POST STROKE SPASTICITY REHAB HELPER
Build instruction V. 01

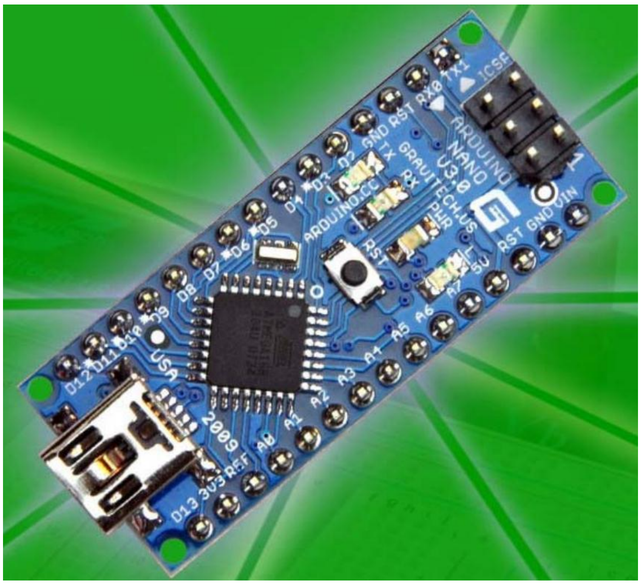
Bill of Materials

We use in the project the components

No	Q	Name	Description
1	1	Controller	Arduino nano R3
2	2	8 digits LED shild	max7219 0,36"LED shild
3	2	Push button	Any push button- momentary
4	10	Servo mini SG90	Servo mini SG90 9g Tower Pro
5	2	5 kohm potentiometr	Any type of linear potentiometr
6	5	Magnetic Snaps	3/4-inch size Magnetic Button Clasp Snaps
7	2	Shottky Diodes	Shottky Diodes 1N5817
8	2	3300 uF 16 V capacitor	Low ESR capacitor.
9	2	0.1 uF 16 V capacitor	Capacitor for high friequency noise damp.
10	3	Low base for servo	3D printed or milled plastic components
11	2	High base for servo	3D printed or milled plastic components
12	10	Servo mounted lever arm	3D printed or milled plastic components
13	6	Short node lever	3D printed or milled plastic components
14	4	Long node lever	3D printed or milled plastic components
15	2	Breadboard	Plastic Breadboard or other flat plastic

We make some introduction about it.

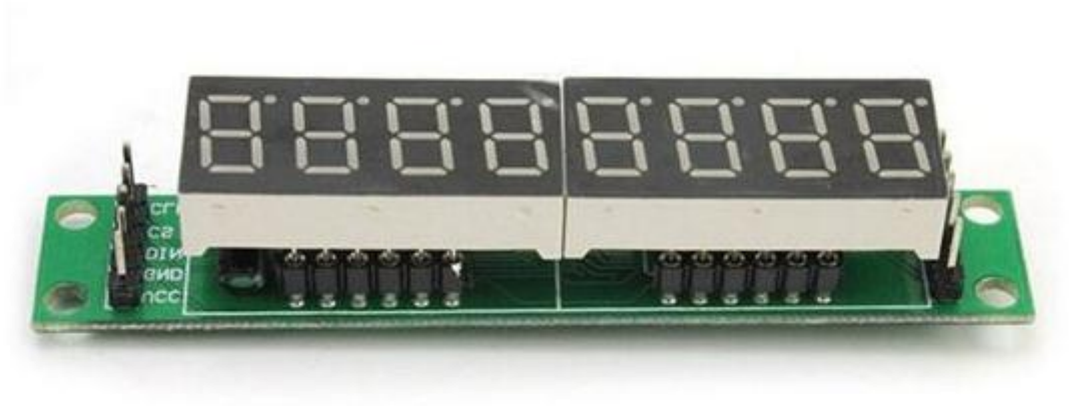
1. Controller Arduino Nano R3.x (992-ARD-NANO30NP) or any Arduino Nano R3.x compatible.


