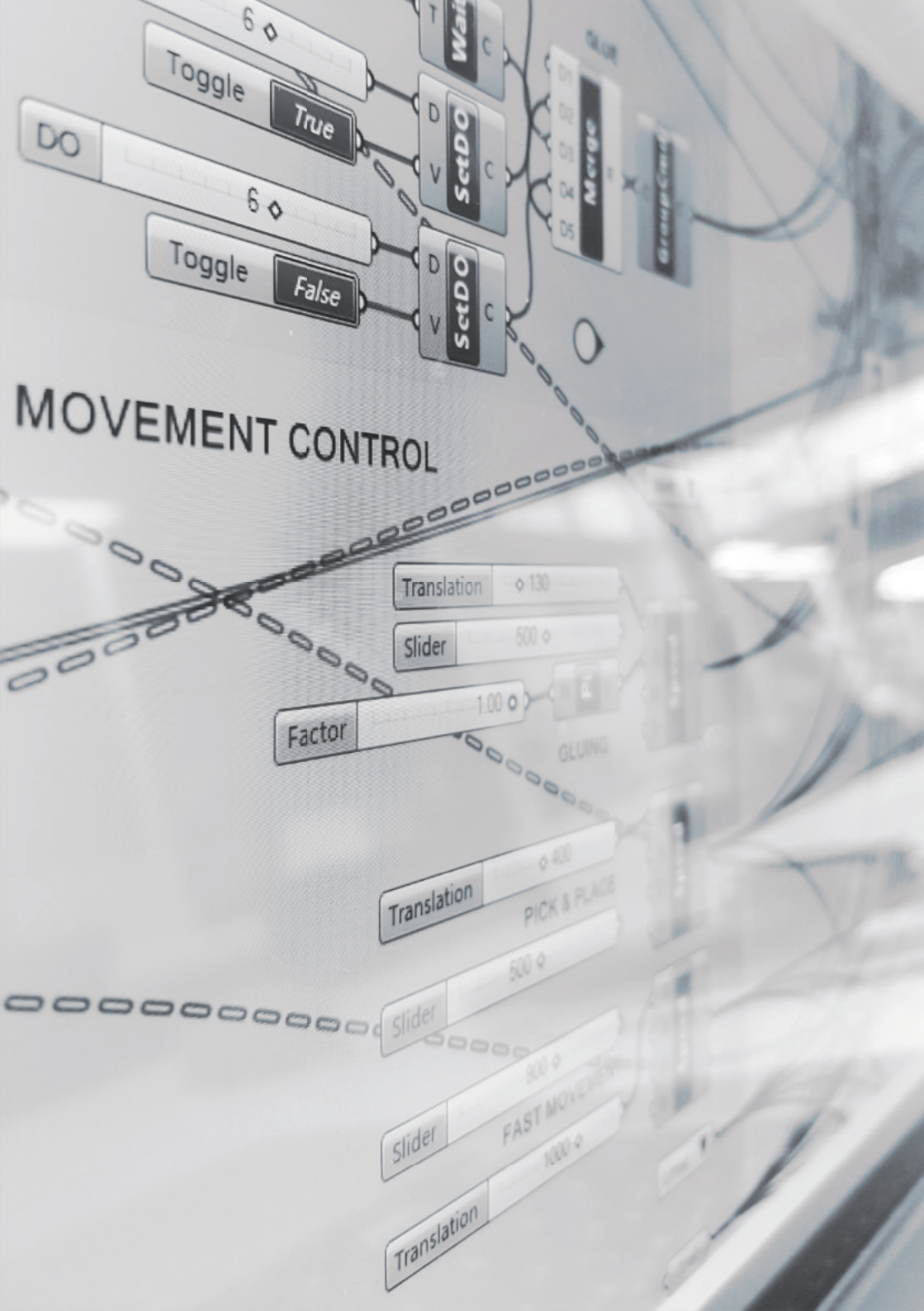
- plexiglas
- short tunnel
- less pressure
- see-through

