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3.1 Muscle-BioAmp-Candy
Muscle-BioAmp-Candy is a candy-sized Electro Myography (EMG) sensor designed to capture precise muscle bio-potential signals. With a compact size and functionality, this device can transform the way of monitoring muscle activity.
It has a fixed gain of x2420 and a Band Pass filter spanning from 72Hz to 720Hz, Muscle-BioAmp-Candy ensures signal clarity and accuracy.
Compatible with standalone ADCs such as the ADS1115 or any microcontroller development board equipped with an ADC, Muscle-BioAmp-Candy offers seamless integration into your existing setup. [1]

Fig. 3 Muscle-BioAmp-Candy [1]
Schematic Diagram-
Fig. 4 Schematic diagram of Muscle-BioAmp-Candy [1]

3.2 Muscle BioAmp Band (EMG Band)
Stretchable in nature, the Muscle BioAmp Band (EMG Band) can be linked to the Muscle BioAmp-Candy via a BioAmp Cable that uses dry electrodes. It makes it simple for you to capture your muscle signals.[14]
Dimensions:
Fig. 5 Dimensions of the Muscle BioAmp Band (EMG Band) [14]
Features & Specifications
Length: 13 inches
Stretchability: 2X (up to 26 inches)
Usability: Reusable as it comes with washable fabric
Interface: Snap electrodes
Compatible Hardware: BioAmp Cable used with BioAmp Hardware (Muscle BioAmp BisCute, Muscle BioAmp Candy, Muscle BioAmp Patchy, BioAmp EXG Pill, Muscle BioAmp Shield)
BioPotentials: EMG
No. of channels: 1
Wearable: Yes

Fig. 6 Electrode Placement Example [14]

3.2 Arduino Nano

Fig. 7 Arduino Nano Board [2]
Arduino Nano is a small, breadboard-friendly development board based on an ATmega 328P SMD package microcontroller and offers the same connectivity and specs as Arduino Uno in a small package.
In our project, we are using it because the size is the main factor. After all, the microcontroller needs to be fit into the 3d printed hand. We are supplying the power to the board with a Mini B USB port present on it. [2]
Specifications:
• It has 22 I/O pins in total of which 14 are Digital (6 are PWM output) and 8 are Analog pins.
• Operating Voltage (Logic Level): 5V.

• Supports Serial, I2C, SPI Communication Protocols.
• Flash memory: 32KB in which 2KB is used by Bootloader
• Clock speed: 16MHz
• DC Current per I/O Pin: 40 mA
• SRAM: 2KB, EEPROM: 1KB
• DC Current per I/O pin: 40mA[2]

3.3 SG90 9 g Micro Servo

Fig. 8 SG90 9 g Micro Servo [3] Fig. 9 Orthographic view of SG90 9 g Micro Servo [3]
SG90 9 g Micro Servo is tiny and lightweight with high output power. The servo motors are used for the movement of the fingers in the hand. The servo motors usually provide control over the 180° range. This angular position control is controlled by the PWM technique so by varying its duty cycle we can control the angular position of the motor. This servo motor can lift a maximum of 1.6 kg when suspended at a 1cm distance from the shaft. [3]
Specifications
• Weight: 9 g
• Dimension: 22.2 x 11.8 x 31 mm approx.
• Stall torque: 1.8 kgf·cm
• Operating speed: 0.1 s/60 degree
• Operating voltage: 4.8 V (~5V)
• Dead band width: 10 µs
• Temperature range: 0 ºC – 55 ºC [3]
Every 20 ms, the servo examines the pulse. The servo can be rotated to zero degrees by a pulse with a width of 1 ms (1 millisecond), to ninety degrees (the neutral position) by a pulse of 1.5 ms, and to 180 degrees by a pulse of 2 ms.. [13]

Fig. 10 Rotation control of SG90 9 g Micro Servo [13]

3.4 Power Bank

Fig. 11 Reconnect Power Hub 10000 mAh Power Bank Series 100 [4]
Here we are using Reconnect Power Hub 10000 mAh Power Bank Series 100. It has a capacity of 10000 mAh, so it can be used for longer intervals. As the microcontroller, servo, and Muscle-BioAmp-Candy draw very little power on a full charge it lasts for about 10hrs.[4]
Specifications and Features
• Over Charge Protection, Over Discharge Protection
• Over Current Protection, Short Circuit Protection
• Input: 5V 2A(max)
• Type C And Micro USB Dual Input Port
• USB A 5V/2A Output Port
• BIS Certified [4]
3.5 Fabrication of 3D Printed Hand
Here we used PLA because PLA is a common 3D printing material to print components. PLA is widely used because of its ease of availability, ecological footprint, and affordability.
PLA is a biodegradable substance derived from food crops like sugarcane, corn, and jowar. Here are some key characteristics of PLA and the 3D printer [9]:
Table 1: Features of PLA[9][10]
S.N. Property Value
1 Melting Point Low (150°C and 180°C)
2 Thermal Expansion Low (68 µm/m-K)
3 Layer Adhesion Moderate
4 Heat Resistance Low(55–65 °C)
5 Tensile Strength High(39.9 MPa to 52.5 MPa)
6 Compressive Strength High (48.2 MPa to 62.0 MPa)

