

Design of Hand Assistive Device for Autistic Children

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Abstract

Autism spectrum disorder (ASD) is a developmental disability related to neurological variations, affecting children's social communication, behavior, learning, and attention. These children often struggle with movement, as they require external support to move their hands and legs. A hand assistive device has been designed to help these children, providing them with movement exercises and physiotherapy. This device also uses EMG (electromyography) sensors to diagnose neuromuscular activities in autistic children. This device is essential for their overall well-being and development.

Keywords: ESP8266, EMG Sensor, Arduino UNO, Servo Motor – MG995, SG90, IOT.

1. Introduction

Autism Spectrum Disorder (ASD) [1,2] individuals often require external assistance for daily tasks [3,4]. Common support systems include “Picture Exchange Communication System (PECS)”, visual support, social skills training, and communication devices [5,6]. However, it is essential for children with autism to engage in exercise to prevent muscle weakness and potential health issues.[7].

Physiotherapists are needed to assist with body part movements. A hand assistive device has been designed to assist children with autism and physiotherapists in finger

movement [8] by using motors [9,10]. This wearable device can diagnose neuromuscular activity using an EMG sensor [11-14], enabling finger movement.

2. Proposed System

Autism Spectrum Disorder (ASD) individuals often require external assistance for daily tasks. Common support systems include Picture Exchange Communication System (PECS), visual support, social skills training, and communication devices. However, it is essential for children with autism to engage in exercise to prevent muscle weakness and potential health issues. Physiotherapists are needed to assist the children in their exercise. A hand assistive device has been designed as shown in Figure 1 to assist and offer physiotherapy in finger movement for children with autism. This wearable device can diagnose neuromuscular activities using an EMG sensor, allowing movement of fingers.

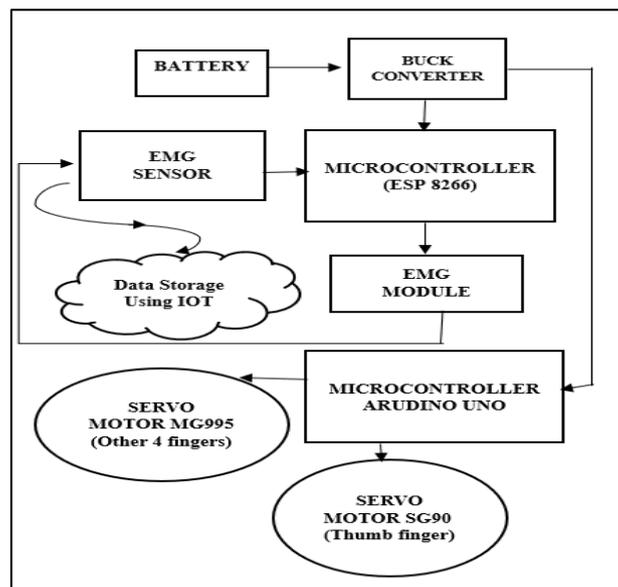


Figure 1. Block Diagram of the Assistive Device

- **ESP32 Microcontroller**

This is the central processing unit of the device. It's a low-cost, low-power microcontroller with integrated Wi-Fi and Bluetooth capabilities. The ESP8266 (Figure 2) features a 32-bit LX6 microprocessor and supports various features like Wi-Fi, Bluetooth, GPIOs, ADCs, and DACs. It helps in processing data from the EMG sensor, controls the servo motors, and manages communication with other components in the device.

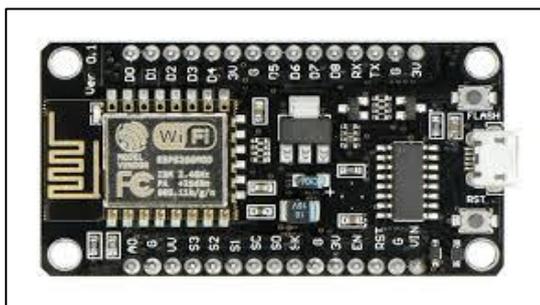


Figure 2. ESP8266 Microcontroller

- **Servo Motor (MG995)**

The MG995 servo (Figure 3) motors are highly regarded for their high torque and quick response time, making them ideal for robotics and automation of the devices. These precision motors can operate with a supply voltage ranging from 4.8V to 6V.

