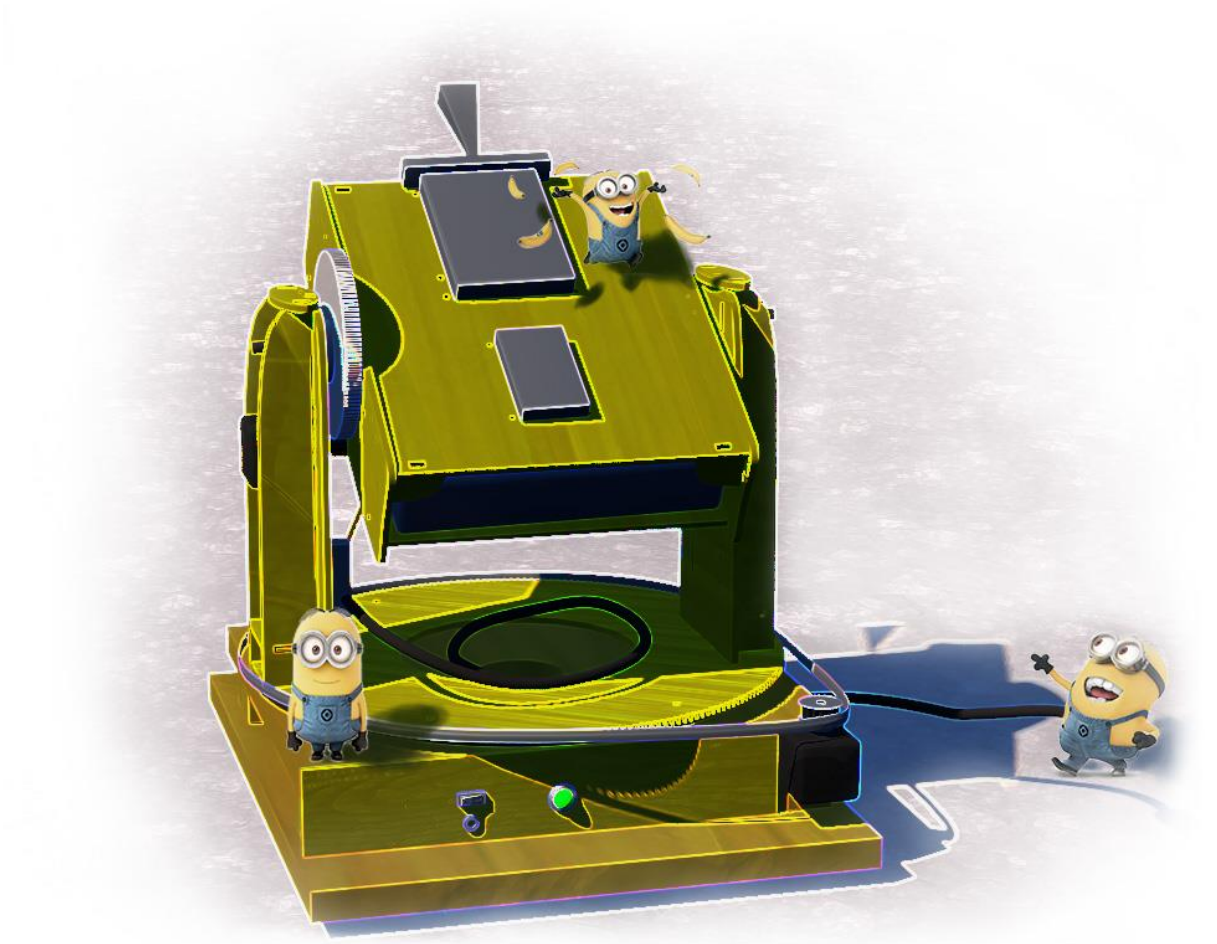
User Guide



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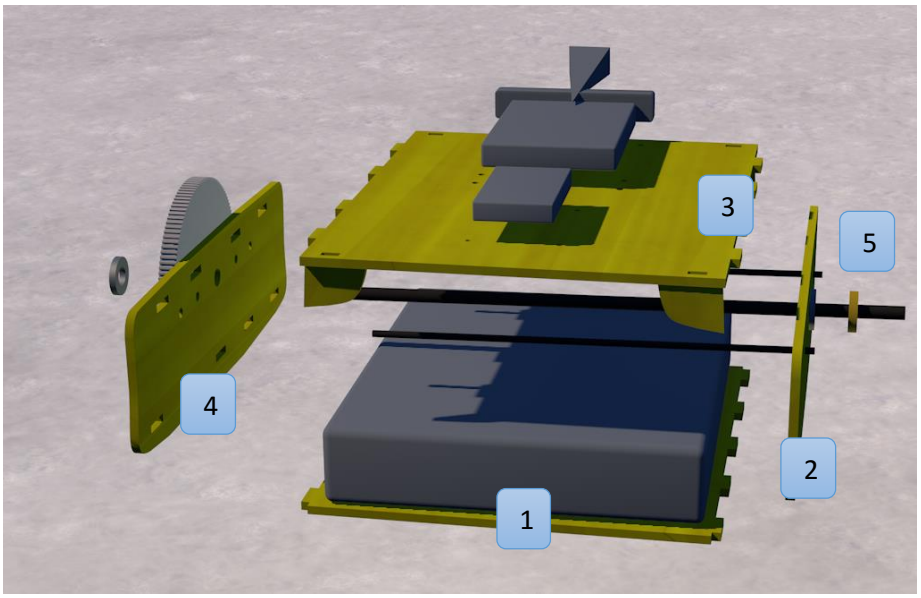