7 Dimensional Accuracy High

Table 2: Features of 3D Printer[11]
Model X1E
Physical dimensions (w) 40 cm x (d) 22 cm x (h) 46 cm
Maximum printing area (w) 21 cm x (d) 21 cm × (h) 24 cm
Print layer height 0.04~0.32 mm
Wire diameter 0.2mm
Nozzle diameter 0.4mm
Platform temperature ~100 °C
Nozzle printing temperature ~200 °C
Cooling method Air Cool
Motor drive 1/32 micro-stepping motor (8825 driver chip
Now let us discuss the specification of the 3D Printed Hand
Table 3: Technical Specification of 3D Printed Parts[12]
No. Name of the parts No. of joints/parts Length (cm)
1 Thumb finger 2 5.5
2 Index finger 3 6
3 Middle finger 3 8.5
4 Ring finger 3 7.5
5 Pinky finger 3 5.5
6 Palm 1 10
7 Wrist - 2.3
8 The diameter of the end of the wrist - 10
9 The total length of the arm - 30

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Title:Brain BioAmp Band - Multi Channel EEG Band - Tindie

🔎Usability: Reusable as it comes with washable fabric ✔ ; Interface: Snap electrodes; Compatible Hardware: BioAmp Cable used with BioAmp EXG Pill; BioPotentials: EEG; No. of channels: 2; Wearable: Yes; Note:🔎 Don't leave the gel residue on ✔ snap electrodes🔎 longer than an ✔ hour as🔎 it may damage them over a period of time. ✔

https://www.tindie.com/products/upsidedownlabs/brain-bioamp-band-multi-channel-eeg-band/

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Title:Arduino Nano 328 CH340 Chip Soldered with USB Cable

🔎Arduino Nano is a small, breadboard-friendly development board based on an ATmega 328P SMD package microcontroller and offers the same connectivity and specs as Arduino Uno in a small package ✔ . DC Power Jack is not available on this board so power can only be supplied by a Mini B USB port present on it.

https://calcuttaelectronics.com/product/arduino-nano-328-ch340-chip-soldered-with-usb-cable/

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Title:Arduino Nano V3.0 (Without Cable) – QuartzComponents

🔎Flash memory: 32KB in which 2KB is used by Bootloader ✔ . Clock speed: 16MHz. DC Current per I/O Pin: 40 mA. SRAM : 2KB, EEPROM: 1KB. DC Current per I/O pin: 40mA. Product Description. To connect and program this development board you need to have Arduino IDE installed in your computer and the Mini USB Programming Cable.

https://quartzcomponents.com/products/arduino-nano-v3-0-without-cable

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Title:What is the maximum current for each I/O pin?

Nov 20, 2016 — The 20 mA is a recommended MAXIMUM current per pin - you should always try to use less current. There is no problem sinking or sourcing 5 mA, or ...

https://arduino.stackexchange.com/questions/31660/what-is-the-maximum-current-for-each-i-o-pin

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Title:www.datasheetcafe.com › SG90-pdf-23123SG90 PDF Datasheet - Micro Servo Motor - Tower pro

May 16, 2023 · Specifications: • Weight: 9 g. • Dimension: 22.2 x 11.8 x 31 mm approx. • Stall torque: 1.8 kgf·cm. • Operating speed: 0.1 s/60 degree. • Operating voltage: 4.8 V (~5V) • Dead band width: 10 µs [...] SG90 PDF Datasheet. Post navigation. ← Previous post. Next post →.

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Title:4.8-6V Servo Motor Tester

Every 20 ms, the servo examines the pulse. A pulse with a width of 1 ms (1 millisecond) may spin a servo to the neutral position (0 degrees), 90 degrees ...

https://robocraze.com/products/servo-motor-tester

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Title:(PDF) Effect of Printing Parameters on the Thermal and ...

May 7, 2021 — ... Motor drive 1/32 micro-stepping motor (8825 driver chip). Table 2. The specifications of the printing materials. Name Specification. Material ...

https://www.researchgate.net/publication/351925060_Effect_of_Printing_Parameters_on_the_Thermal_and_Mechanical_Properties_of_3_Printed_PLA_and_PETG_Using_Fused_Deposition_Modeling

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