- **Interfacing Servo Motor with Arduino UNO**

The servo motor's signal pin (orange wire) is connected to pin D2 on the Arduino board. The VCC pin (red wire) is connected to the 3.3V pin on the Arduino board. The ground pin (brown wire) is connected to the GND pin on the Arduino board. The servo motor’s connected to Arduino UNO helps in controlling the finger movement. Table 1 illustrates the specifications



Figure 3. Servo Motor MG995

Table 1. Specifications

Voltage	4.8V to 6.6V DC
Torque	9.4 kg/cm at 4.8V 11 kg/cm at 6.0V
Speed	0.20 seconds / 60 degrees at 4.8V 0.16 seconds / 60 degrees at 6.0V

Current	10 mA (Idle Current) 170 mA (No Load Current) 1200 mA (Stall Current)
Gear Type	Metal
Operating Temperature	0°C to 55°C
Weight	55g

- **EMG Sensor**

It is used in detecting the muscle activity. EMG technology records the electrical activity generated by the muscle contractions and send the recorded information to the microcontroller. The microcontroller interprets the EMG data and regulates the servo motor to assist in the hand movement exercise.

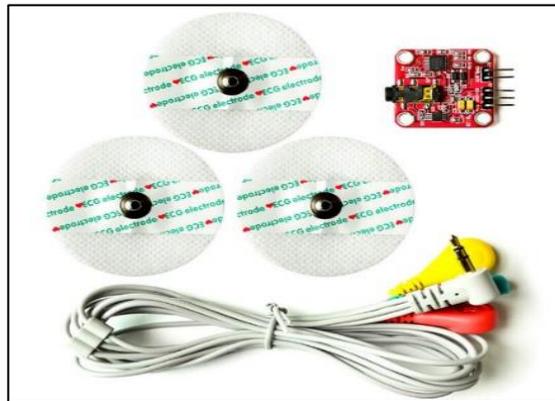


Figure 4. EMG Sensor

Figure 4 illustrates the EMG sensors. The positive and negative electrodes are placed directly on the muscle being monitored, while the ground electrode is placed on a nearby bony area with minimal muscle activity.

- **Servo Motor (SG90)**

The SG90 (Figure 5) servo motor is a low-cost, and lightweight motor specifically used for thumb finger movement, While the MG995 is used for the other four fingers. Figure 5 illustrates the servo motor SG90.



Figure 5. Servo Motor SG90

- **Servo Motor Specifications**

Working Torque: 1.4kg/cm (4.8v)

Operating speed: 0.12sec/60degree (4.8v)

Operating voltage: 4.8~ 6v

Degree:180/360

Servo motor sg90 is interfaced with Arduino. By connecting the jumper wires to Arduino connectors, black to ground, red to 5V, orange wire to Pin 9, and a USB cable to a computer.

- **Arduino**

Arduino (Figure 6) is an open-source micro controller platform used for building digital devices. It can read input from sensors and control outputs like motors and lights. It has a series of input/output (I/O) pins enable the connection to different components.

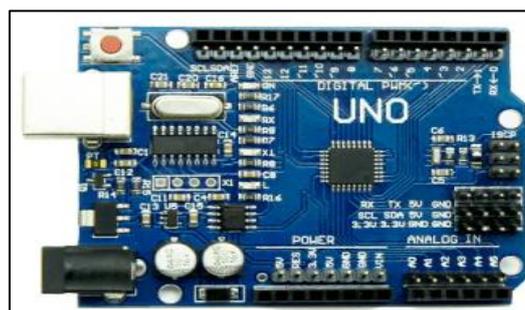


Figure 6. Arduino UNO

- **IOT**

IoT (Internet of things) refers to a network of physical devices, sensors, and actuators that are connected to the internet or each other to collect, exchange, and process data.