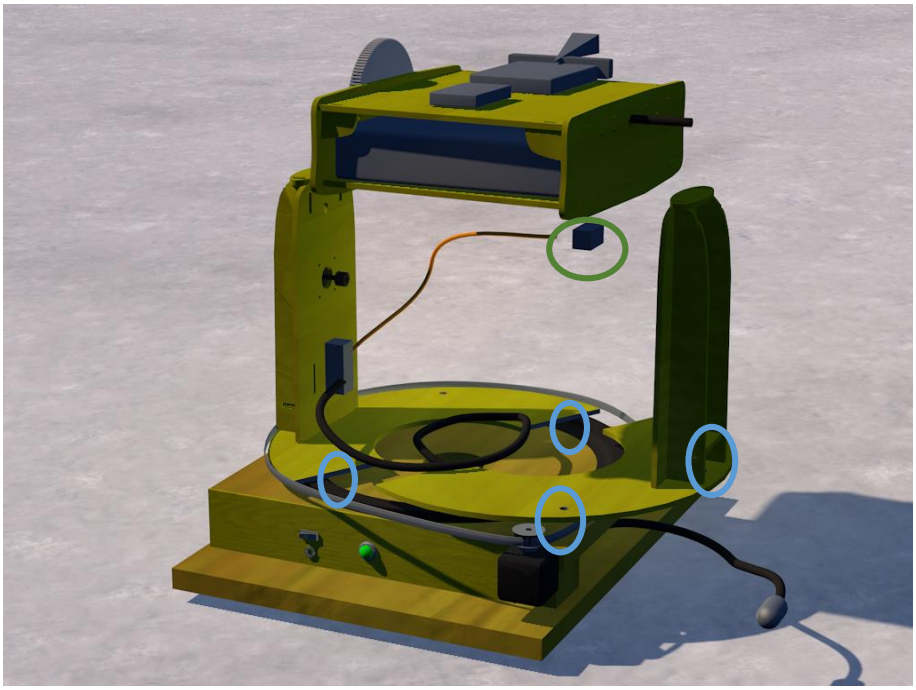
Assembly



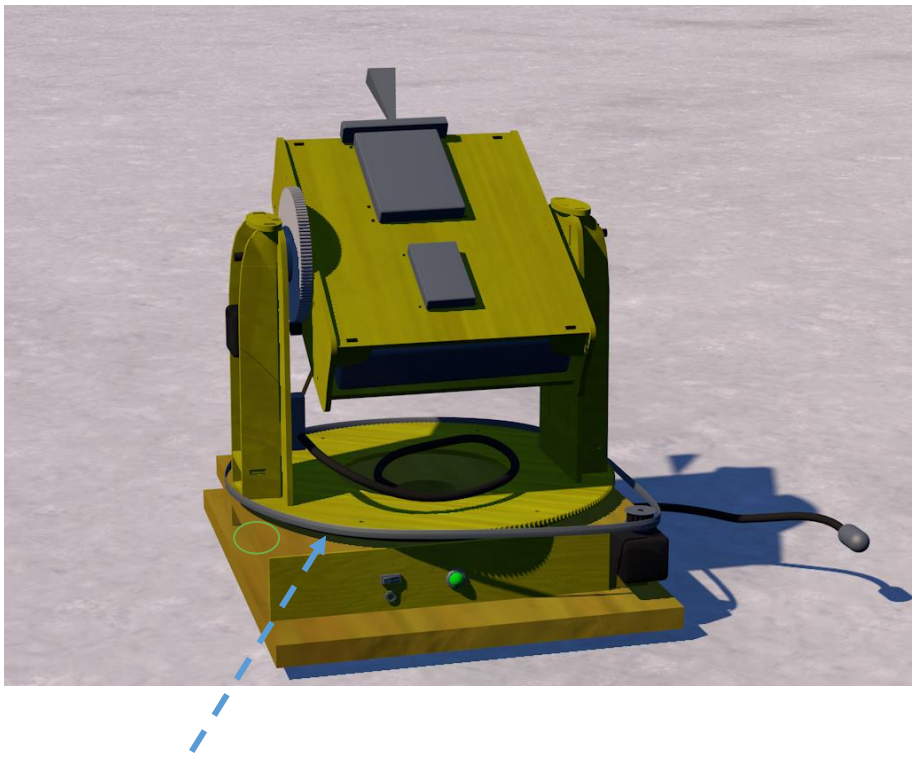
The **arrows** on top and bottom plate should point towards the tooth wheel