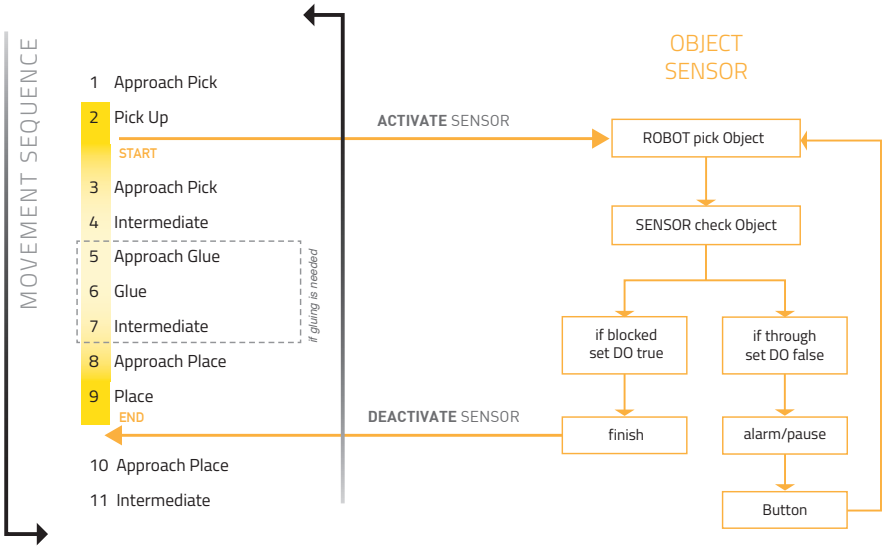


Final Product

SOFTWARE

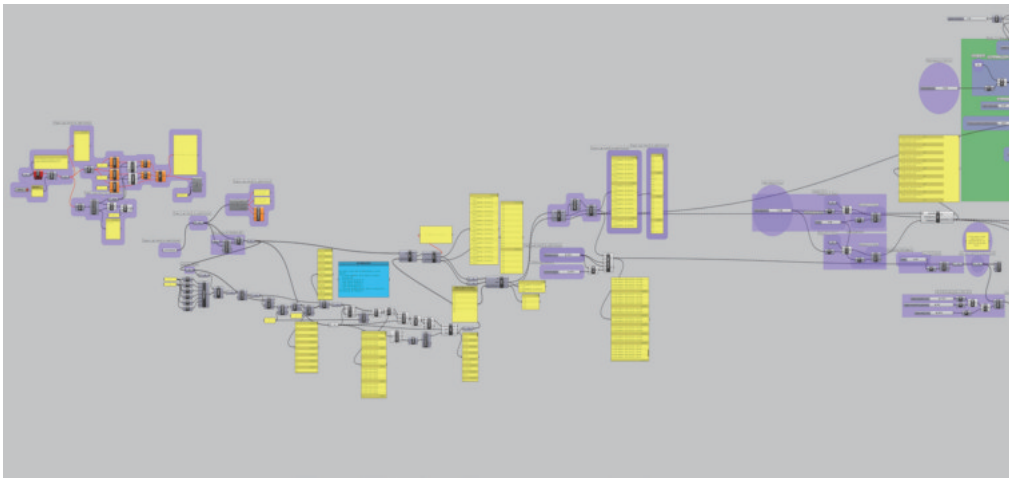
CODE MIGRATION


MOVEMENT CONTROL
Toggle
True
Toggle
False
DO
6
6
SetDO
SetDO
Merge
Translation
Slider
Factor
1.00
GLUING
Translation
PICK & PLACE
Slider
Slider
FAST MOVE
Translation

