Turbulence Generation with an Active Grid

Current status and plans

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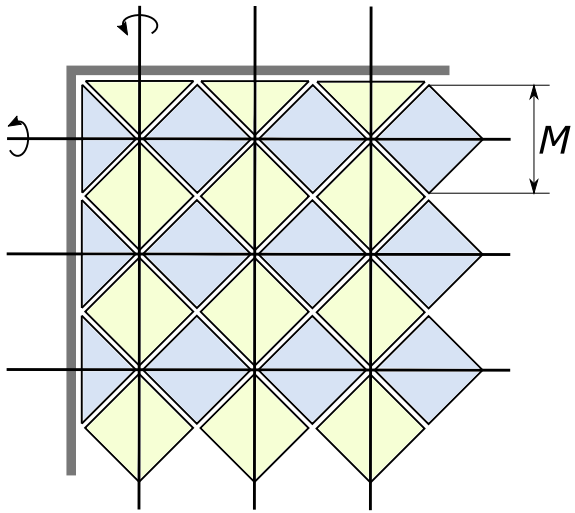
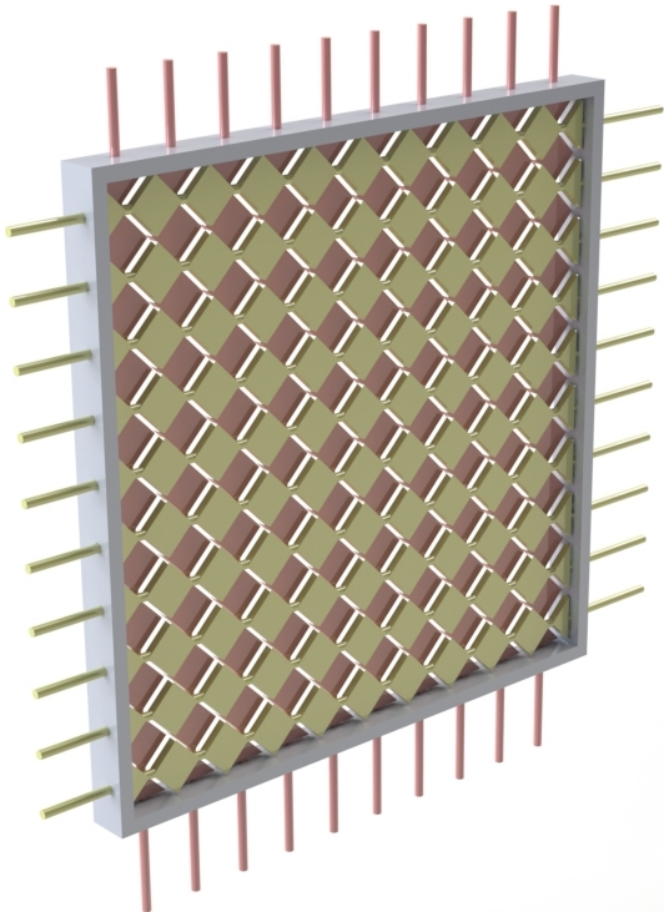
Plan for turbulence generation

- Active grid of size 200 mm $\times$ 200 mm
- mesh size $M = 20$ mm (and additionally various sizes of M)
- each rod can be rotated independently (synchronous and random configurations of rotational speed and direction)
- measuring of the flow field behind the grid in the wind tunnel in Berlin (as used for the fractal trees) with size of test section 500 mm $\times$ 500 mm
- afterwards (if turbulence characteristics are satisfying) the grid can be used in the wind tunnel in Rostock