• **Circuit Explanation**

The circuit in Figure 7 developed using Proteus consists of a microcontroller unit powered by a rechargeable battery, supplying a stable voltage for operation by using Buck converter. servo motors are connected to digital output pins, allowing precise control over hand movements based on programmed signals. An EMG sensor detects muscle activity and sends analog signals to an amplification and filtering circuit, which processes the weak signals and converts them into a usable 5V signal. This processed signal is then fed into one of the analog input pins, enabling real-time response to muscle contractions. The microcontroller interprets the EMG data and controls the servos accordingly, assisting in hand movement exercises. The system is designed for efficient power consumption, ensuring prolonged operation while maintaining stability for continuous assistive functionality.

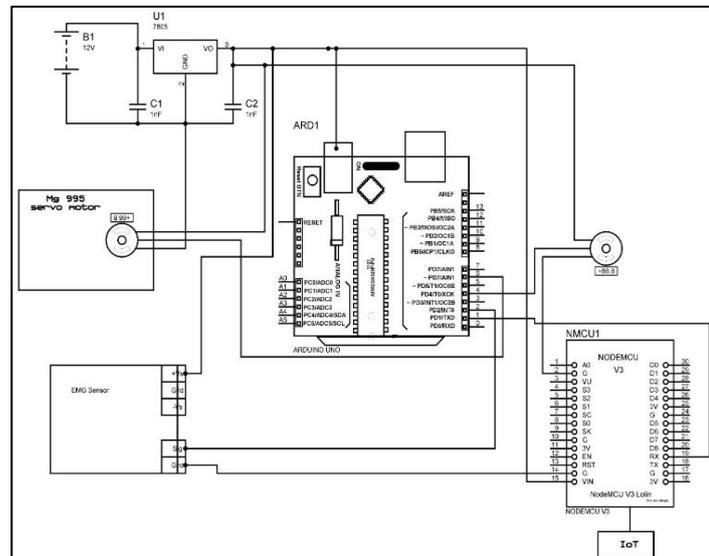


Figure7. Circuit Diagram

3. Working Methodology

A hand assistive device has been designed to assist and provide physiotherapy in finger movement for autistic children. The wearable device can diagnose neuromuscular activities using an EMG sensor, allowing movement of fingers. This device is designed to help children with autism maintain their mobility and avoid potential risks. By using a Servo Motors (MG995) the finger movement is done and it is controlled by Microcontroller. Using electromyography sensors, the data could be collected from the autism disorder children to calculate the muscle impulse for the contraction and retraction. The battery is essential for powering the device when a direct connection to a power outlet is unavailable or impractical.

In device, the battery will power all the components such as the Arduino, servo motor, EMG sensor, and any IoT-related modules (e.g., Wi-Fi/Bluetooth). The Battery used in the device is Li-ion (Lithium-ion) battery with rechargeable applications.

A regulated circuit ensures that the voltage delivered to the components remains constant, even if the battery voltage changes as it discharges. The battery voltage will naturally decrease as it discharges, which can cause instability in the circuit. A regulated circuit—using components like voltage regulators or DC-DC converters—ensures that the components receive a stable voltage (e.g., 5V for Arduino, 3.3V for certain sensors). The DC-DC buck converters is used for step down the battery voltage to the required level, ensuring stable operation.

The Microcontroller (ESP8266, Arduino UNO) is the core of this device. It will control and process the data coming from the EMG sensor, send signals to the servo motor, and manage communication with IoT devices (like a smartphone or cloud platform). Arduino controls the servo motor by sending PWM (Pulse Width Modulation) signals, which specify the angle of rotation. Here servo motors are interfaced with Arduino UNO microcontroller. Servo motor SG90 is used for the Thumb finger movement and MG995 is used for other four fingers.

An EMG sensor detects the electrical activity generated by muscles when they contract. These sensors are commonly used in medical, robotics, and wearable technologies. The EMG sensor will detect muscle contractions and send this information to the ESP32 Microcontroller. When a finger movement is given by servo motor muscle activity is detected. The ESP8266 act as a node in an IoT setup. To t collect data from the EMG sensor, process that data, and send it to a cloud server or mobile device.

In this IoT setup, the Arduino can be connected to the internet using the ESP8266. It is used to send real-time data about the muscle activity readings from the EMG sensor) to a cloud platform that is to be integrated in the future work.