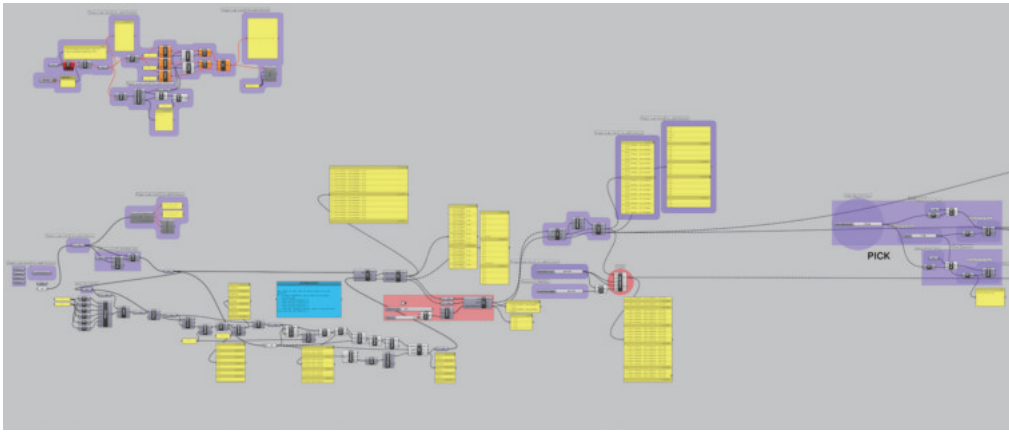


CODE

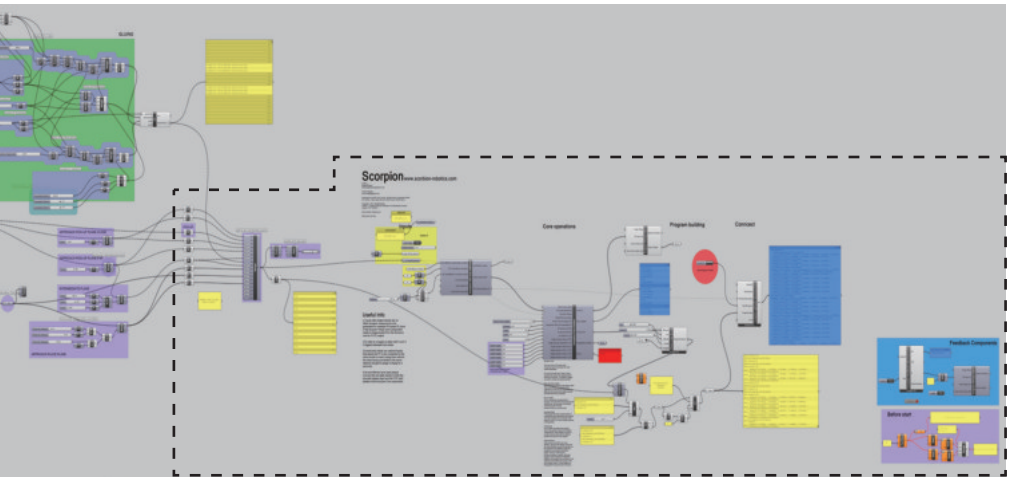
The structure of the grasshopper code can be concluded as:
Input of the model – get the building and gluing planes – control robot movements – upload to robot.
In this project, mainly the last three parts had been modified, but main focus was on getting the planes and movement control. The "Scorpion" upload tool performed actually better than the of "ROBOTS", so it was remained. Due to actual long assembly time, model can be built by different phases, building can continue from any levels as designated.
The movement sequence can be seen in the diagram above. When gluing is not needed, step 5-7 will be skipped. The idea of complementing an object sensor was also considered, however due to time limit it was not developed.

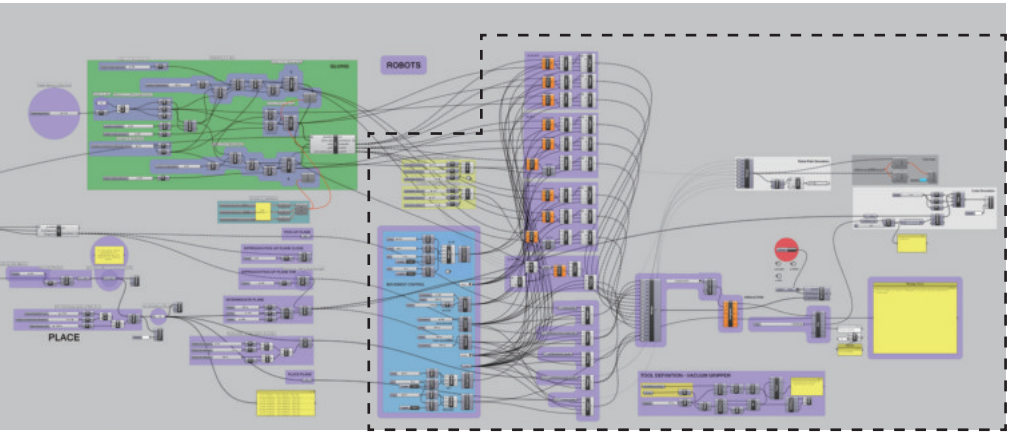


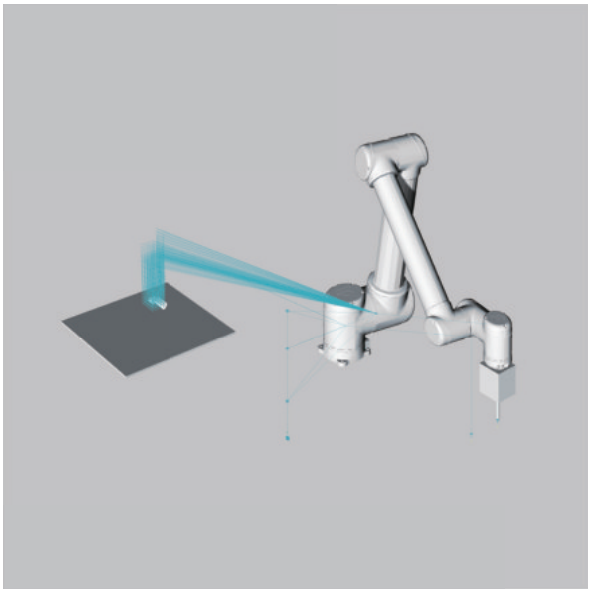
previous script using „Scorpion“



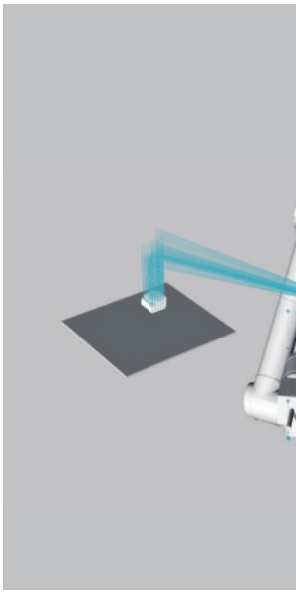
current script using „ROBOTS“


Scorpion
Core operations
Program building
Connect
Feedback Components
Before start

