ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Special Issue 11, March 2017

Brain Wave Controlled 3-D Printed Robotic Arm

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Abstract—In this paper we introduces the initial design of a mind-controlled, smart, 3D printed prosthetic arm. The arm is controlled via brain commands, obtained from an electroencephalography (EEG).The headset is equipped with a network of smart sensors and actuators that give the patient intelligent feedback about the surrounding environment and the object in contact. A prototype robotic system is developed to rehabilitate individuals who sustain neurological impairments such as cervical level spinal cord injury(SPI), acquired brain injury or stroke. This network provides the arm with normal hand functionality, smart reflexes and smooth movements. Preliminary experimental results show that the proposed EEG Mind-controlled Arm is a promising alternative for current solutions that require invasive and expensive surgical procedures.

Keywords—Neurosky Mind wave head set,Arduino Mega 2560,Robotic arm,3-D printing

1.Introduction

This paper aims to design and fabricate 3-D printed robotic arm for assisting physically weak persons to support their arm motions with necessary forces using mind wave**.** The EEG method is not only cost effective, but it is also accurate and gives the patient complete control of the arm. It also gives the user the luxury of taking it off when feeling discomfort.

EEG is a noninvasive method of monitoring brain activity. Typically, it uses electrodes placed on the outside of the head, and measures voltage oscillations in the neurons of the brain caused by ionic current. It has been used in medical applications for a very long time. The Emotiv EPOC is an example of an EEG headset with 14 sensors and having an internal sampling rate of 2048 Hz. After filtering the signals, it sends the data to the computer at approximately 128 Hz. The signals are transferred from the headset to the computer through wireless technology. This offers much greater mobility, and instead of requiring a special gel, the electrodes of the EPOC simply need to be dampened using a saline solution that in disinfectant and common.

The project presented in this paper aims to develop a low- cost and versatile human-like prosthetic arm controllable via brain activity using EEG neuro-feedback technology. The arm is equipped with a network of smart sensors and actuators that give the patient intelligent feedback about the surrounding environment and the object in contact. It also allows the arm to react and execute pre-programmed series of actions in critical cases (extremely hot or fragile objects, etc.) A first prototype has been developed to test the prosthetic arm with the embedded electro-mechanical system. This prototype is controlled using flex sensors integrated within a wearable glove. A microcontroller is added to the system, thus allowing to perform programmed actions and tasks. This prototype focuses on the arm-environment interaction. A second prototype based on the EEG control has also been developed and still under test. Preliminary experimental results show that the EEG

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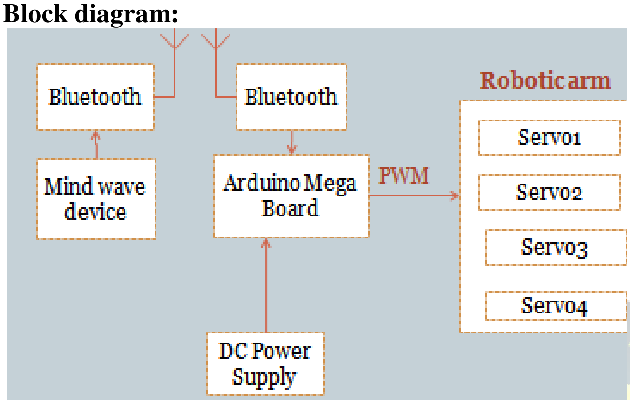
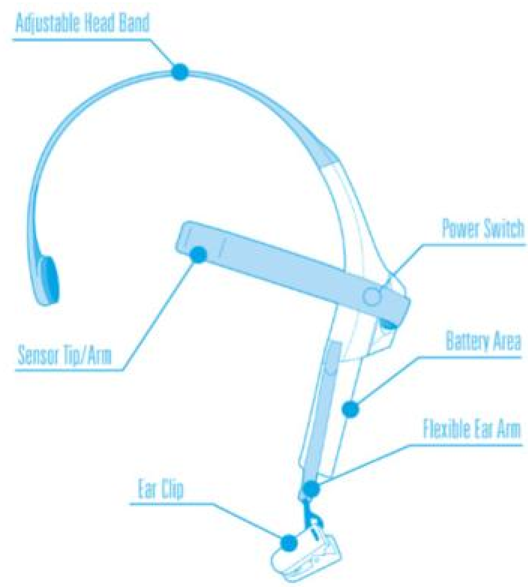
technique is a promising and good alternative to other existing techniques.