ARDUINO
NANO
V3.0
ICSP
ARDUINO.CC
GRAVITECH.US
2009
USB
D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 GND RST RX0 TX1
D13 3V3 REF A0 A1 A2 A3 A4 A5 A6 A7 5V RST GND VIN
RST
TX
RX
PWR

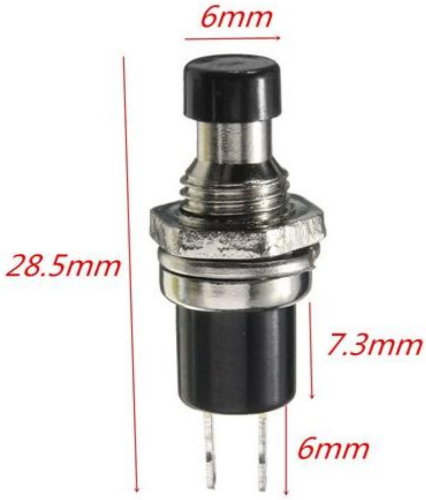
The Arduino IDE code works with any native or compatible PCB.

2. Max7219 0,36"LED shield

The Shield made using max7219 chips. The shields (two) show the force of fingers press in digital (4 signs in Gramms) or bar views.



3. Push button
   You can use one any momentaty normal open push button, and one toggle push button.



4. Servo SG90 9g Tower Pro

   You can use any type of Servo. Please pay attention that some servos can have other control pulse parameters.
5. 5 kOhms potentiometer

   Any type of linear potentiometer can be used, 1-10 kOhms.

6. Magnetic Button Clasp Snaps
   18mm (3/4-inch) size Magnetic Button Clasp Snaps

7. Shottky Diodes
   1N5817 Diodes.
8. 3300 uF 16 V capacitor Low ESR capacitor.

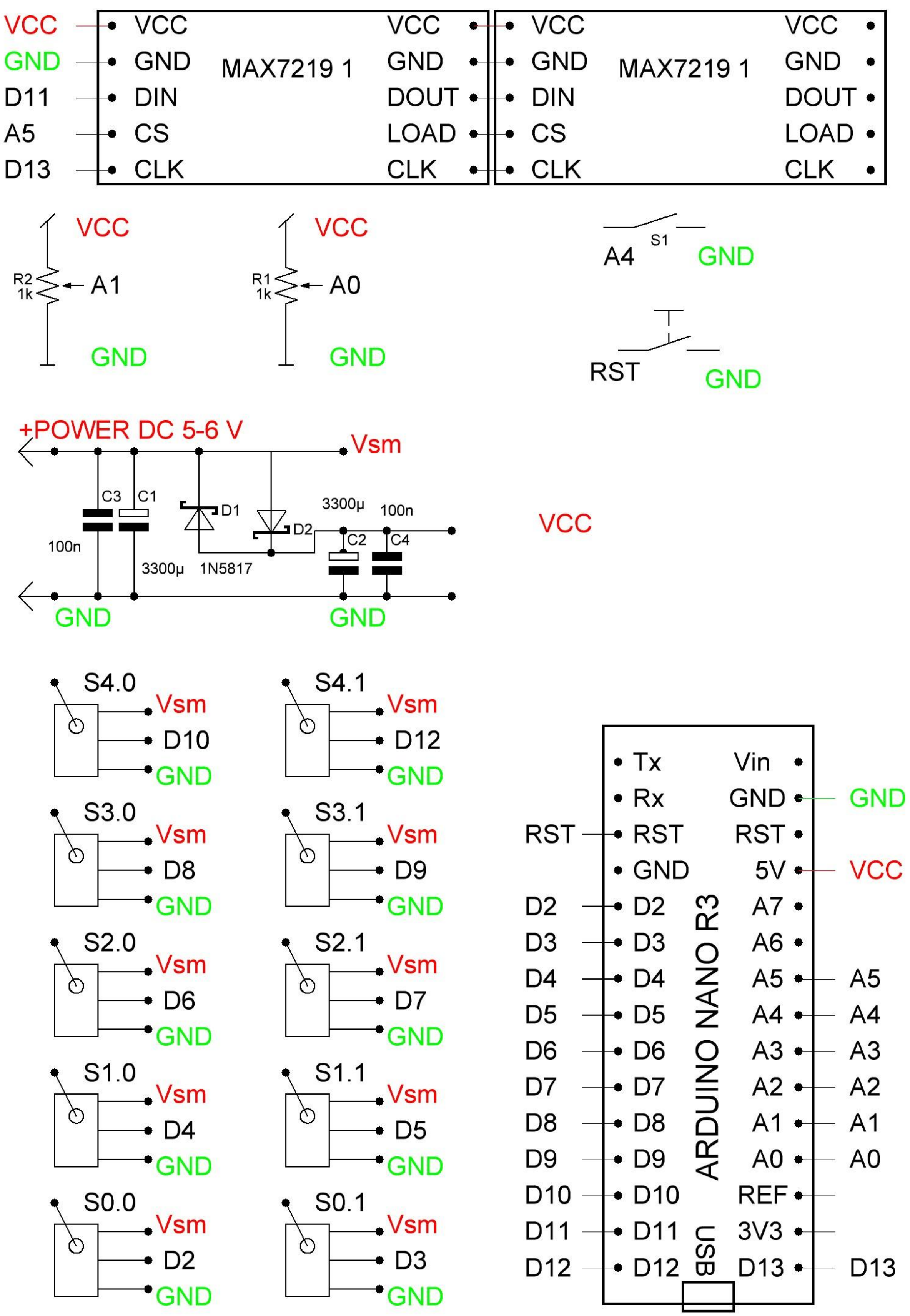
9. 0.1 uF 16 V capacitor
10. Low base for servo. All holders and lever arms for servos (components 10 – 14) are described in “Mechanics”.