Active Grid 20 mm × 20 mm



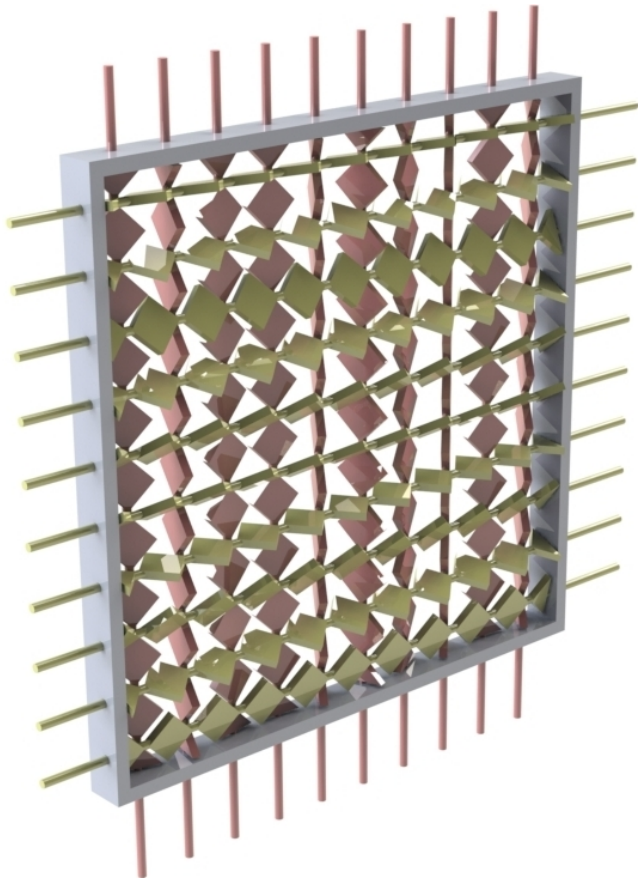


Abbildung: grid of brazen rods with 3D printed vanes of synthetic resin, brazen frame (used as bearing as well)

Vanes as used right now

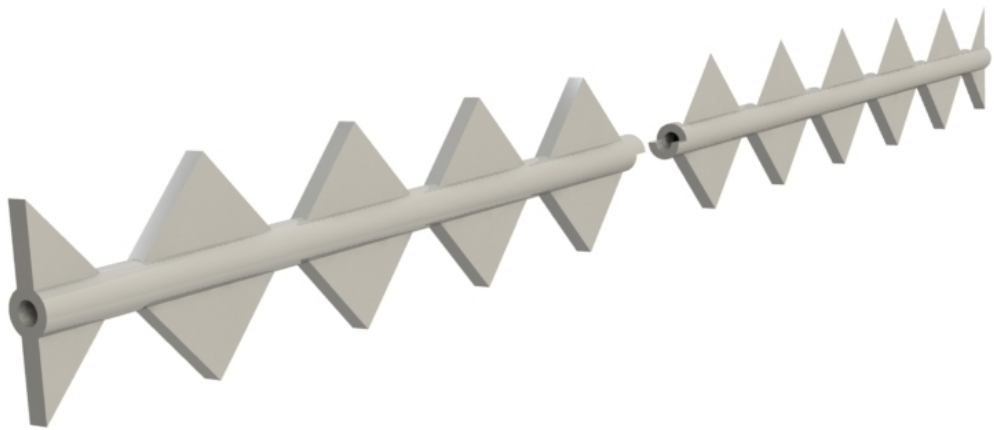


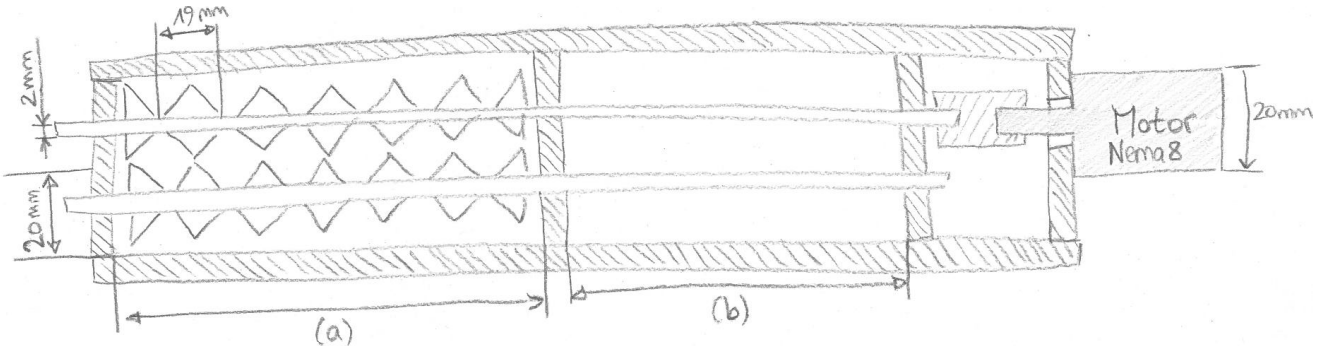
Abbildung: CAD Model of the vanes

to be printed with a 3D printer at TU Berlin (Formlab, laser sintered synthetic resin)

