**Stereotaxic motorized arm**

**Bastijn van den Boom 2018**

Summary

We have mounted a stepper motor onto a Kopf stereotaxic arm to lower electrodes/lenses/other equipment automated and by predefined settings (i.e., speed, distance, retract). The arm was left over from a setup, presumably from Kopf 902.

Stepper motor was mounted onto the Kopf arm with a custom-made aluminum holder that holds both the arm and the motor **(folder “drawing\_connection\_motor\_arm”)**. Connection between the motor and arm made use of a flexible joint. The knob of the stereotaxic arm was mounted onto the other end of the motor so one could still manually lower the arm (and zero to bregma). Importantly, the motor axis was reversed by opening the motor and changing direction. This way, the short end was oriented towards the stereotaxic arm and the knob mounted on the long end.

An Arduino connected to a driver, the SilentStepStick (strong and silent driver), controlled the motor by a custom-written script **(folder “arduino\_script\_stereotact\_motor\_arm”)**. A cooling block was attached using thermal tape to the SilentStepStick to prevent heating issues (highly recommended). Board-To-Board connectors were used to make the driver pluggable in a socket (you may well blow one up, this makes replacing easier). Two programmable buttons connected to the Arduino (A and B) were used to lower at different speeds (or retract, or a combination). A switch (connected to the “enable” port of the SilentStepStick) was added that enables or disables the driver. In case of an emergency, one could use this button instead of pulling out the power cable, which can damage the driver. In addition, by disabling the driver it was possible to use the knob mounted on the motor to level the lens/electrode/etc onto bregma and center above the target area.

Input to the Arduino was 9V. Additionally, there was a LED connected to an output port of the Arduino that was programmed to give feedback when motor is running (on button press lower arm and LED high in Arduino script). Otherwise, it was hard to see if the motor is running with low speeds.

Adjusting speed

How many rotations correspond to millimeters was empirically found (highly depends on arm). The arm was lowered based on different numbers of rotations and the distance was measured. Next, the lowering distance was calculated for each rotation.

Always write down the coordinates or zero (dorsal-ventral of bregma) before lowering anything and check afterwards if the object (lens/electrode/etc) is indeed lowered to the correct depth. So far (over 30 times used), no wrong placements have been experienced.

Additional info

Notes: we use the pull-up button function (pull-up resistor input) on the Arduino (instead or regular push down button function). A pressed (deflected) button in the Arduino script will read LOW (instead of HIGH).

Finally, the axis of the stereotaxic arm is not centered, which depends on your stereotaxic arm. We manually milled some out of the upper part of the “ConnectionArmMotor” to center that axis with the motor axis. This can have small abbreviations as the flexible joint connects both axes.

Materials (MFG part no – e.g. digikey.nl)

Arduino uno or any replica

Arduino Proto Shiled REV3 (1050-1035-ND)

Stepper motor driver SilentStepStick (digi-key.nl part no: 1460-1159-ND)

Heatsink Alum Anod (V5618A)

Thermal tape double sided .005 (BP100-0.005-00-1112)

2x Switch pushbutton SPDT 3A 125V (EB2011P-BA)

1x Rocker switch DPST 16A 125V (CH791-ND)

RCPT female 4pos rect flange (M-XL-4-31)

Plug male 4pos metal cap (M-XL-4-12M)

Socket for driver:

Board-To-Board connector, 2.54mm, 16 contacts, header, BBS series, Solder, 1 Rows (BBS-116-T-A)

IC & Component Socket, 20 Contacts, SIP Socket, 2.54 mm, Beryllium Copper (1-1814655-5)

Stepper motor:

Stepper Motor Nema 17 - 0,5Nm TWIN AXLE

# Flexible joint: Torsionally-stiff coupling HZ with blind hole bore 4mm max. torque 0.21 Nm outside diameter 9.5mm (one side drilled to 5mm!) https://www.maedler.nl/Article/60120400

Misc.:

Stereotaxic arm

Cables to connect switches, LED, and flange connector

Cable, 4 strand (for stepper motor)

Box (for Arduino, shield, driver, buttons)

USB cable A-B (Arduino prog. Cable)

Wall plug power supply, 9V, 3A

Connection scheme SilentStepStick to Arduino

VREF is set to 1V (not too high to prevent heating)

1 full step (16 steps, interpolate to 256 microsteps) = 0.3mm on the stereotaxic arm

1 full step = 3200 steps (16 \* (360 / 1.8))

1 step = 0.93125 um (29800 / 32000)

**Buttons**

Button A (top) = 7 Arduino port

Button B (bottom) = 6 Arduino port

Button I/O = enable port SilentStepStick and GND (enable port directly to 5V with a resistor (pull-up), also connected with button I/O to GND   
 [button O = EN to 5V, button I = EN to GND])

**SilentStepStick inputs**

CFG1 = 3 Arduino port

CFG2 = 4 Arduino port

Step = 8 (with pull-down 10K ohm resistor to GND) Arduino port

Dir = 9 (with pull-down 10K ohm resistor to GND) Arduino port

Programming Arduino

If you use the “arduino\_script\_stereotact\_motor\_arm” Arduino script, you only need to change:

Button A variables:  
total\_distance\_A – distance to target for needle (unit is micrometer (um))  
time\_A - time it should take to lower to and then retrack from target (min)  
stay\_in\_A – duration to stay at target (min)

Button B variable:   
total\_distance\_B – distance to target for lens (unit is micrometer (um))  
time\_B - time it should take to lower to target (min)