11. High base for servo
12. Servo mounted lever arm. Big hole must fit servo shaft.
13. Short node lever
14. Long node lever
15. Breadboard
    We used plastic cutting board, but any flat surface can be used.

16. Nuts, screws and washers

Schematics

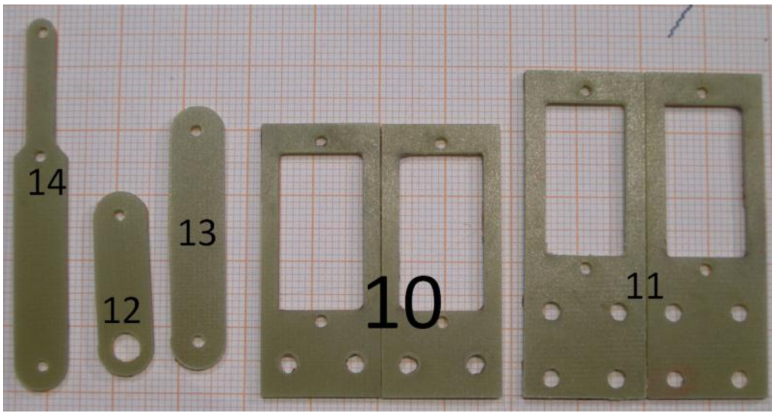
5 CHANNEL 5 BAR LINKAGE LED 8X2



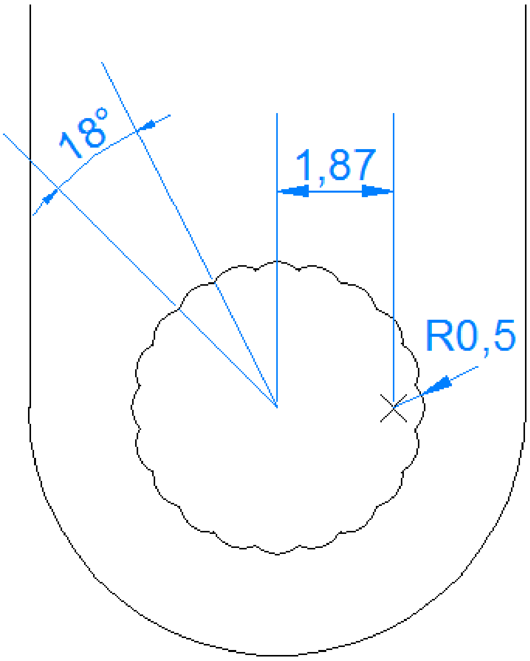
Peak power current can reach 2 A, so you have to use appropriate power supply. Not all computer USB connectors can give 2 A, so please be careful.