4. Embedded Coding

Pseudo Code 1 : Coding for EMG Sensor with ESP8266

```

#include "ThingSpeak"
#include <ESP8266WiFi.h>
const int ECG = A0;
//----- Enter you Wi-Fi Details-----//
char ssid[] = "project"; //SSID
char pass[] = "12345678"; // Password
//-----//
WiFiClient client;
unsigned long myChannelNumber = 2889736; // Channel ID here
const int FieldNumber = 1;
const char * myWriteAPIKey = "VGWNVUFRE0807JI6"; // Your Write APIKey here
void setup()
{
  Serial.begin(9600);
  WiFi.mode(WIFI_STA);
  ThingSpeak.begin(client);
}
void loop()
{
  if (WiFi.status() != WL_CONNECTED)
  {
    Serial.print("Attempting to connect to SSID: ");
    Serial.println(ssid);
    while (WiFi.status() != WL_CONNECTED)
    {
      WiFi.begin(ssid, pass);
      Serial.print(".");
      delay(5000);
    }
    Serial.println("\nConnected.");
  }
  int ECG = analogRead(A0); /* Read Temperature */
  /* LM35 gives output of 10mv/°C */
  Serial.print("ECG = ");
  Serial.print(ECG);
  Serial.println("");
  delay(1000); ThingSpeak.writeField(myChannelNumber, FieldNumber, ECG,
myWriteAPIKey);
  delay(1000);
}

```

The coding developed for the interfacing the EMG with ESP8266 is depicted in the Pseudo Code 1 above.

5. Results

Figure 8 is a prototype model of the Hand Assistive device for Autistic Children, It gives a successful out comes by providing them with movement exercises for fingers and also EMG (electro myography) sensors that diagnose neuro muscular activities in autistic children while the device is in use.

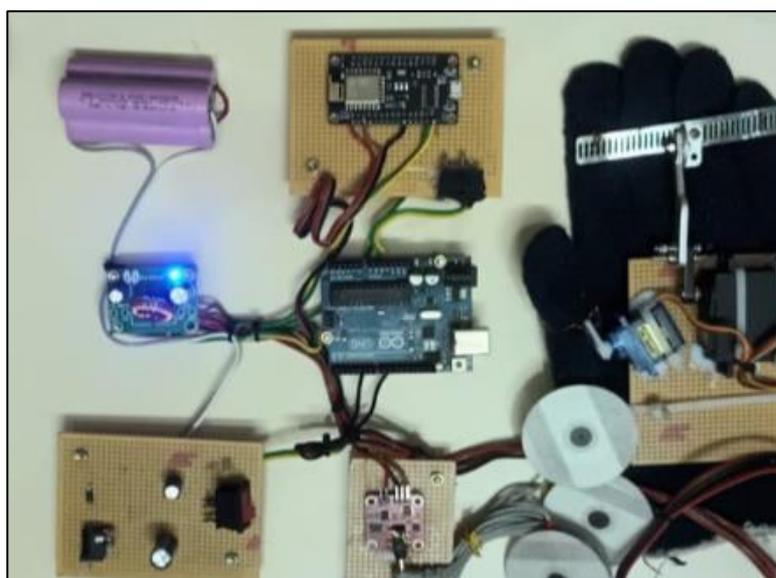


Figure 8. Output Image

6. Conclusion

In conclusion, the design of a hand assistive device for autistic children holds significant promise in improving their daily functioning and enhancing their sensory experiences. By considering the unique needs of children with autism spectrum disorder (ASD). The device design must prioritize ease of use and comfort. Lightweight materials, soft textures, and ergonomic designs can make the device not only effective but also pleasant to wear and use. By focusing on comfort and minimizing any sensory discomfort, the device can encourage consistent use and ultimately help children develop essential motor skills and improve hand-eye coordination over time. In summary, this device can help improve motor skills, provide sensory regulation, and enable emotional support, ultimately contributing to the child's development. By emphasizing personalized features, comfort, and user feedback, such

a device can be a game-changer in the lives of children with autism and their families, promoting greater independence and well-being.

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