Block diagram:



Block diagram mainly consists of three major parts as mind wave device ,arduino mega board and Robotic arm. Mind wave device which is used to get brainwave signals from brain and transmitting brain wave signal to Bluetooth which is connecting to ardunio mega board with the help of Bluetooth in mind wave device. The output that get from mind wave device is raw data. Raw data is nothing but a combination of numbers and characters. Arduino mega board is used to pick the particular data from the output of mind wave device. It provides the PWM signal as an out. This PWM signal is used to run the servo motors. Servo motors are used to provide the angular rotation to the robotic arm. .[6] presented a short overview on widely used microwave and RF applications and the denomination of frequency bands. The chapter start outs with an illustrative case on wave propagation which will introduce fundamental aspects of high frequency technology.

II. MIND WAVE DEVICE



Fitting the Mind Wave:

1. Orient the Mind Wave with the forehead Sensor Arm on your left hand side. Rotate the Sensor Arm from its base by about 90 degrees. It can be rotated slightly more if necessary to get proper fit and comfort.
2. The overhead band of the Mind Wave is adjustable and can be extended to fit various sizes. Put on the Mind Wave. If the sensor does not make contact with the forehead or if the fit is not comfortable ,remove the Mind Wave to readjust the overhead band and the forehead Sensor Arm. The forehead Sensor Arm is flexible and should arch inwards.
3. Allow the rubber ear hoop to rest behind your left ear, and then clip the ear clip onto your earlobe.
4. Make sure the two metal contacts on the inside of both sides of the ear clip make skin contact with your earlobe or ear. Move any hair or obstructions (such as jewelry) out of the way. Readjust the ear clip as necessary to make proper contact with the skin of your ear. You

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may need to squeeze the ear clip against your ear for a few moments.

5. Adjust the forehead Sensor Arm of the headset so that the Sensor Tip makes contact with the skin of your forehead. This Sensor Tip must maintain steady skin contact in order to properly measure your brainwaves. The Sensor Tip should be comfortable, yet stay firmly in position. Keep hair away from the sensor – the sensor must be able to directly contact the skin at all times. Make up, dead skin, or debris can interfere with the connection. Scratch or wipe the obstruction away if you have trouble obtaining a clean signal.

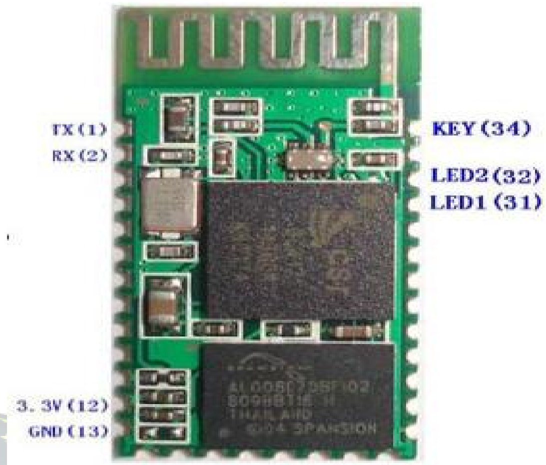
6. This is how the Mind Wave should look when properly worn. During usage, if you are not receiving a signal, repeat the steps above to make minor adjustments to ensure the sensor and contacts have proper **skin contact**.