Mechanics

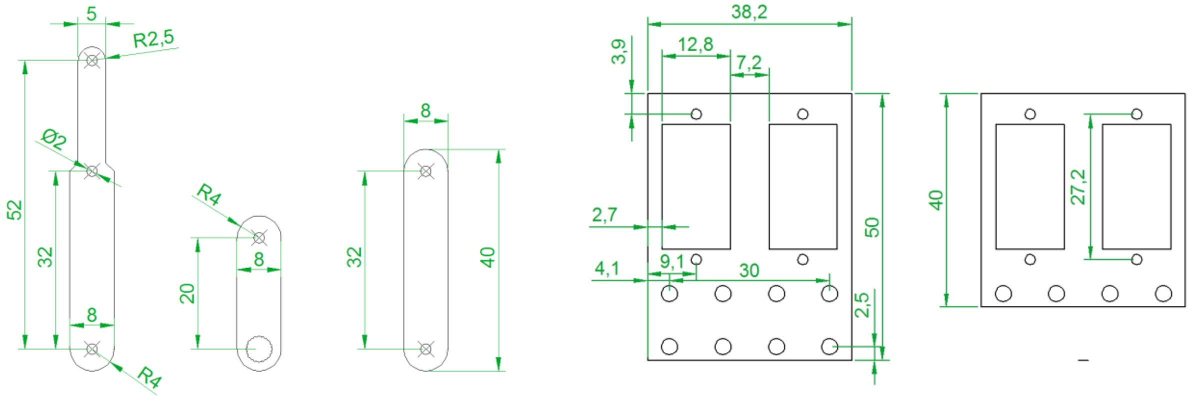
We use the simplest analogue servo. You can use any kind of servos. The bases, lever arms are shown in a figure:



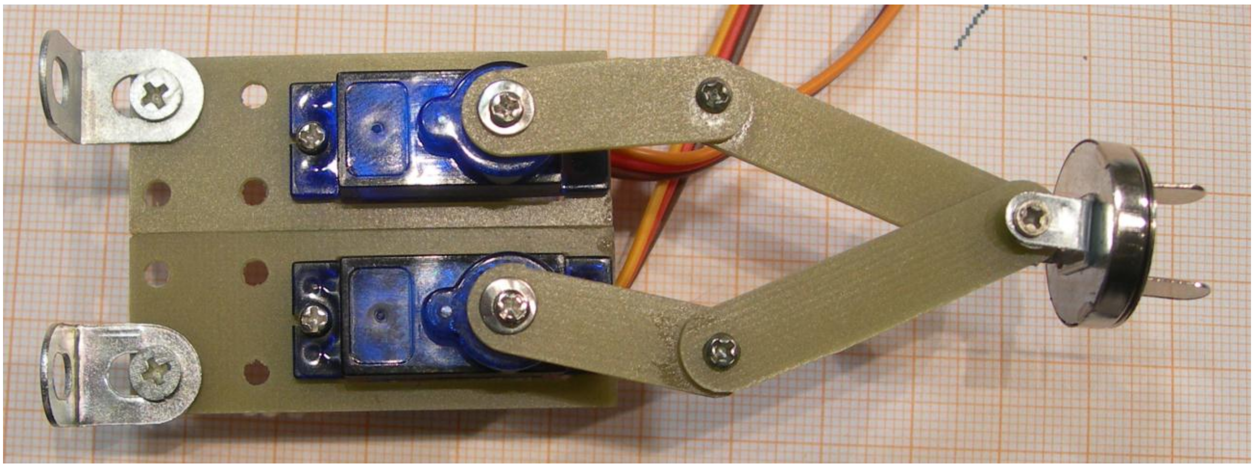
The only difficult part of mechanics component fabrication is lever arm 12. The perforation on arm must fit servo shaft perforation. We make perforation by drilling 20 holes via 18° (our servo shaft has 20 teeth) with 1mm radius drill with centers on the R=1.87 mm circle.