1. Start with the USRP on the bottom plate
2. Add the rightmost plate with two threaded rods and the main axle
3. Add top plate (power converter & SIVERSIMA already mounted)
4. Close the box and fix the threaded rods with two nuts
5. Check the fitting of both ball bearings and add the wooden spacer to the axle



- Position the box and mount the second tower
- Put in the screws
- Add the accelerometer

Startup and control



- Connect the Arduino to allow defined states at all I/O pins
- Flip the power switch to enable all other circuit boards
- Push the button to wake the vertical motor and start the accelerometer
- Push the button again to tilt the box to equilibrium (can also be repeated later)
- Turn until the marker aligns with the distance sensor to wake the horizontal motor and let it turn to 0°

The button can be used to **interrupt** the motor movement.

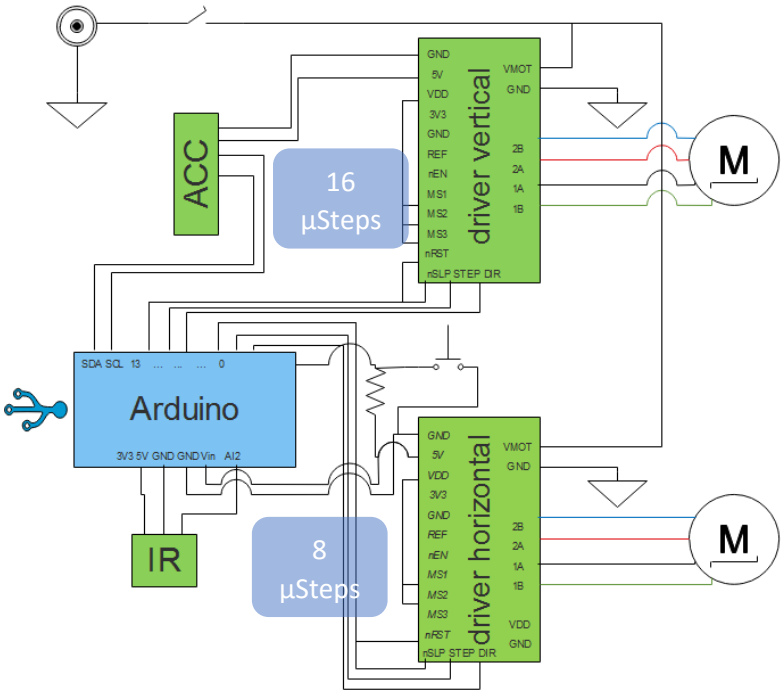
The Arduino listens on the USB (9600 Baud); currently possible **commands** are:

[Replace '_x' with '_h' for horizontal or '_v' for vertical]

- help - print commands
- move_x "angle" - **positive angle** turns the box left or tilts the box up.
- trig - trigger the other turntable
- sleep - disable both motors
- set [offset_x , msteps_x , trans_x]
- get [offset_x , msteps_x , trans_x , trig_width_x , spd_x]

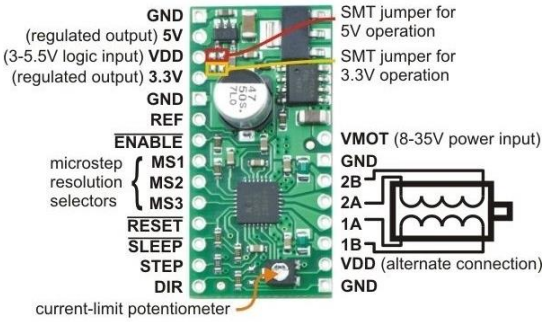
Miscellaneous

digital I/O	
0	SyncIn
1	SyncOut
2	(SDA)
3	(SCL)
4	nSLP_h
5	STP_h
6	DIR_h
7	button
11	nSLP_v
12	STP_v
13	DIR_v
analog I/O	
2	IR sensor