Think Gear

Think Gear is the technology inside every NeuroSky product or partner product that enables a device to interface with the wearers' brainwaves. It includes the sensor that touches the forehead, the contact and reference points located in the ear clip, and the on-board chip that processes all of the data. Both the raw brainwaves and the eSense Meters (Attention and Meditation) are calculated on the Think Gear chip.

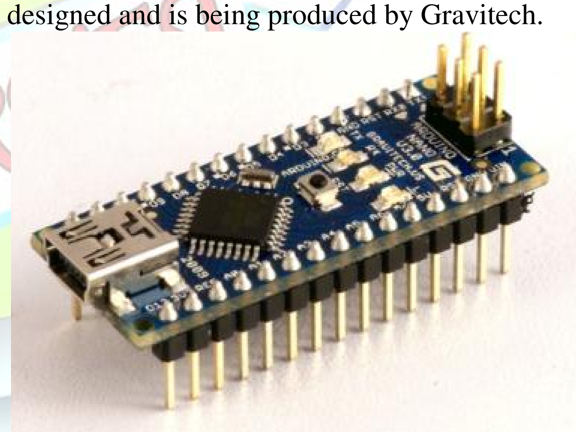
III. HC 05 Bluetooth

This external Bluetooth device is used to receive the mind wave signal from mind wave device and it transmits that signal into Arduino mega board. There are two kinds of modes in Arduino mega board as command mode and data mode.



IV. Arduino Mega 2560

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.0) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Nano was designed and is being produced by Gravitech.



Technical Specifications:

- Microcontroller : Atmel ATmega168 or ATmega32
- Operating Voltage (logic level): 5 V
- Input Voltage (recommended): 7-12 V
- Input Voltage (limits): 6-20 V
- Digital I/O Pins :14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O Pin: 40 mA

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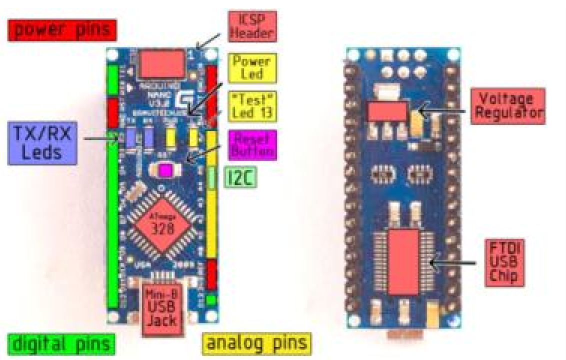
- Flash Memory :16 KB (ATmega168) or 32 KB (ATmega328) of which 2 KB used by bootloader SRAM 1 KB (ATmega168) or 2 KB (ATmega328) EEPROM 512 bytes (ATmega168) or 1 KB (ATmega328)
- Clock Speed: 16 MHz Dimensions 0.73" x 1.70"

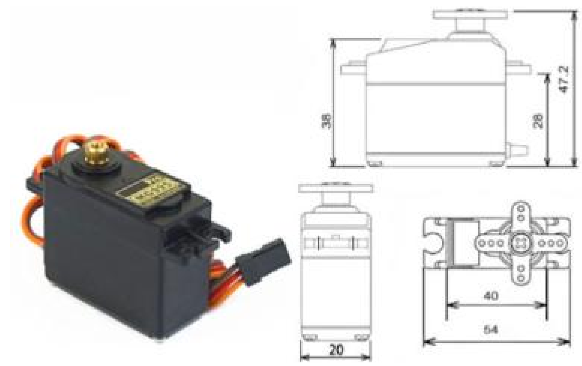


V. MG995

High Speed Metal Gear Dual Ball Bearing Servo

The unit comes complete with 30cm wire and 3 pin 'S' type female header connector that fits most receivers, including Futaba, JR, GWS, Cirrus, Blue Bird, Blue Arrow, Corona, Berg, Spektrum and Hitec.