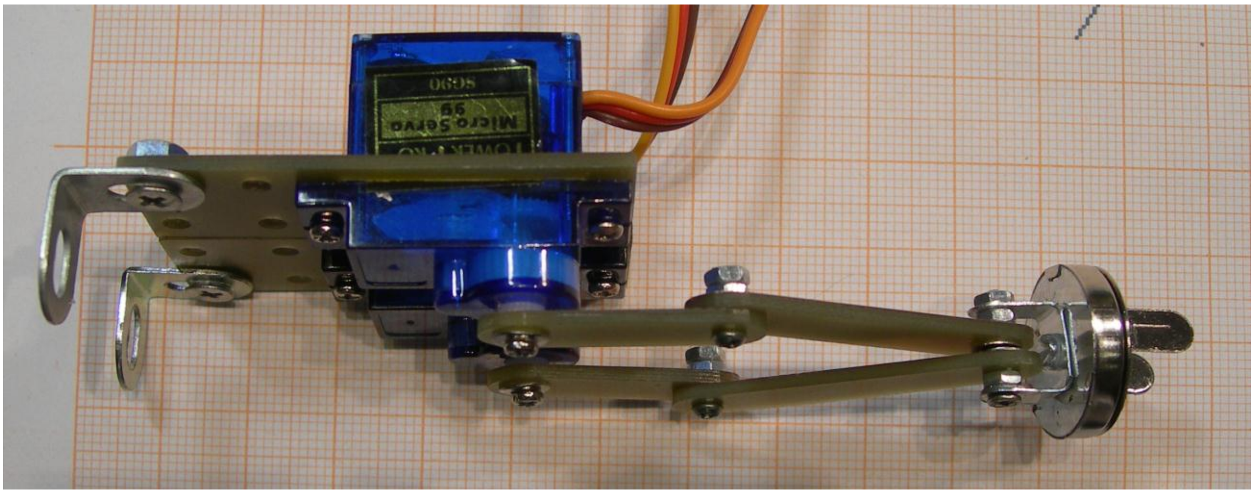


The drawings of lever arms and bases are here

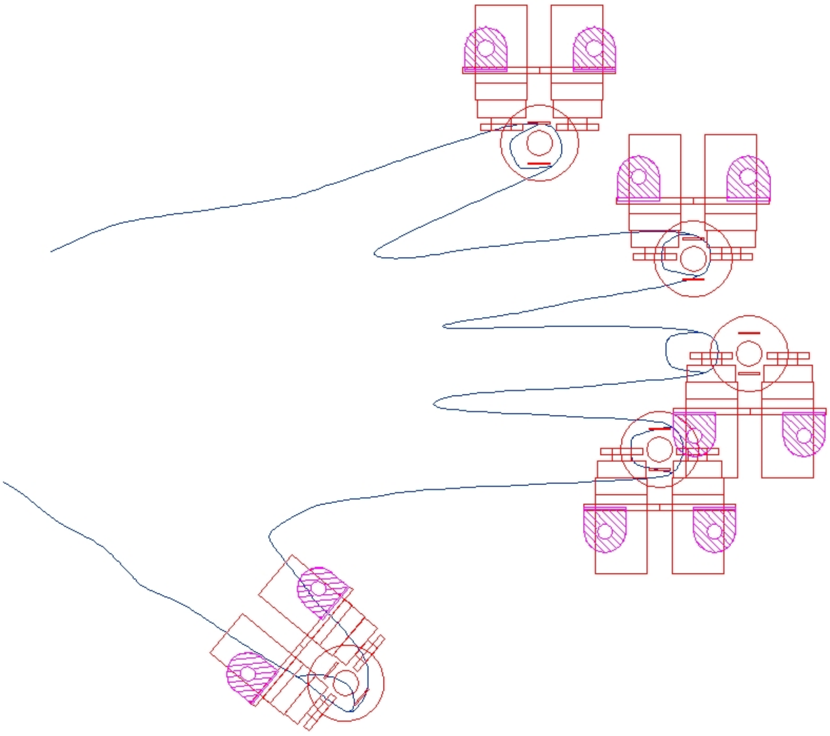


The size of components are defined by the servo in use. We made all drawings for Servo mini SG90 9g Tower Pro. Here is one block

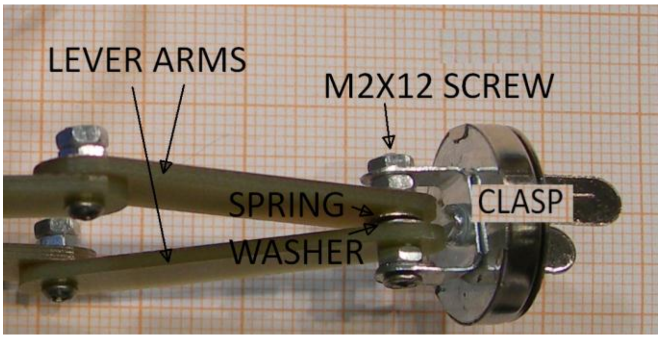




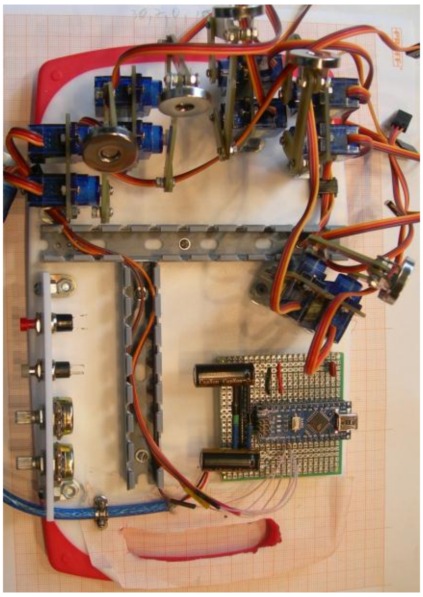
We took plastic breadboard and install 5 blocks on it, for example it is left hand drawing