Further details

- 1 mm distance between the vane's tips (to enable rotation)
- vane thickness: 1.8 mm
- stepper motor (Nema 8, 200 Steps/Rev, micro stepping possible) with DRV8825 Stepper Motor Driver Carrier (by Pololu, highest step rate: 250 kHz)
- highest possible rotation rate with these devices: from 39 rps (micro stepping with $200 \cdot 32$ Steps/Rev) up to 1250 rps,
  highest possible step rate depends on highest PWM frequency of the controller
- controller: ESP8266 (to be replaced) via laptop,
  highest step rate: 1 kHz (with this micro controller only 5 rps of the rod)

Test-frame (under construction right now)



Construction of a prototype-frame to test if

- construction can be done exact enough to enable rotation
- brazen frame can be used as bearing
- rotation with the motor works in this set-up

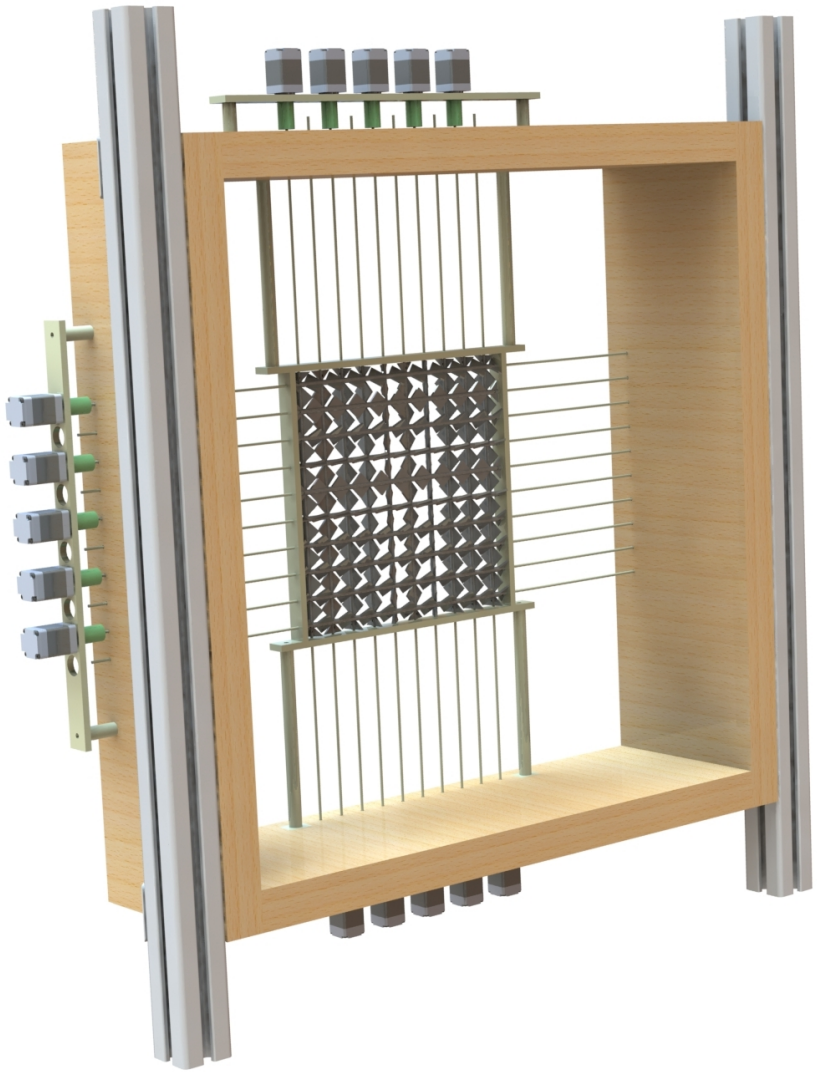
with $a = 200\,\text{mm}$ and b the same length as the distance between wooden and messing frame will be in the module in the wind tunnel in Berlin

Next steps (as planned)