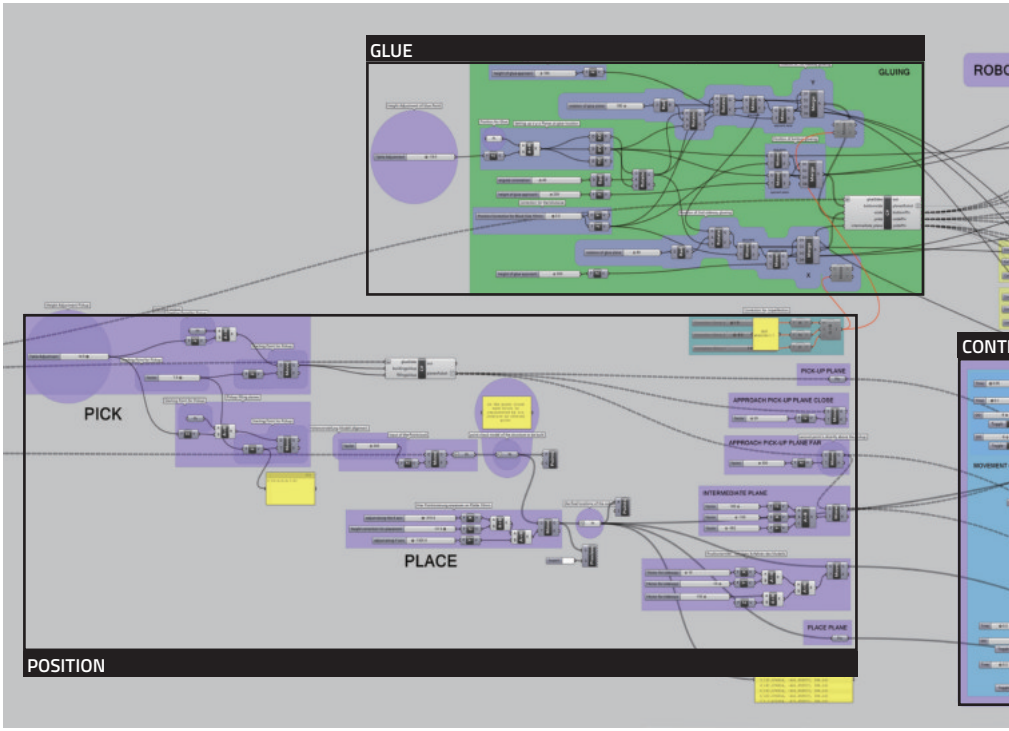

ROBOTS
PLACE



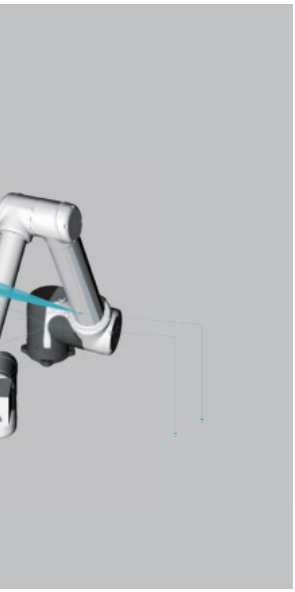
robot simulation: pick

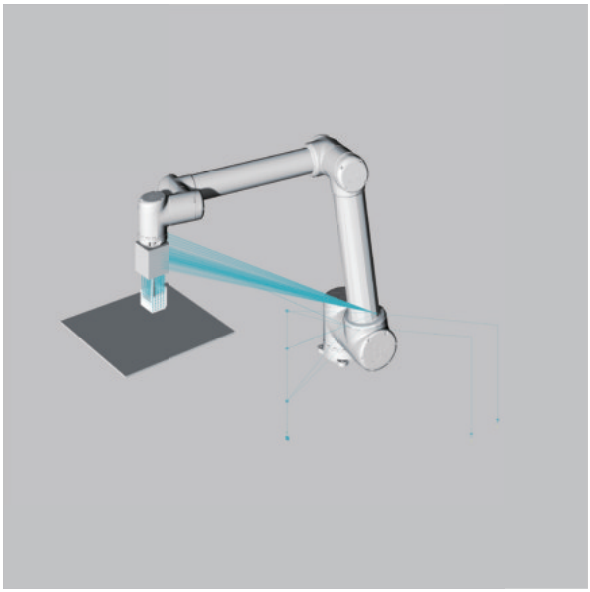


robot simulation: glue

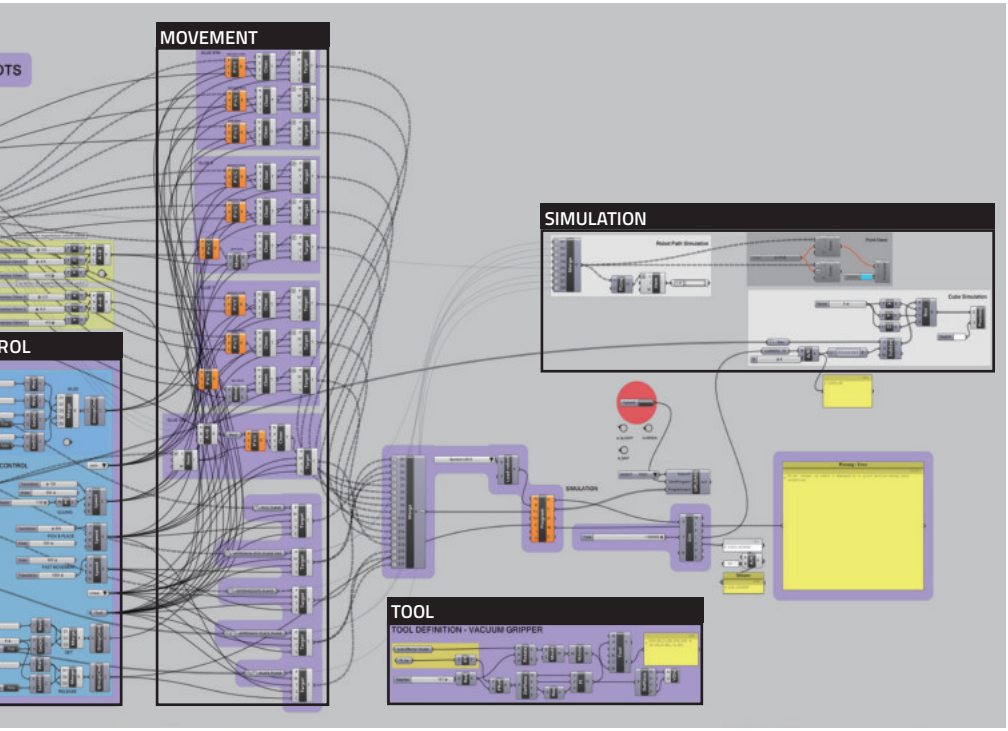


current script updated part





robot simulation: place



TESTING

>PROTOCOL

/TEST#4

TOTAL CUBES: 1147
TOTAL MOVEMENTS: 10344
EST.TIME: 131MIN
ACTUAL TIME: 328MIN (5H28MIN)
2.5X AS EST.TIME
PER MINUTE 3.5 CUBES

DAY 1
STARTED AT 16:21
LEVEL 2 BUILT
STOPED AT 17:31

DAY 2
STARTED AT 13:18
LEVEL 4 BUILT AT 14:30
PAUSED FOR CORRECTION AT 14:43
FINISHED AT 17:36

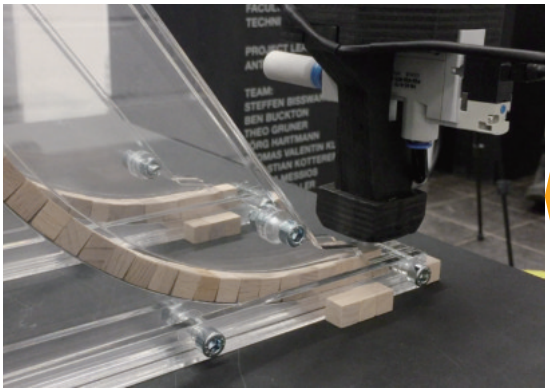
PROTOCOL

Generally speaking, the overall assembly process ran well, however there were still some annoying problems.

Pick: Very stable and high precision of gripping. Cubes would stuck at dispenser sometimes when vibration was constant. (Possible solution: implement time control to motor)

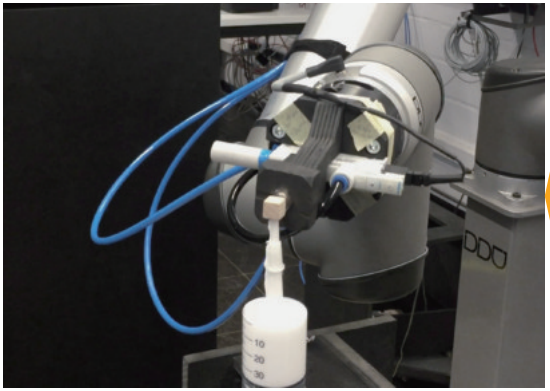
Glue: Imperfection of reaching every glue planes, actual position might vary from previous movement. Glue portion could be different from time to time – motor might not be able to rotate sometimes. Slow movement, when building smaller model speed can reach 500 smoothly but not with bigger model.