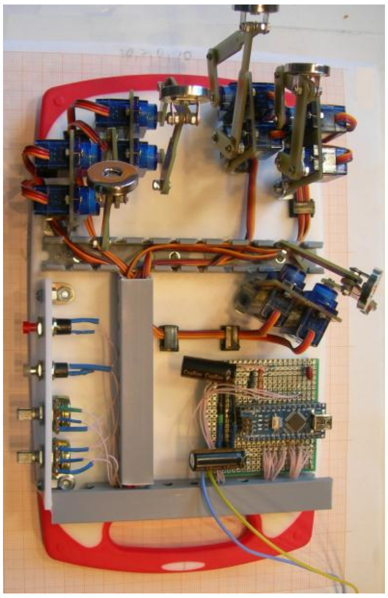


We use 3/4-inch size Magnetic Button Clasp Snaps. It is screwed with two node lever arms so it can be rotated.



Here You can see the breadboard with installed blocks and fully assembled





Programming

Program code is Arduino IDE compatible. You can download code from git hab https://github.com/DrOnkel/Rehab/tree/ReHab0 or Hackaday project file section.

Download the program to Your Arduino Nano using Arduino IDE. You can download it from arduino.cc .

The movement is defined by arrays MassX[8][2]. It contains 8 main points of finger base path. The movement between main points is calculated using linear interpolation. The full review of program code is in Program instruction.

Math and Calculation.

We calculate the angles of servo using simple model. Doctor give as some function X=X(t), Y=Y(t). We simulate the movement using model and test program ServoPot2Tester.ino (download from git hab https://github.com/DrOnkel/Rehab/tree/ReHab0 or from file section of our Hackaday project), two potentiometers (A0, A1) and two servo (pins 2,3).

Conclusion.

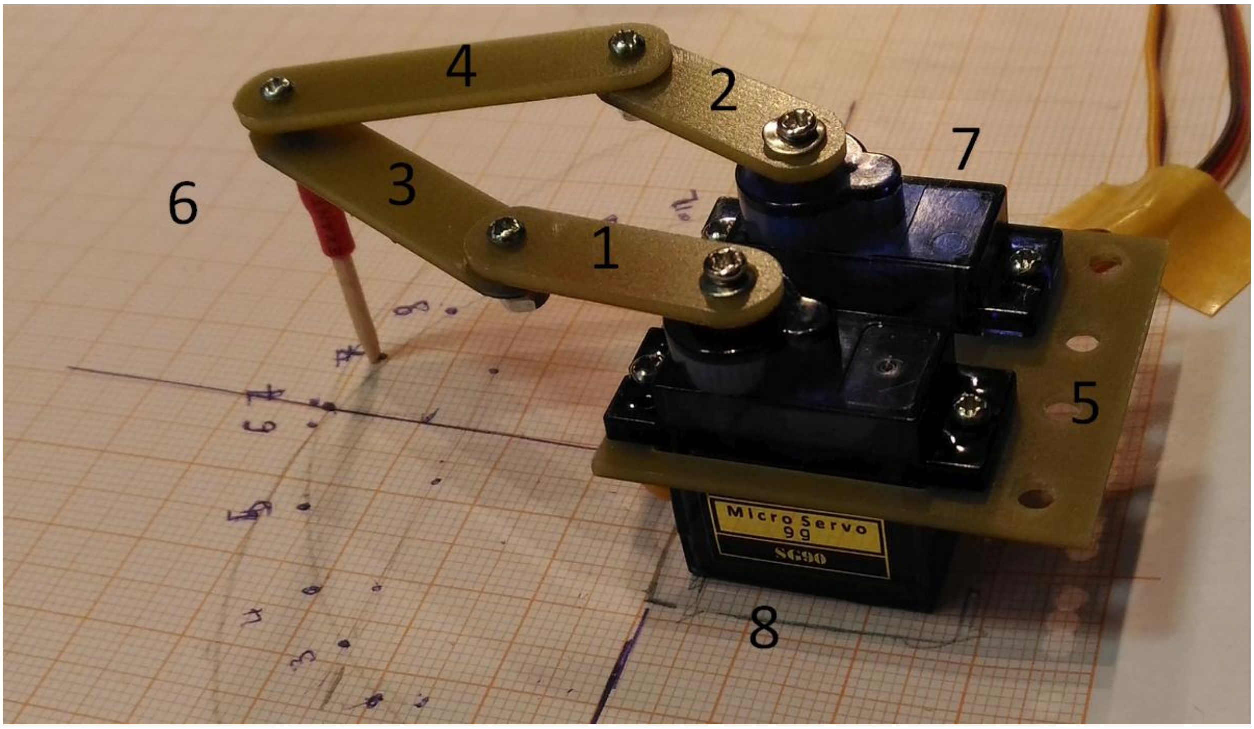
Take an interesting experience. Electronics is useful and interesting.