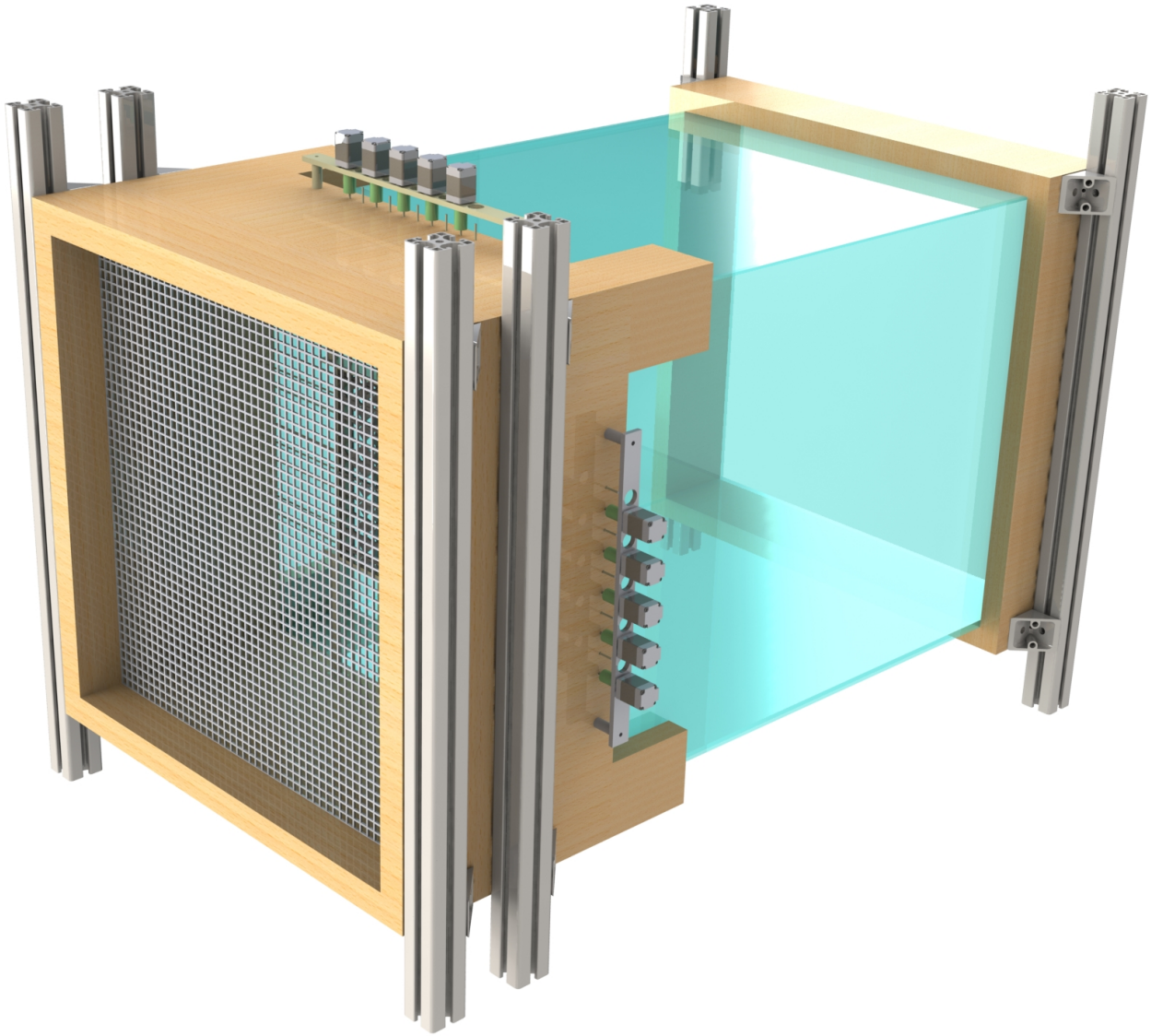
- use better controller: ESP32 pro via laptop (higher step rates possible and probably easier to control more motors than with an ESP8266)
- preparation of the hardware and software to control several motors
- construct the whole module for the wind tunnel of test section size $500\,\mathrm{mm} \times 500\,\mathrm{mm}$
- prepare and perform measurements of the flow field behind the active grid

(construction of the whole module and the measurements will probably take a while)