Place: Higher precision when building smaller model. Overflown glue could led to uneven surfaces.



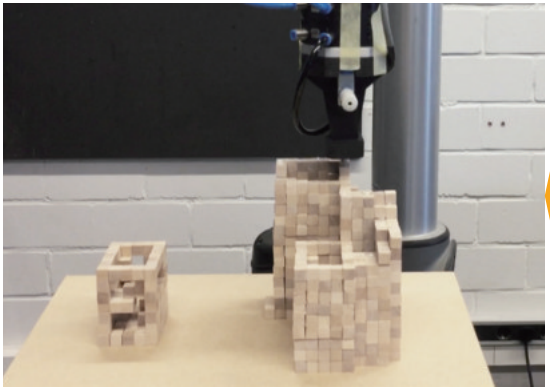
picking: new feeder performed well

problem: stuck

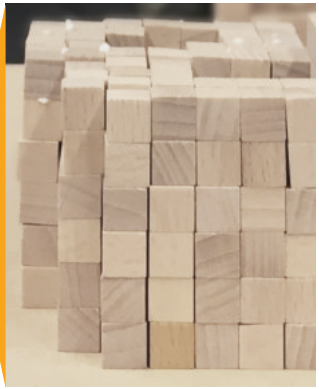


gluing: position inaccuracy when glue on the side and uneven glue portion

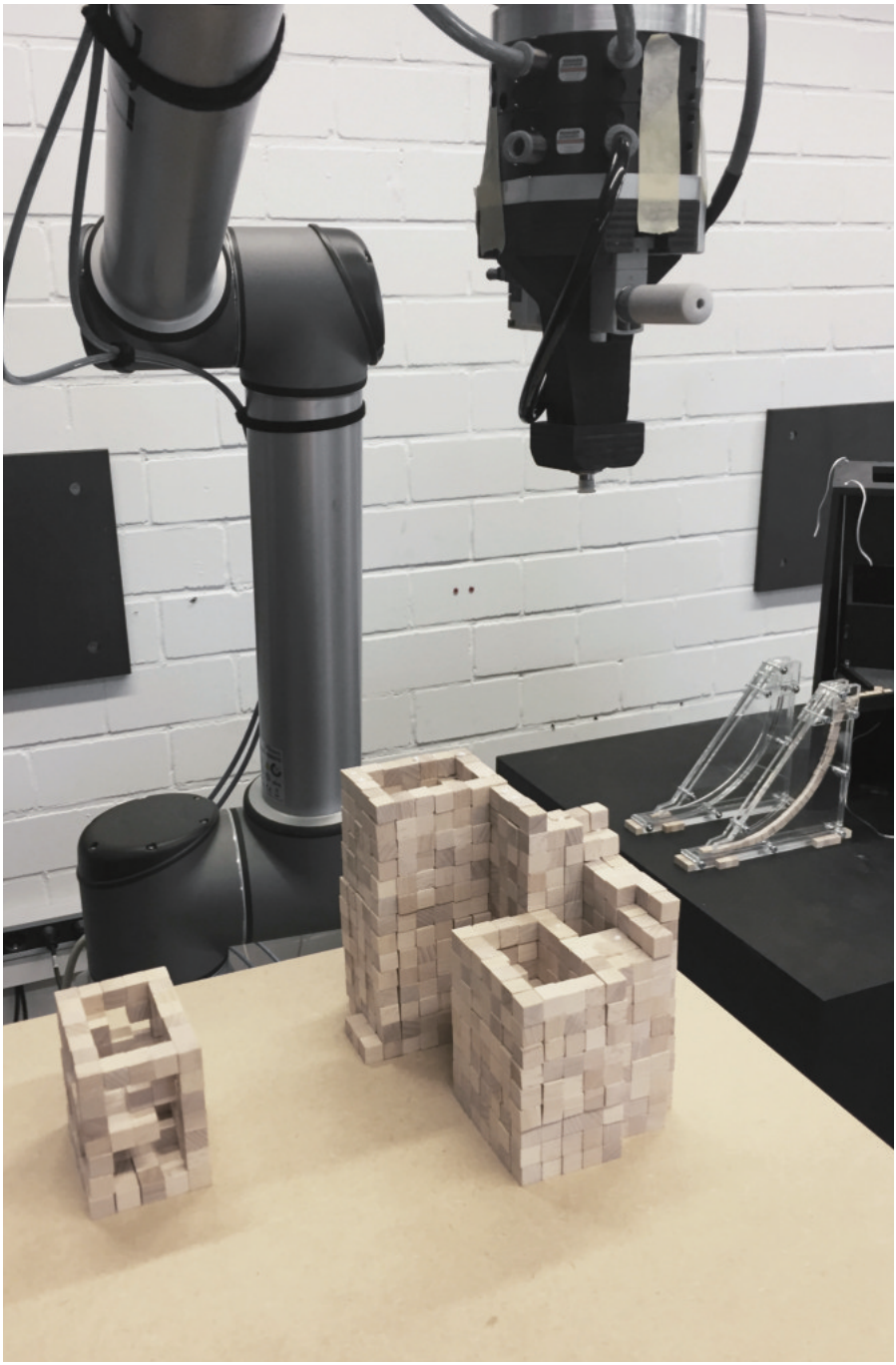
problem: over glue



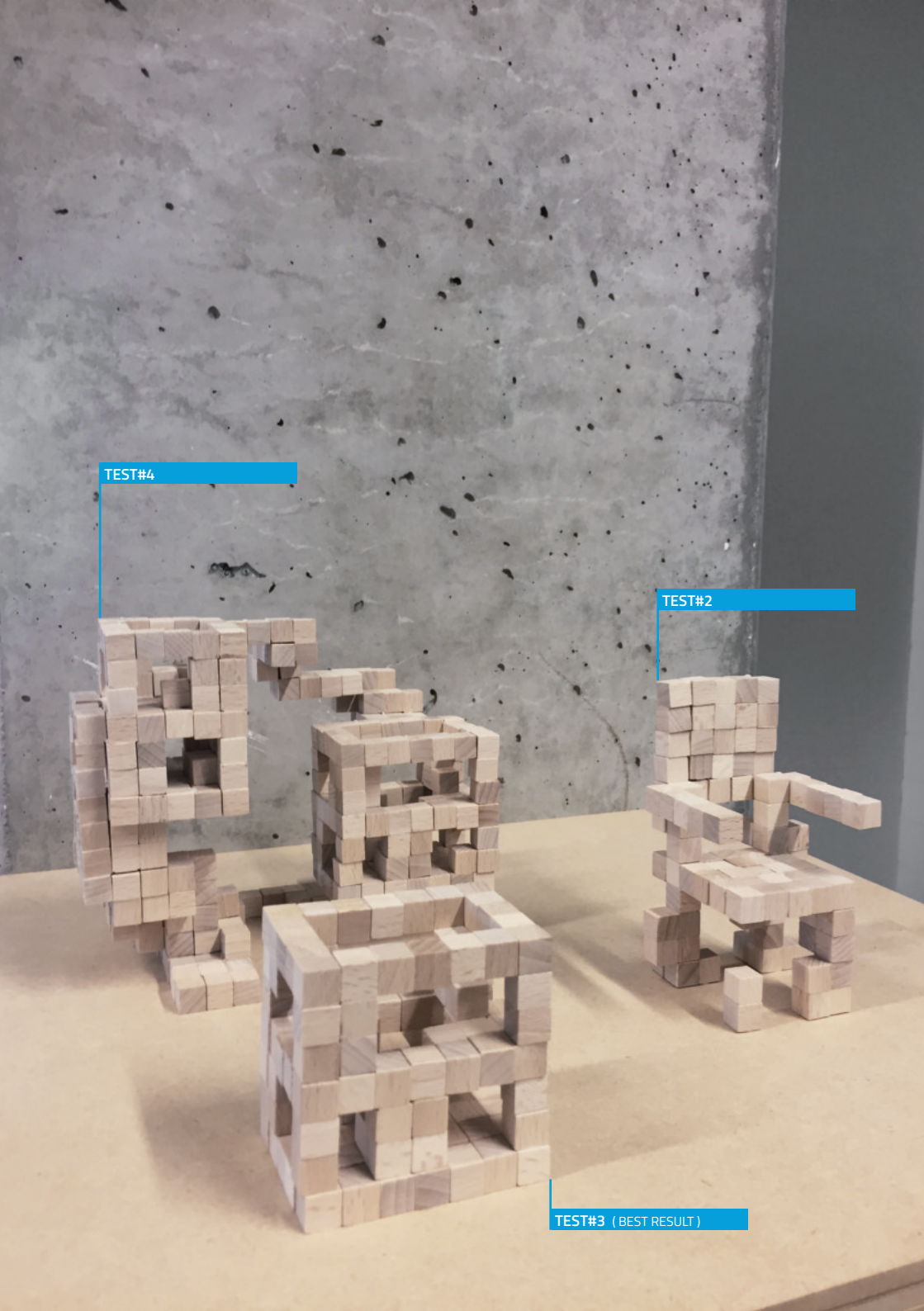
placing: quick and accurate



problem: uneven suface due to over glue



test #4 final result


TEST#4
TEST#2
TEST#3 (BEST RESULT)

Link to video:
https://youtu.be/Ww9v6w44jqc

RESULT

After the update, gripping failures became less significant as over glue or under glue. Since the probability of gripping failure was very low, the idea of object sensor at the beginning is not necessary anymore. Although model can be built by more phases, a continuous building process is recommend for best gluing performance.