Appendix

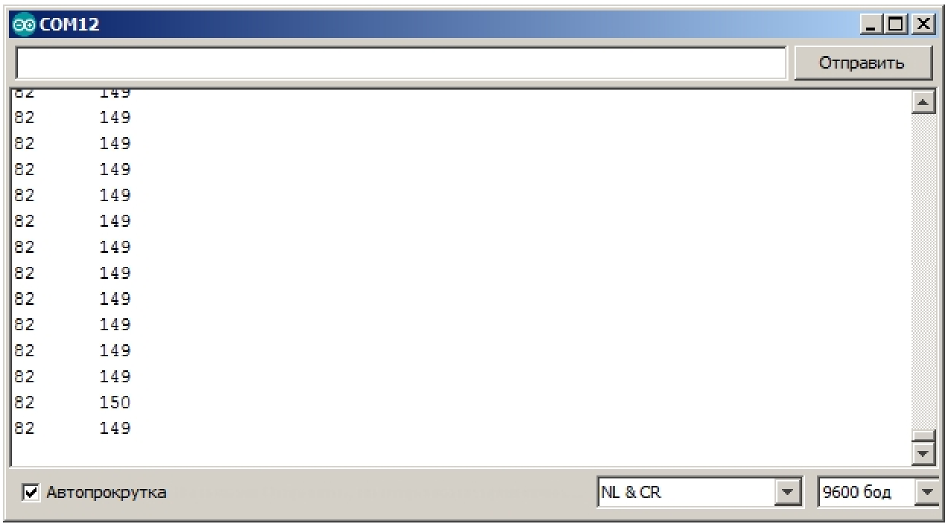
ReHab Helper - Program comments and math

5-bar linkage

We use 5-bar linkage for 2D- movement. Two servo (7,8) rotate two lever arms (1,2), coupled with secondary lever arms by screw and nuts. Other ends of secondary lever arms coupled by screw and nuts too. In test system pointer is linked to this joint. The system of lever arms can rotate in all joints. The pointer can reach any point in area between two semicircles with radius= L1+L2 with centers in the middle of servo shafts. We connect servos to Arduino controller and



download ServoPot2Tester.ino program. We rotate potentiometers until the pointer is in the point we need. On monitor we can see the values of servo angles, we denote this angles as fi and psi.



```
82      149
82      149
82      149
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Write down the data for all 8 points of the path. You can insert the data in arrays of the program, in the array x (x=1,2,..7) Massx[8][2] in the order fi$_0$, psi$_0$, fi$_0$, psi$_0$ …. fi$_7$, psi$_7$, and   for the reverse array Massxr[8][2] in the order order fi$_7$, psi$_7$, fi$_6$, psi$_6$ …. Fi$_0$, psi$_0$. You can insert data for any or all arrays instead of our default data. Modes 7 -16 are the same but with thumb movement. The Mode 17 is only thumb movement.

The program

Let us see the main parts of program. From the beginning.

You have to load LedControl library to you Arduino IDE program, please find it on http://playground.arduino.cc/Main/LedControl .

We use servo library from Arduino IDE program, the servo library is as a rule installed in core IDE.

Arduino controller calculate intermediate points within 8 points of the array. It makes the servo movement smooth and without jerks. The number of intermediate points can be from 3 to 35. The more the number the slowly moves the lever arms.

In the end of a program is a code for serial output of some data, it show the Mode , i and ns – number of point and of iteration within the points, Fi and Psi – angles of servo, Timer – time in milliseconds between the movements, Frames – quantity of iterations within the points, and Wipes- total wipes done.