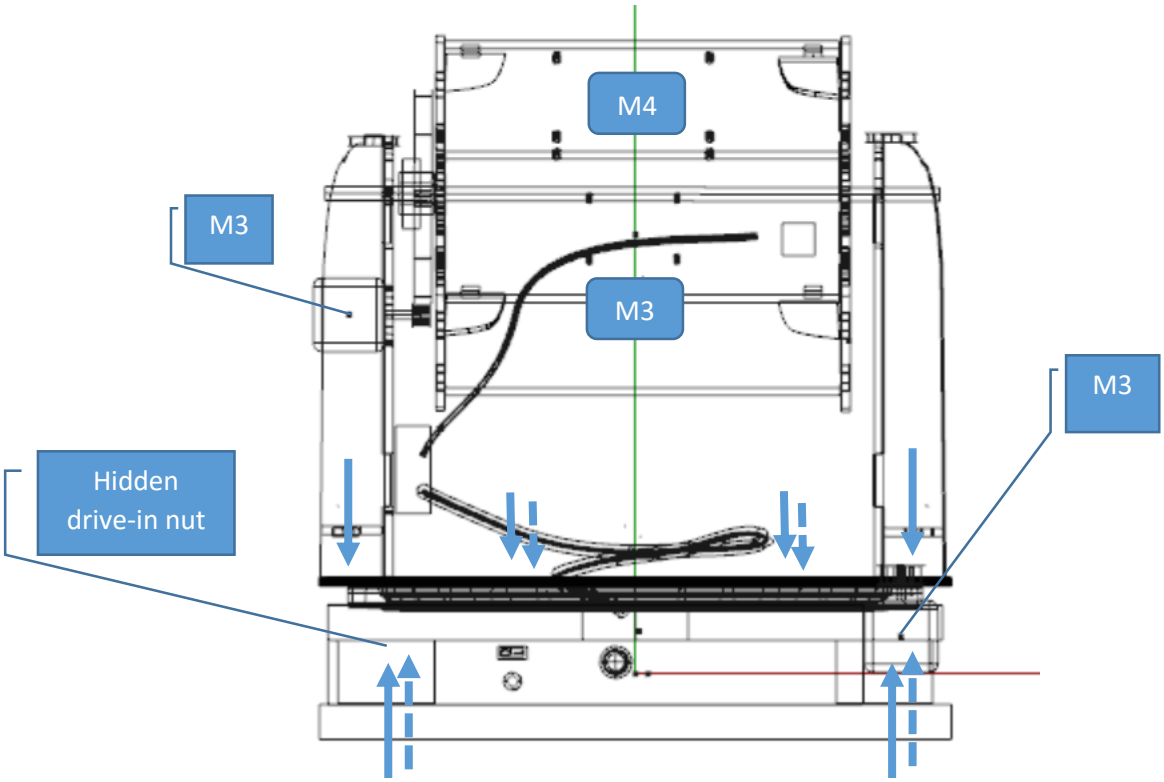


For **maintenance** remove the box from the turntable (secure the second tower again) and flip everything upside down. Undo the 4 screws and remove the baseplate.

Both **motor drivers** *(A4988)* have the 5V regulated output enabled (jumper). The nENABLE pin is not connected, thus always LOW. Pulling the nSLP and nRST pins HIGH (same Arduino pin) enables the driver. The phase current (max. 1A) can be adjusted to allow more torque or reduce noise and heat generation. [$Vref \times 2{,}5 \approx Imax$]



The **accelerometer** *(LSM 303D)* is only used to determine the current tilt angle of the box by polling the horizontal acceleration. The Arduino library for I2C communication can be found online.



M6 cylinder bolts with hexagon socket are used in the marked spots and for the box.

The tooth wheel (HTD profile) was generated using an OpenSCAD template and cut from 5mm fiberwood as were the towers and the box. The FabLab offers access to a laser cutter, maximum possible dimensions are 30 cm x 60 cm.

All vector graphics, spec sheets and code can be found in the git repository.

Version #	Transmission	µSteps	Steps per degree
1.0	$^{60}/_{12} = 5$	16	44.4
1.1	$^{150}/_{15} = 10$	16	88.9
2 [horizontal]	$^{227}/_{18} = 12{,}6$	8	56
2 [vertical]	$^{120}/_{12} = 10$	16	88.9