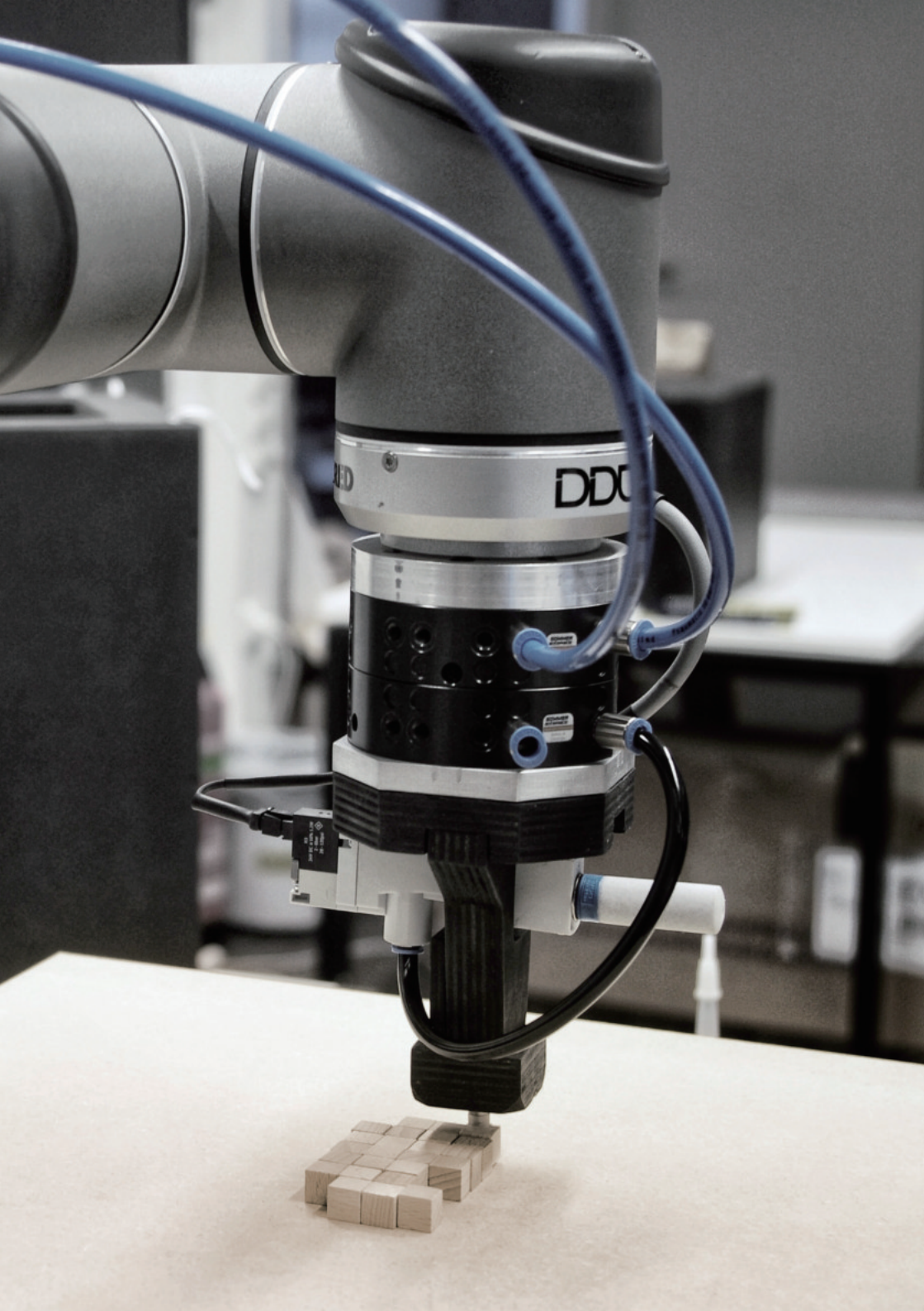
For future development, the focus on following three aspects are strongly recommended:

1. improve design of material dispenser – smaller and quieter

2. reexamine the script of gluing part, to gain quicker movement and more precise position

3. reduce upload time


FRED



Digital Design Unit — Digitales Gestalten