Active Grid module for wind tunnel in Berlin

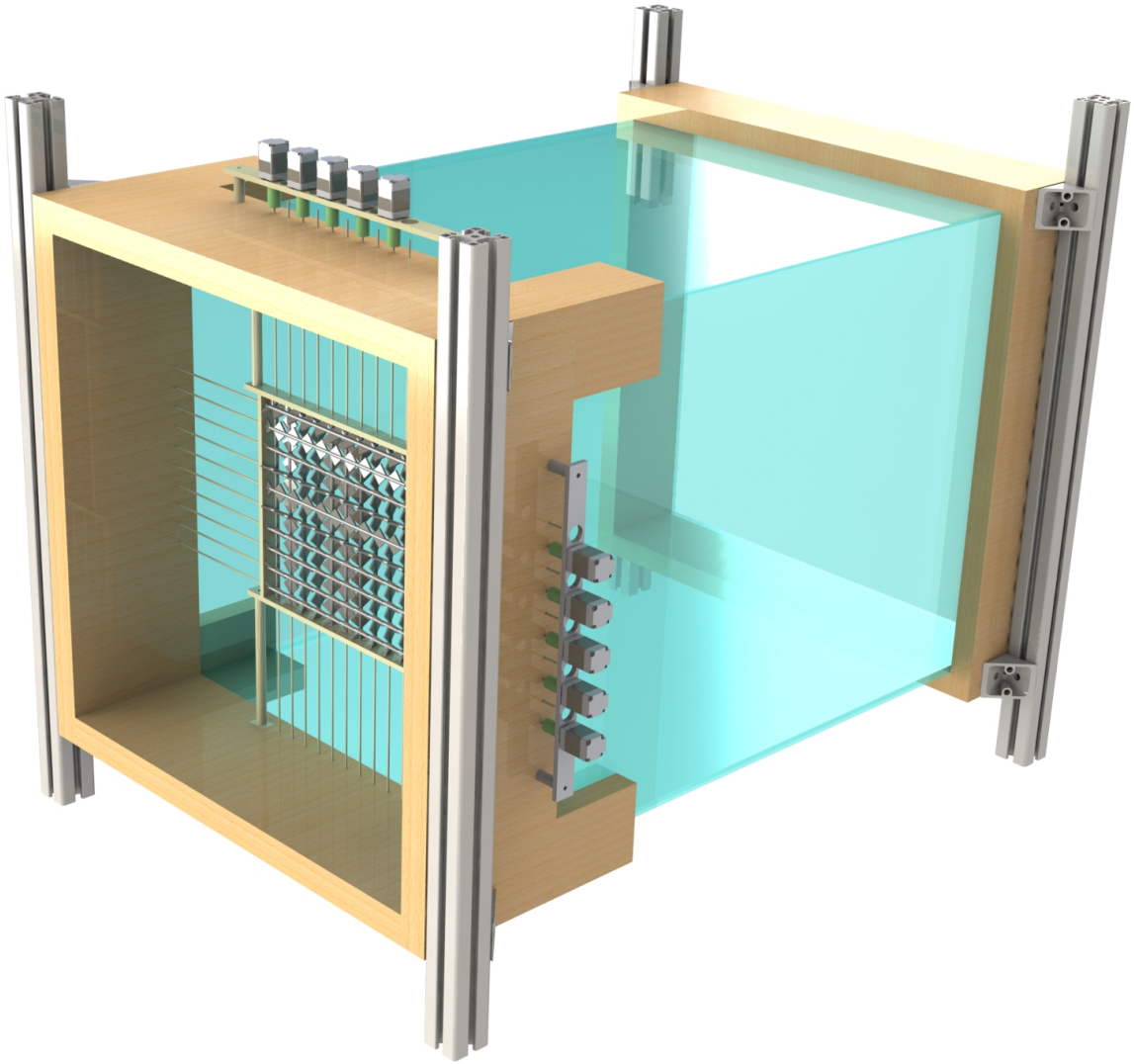


Active Grid in part of the wind tunnel in Berlin



this will not be an aquarium...

Active Grid and test section of the wind tunnel in Berlin



Questions and further ideas

- What different mesh sizes other than $M = 20\,\text{mm}$?
- First measure $M = 20\,\text{mm}$ and then, if interesting, use e.g. $M = 40\,\text{mm}$ (new rods and vanes are necessary) or planning to do so right away?

If everything works and the turbulence characteristics are as requested:

- construction of a frame for the wind tunnel in Rostock ($200\,\text{mm} \times 200\,\text{mm}$, fitting to the existing set-up)
- if necessary change the way to control the motors