This high-speed standard servo can rotate approximately 120 degrees (60 in each direction). You can use any servo code, hardware or library to control these servos, so it's great for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. The MG995 Metal Gear Servo also comes with a selection of arms and hardware to get you set up nice and fast!



Specifications

- Weight: 55 g
- Dimension: 40.7 x 19.7 x 42.9 mm approx.
- Stall torque: 8.5 kgf ·cm (4.8 V), 10 kgf ·cm (6 V)
- Operating speed: 0.2 s/60º (4.8 V), 0.16 s/60º (6 V)
- Operating voltage: 4.8 V a 7.2 V
- Dead band width: 5 µs
- Stable and shock proof double ball bearing design
- Temperature range: 0 ºC – 55 ºC

V. SG90 9 g Micro Servo

Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller . You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.

Specifications

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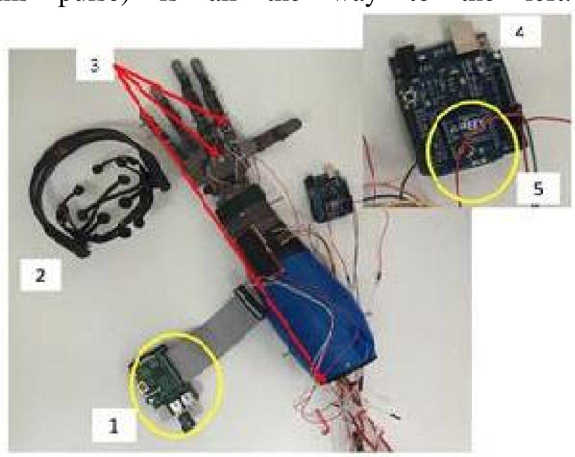
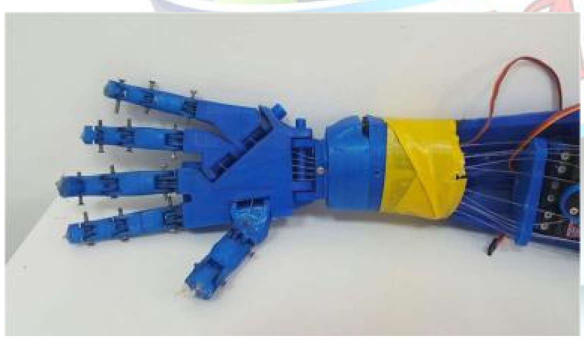
- Weight: 9 g
- Dimension: 22.2 x 11.8 x 31 mm approx.
- Stall torque: 1.8 kgf ·cm
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Dead band width: 10 µs
- Temperature range: 0 ºC – 55 ºC

Position "0" (1.5 ms pulse) is middle, "90" (~2 ms pulse) is all the way to the right, "-90"(~1 ms pulse) is all the way to the left.



VII. Prosthetic arm:



VIII. Conclusion:

The Prosthetic arm is activated by the PWM signal that come from an output of Arduino mega board. By selecting the particular brain wave signal from mind wave device with the help of arduino mega board the arm can perform. The proposed arm hosts state-of-the art technological advancement, communication protocols, control systems, and human interfacing. This gives it great potential in many applications whether related to the health care field or not. On one hand, within health care, the idea could be expanded to other body parts as well as to patients having other dysfunctions 2016 IEEE International Conference on Emerging Technologies and Innovative Business Practices for the Transformation of Societies (EmergiTech) as nerve damage. On the other hand, many industrial and commercial applications can utilize many features of the proposed arm. Within the health care field, there exists a class of patients who need extra help with their daily lives. This includes elderly people, people under rehabilitation, and people with limited mobility, etc. The proposed arm may be interfaced to a robotic-structure and function as a helper or caregiver to this group of people. It can be programmed to do various functions according to specific patient needs. This may vary from cooking to assistance with bathing or dressing. Another example in the medical field is remote high precision surgical procedures, where surgeons can undergo operations remotely with the aid of the robotic arm.

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