Design and Implementation of Prosthetics Arm Improve Sensory Feedback

Submitted by

Nur Mohammad Rayhan

181-35-2361

Department of Software Engineering

Daffodil International University

Supervised by

Md Hafizul Imran

Lecturer

Department of Software Engineering

Daffodil International University

This Project report has been submitted in fulfillment of the requirements for the Degree of
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APPROVAL

This thesis titled on **"Design and Implementation of Prosthetic Arm & improve Sensory Feedback"**, submitted by **Nur Mohammad Rayhan, 181-35-2361** to the Department of Software Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Software Engineering and approval as to its style and contents.

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Institute of Information and Communication Technology (IICT)
Bangladesh University of Engineering and Technology (BUET)

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It hereby declare that I have done this thesis under the supervision of **Md Hafizul Imran**, Lecturer, Department of Software Engineering, and Daffodil International University. It also declare that thorn this thesis nor any part of this has been submitted elsewhere for award of any degree.

Nur Mohammad Rayhan
ID: 181-35-2361
Batch: 25
Department of Software Engineering
Faculty of Science & Information Technology
Daffodil International University

Certified by:

Md. Hafizul Imran
Lecturer
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

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ABSTRACT

Every year, 400,000 road accidents occur in the country due to chaotic traffic and low safety regulations, he added. Furthermore, many impoverished persons have abnormalities or musculoskeletal problems for which they do not receive adequate care. Manufacturing facilities are currently being created here because of the rising demand for prosthetic arms. Friendly and features able design but this design implementation hand movement is not friendly and not fast, if we develop this product around fast sensory movement and user friendly, this product is most useful for our lower-income country people. In this final implementation, we create low cost, user friendly, faster human Prosthetic Hand. Much change is required for future redundancies. There will be an adjustment of the cast from the pin jointed finger Polyurethane elastic joint that will assist ease with controlling The fingers of the hand ought to be moved distinctly in a bowed position Polyurethane elastic will give the fundamental spring Power the finger to stretch out to its resting position.

Keywords:
microcontroller unit(MCU), electromyogram(EMG), ploylactic acid(PLA), world health Organization(WHO);

CHAPTER 1

INTRODUCTION

1.1 Background

A bionic arm is an external device that replaces a portion of the hand that has been lost caused by trauma, sickness, or a natural issue. It works just like a real hand. Brain, spinal cord, and peripheral nerves make up the human nervous system. Every peripheral as well as hand is controlled by the neurological system [1].

Road traffic accidents, Bone Tumors, Congenitally, circulation disorder, disease infection, Industrial Working Time Accident are the biggest cause of amputate [2]. To save a person's life due to various accidents, it is often necessary to take a big risk and Result is amputation. Then unhappiness comes down to the person's life, which harms him physically and mentally. Cambodia has the highest number of amputated patients in the world and most common causes for a leg amputation [2].

All of the regulating impulses for a hand originate in the brain and go through nerves to the hand. These control signals activate the muscles that regulate hand movement [5]. The bionic arm is directed by brain impulses, which may be recorded in a variety of ways. Capturing signals from the tissue surface is one of the best approaches. Electromyography (EMG) is an elector-diagnostic medical technique that assesses and records the electrical activity of muscle fibers. Medical abnormalities, activation levels, and enrolling order may all be detected using EMG signals. It also investigates the biomechanics of human and animal motion. Researchers also propose EMG signals as a control signal for prosthetic devices [6].

1.2 Motivation of the Research

A prosthesis is nothing more than a tool. It is an artificial limb or part of a limb that can help us restore flexibility after an amputation or if we have been suffering with physical disabilities for a long time. Whether or not to wear a prosthesis is a personal decision. The finest prosthesis is one that will assist me in achieving my objectives and living the life we desire. Overall 3 million amputated people in World Population and Where 2.4 million in developing Country. below Elbow are 1.77 million [3], as like Bangladesh is Developing Country in South Asia Region and its Population is 167 Million, which economy depends on the labor force and it's 60%. Majority labor force is Industrial Worker, Construction Worker, Agriculture Worker; almost every accident involves an injury to the elbow or leg, which later takes the form of amputation [3-4].

Every year, 400,000 road accidents occur in the country due to chaotic traffic and low safety regulations, he added. Furthermore, many impoverished persons have abnormalities or musculoskeletal problems for which they do not receive adequate care. Manufacturing facilities are currently being created here because of the rising demand for prosthetic arms. Artificial limbs are becoming increasingly popular in Bangladesh. We sell around 400 to 500 prosthetic limbs every month. We also import high-end mechanized items from Germany, such as the Proprio Foot and the C-walk. However, those are expensive, their items range in price from Take 600 to take 400,000. [7]

1.3 Problem Statement

The absence of skilled staff in poor nations is one of the most significant challenges in supplying prosthetic limbs to these countries. A higher level of competence is required to properly design, fit, align, and modify a prosthetic limb, and despite the enormous need for this knowledge, low-income nations have limited training programs. According to WHO studies, although the present supply of technicians is around 40,000 short, training only 18,000 additional trained experts will take about 50 years. [7-8]

Another issue is that importing components for prosthetic limbs from industrialized nations is not only expensive, but these parts are also built for very different lifestyles and sometimes do not withstand the rigors that nature provides in rural locations. These countries have a tropical environment and a farm-based economy. Traditional limbs composed of wood and resin have a lifetime of roughly 18 months in these severe settings. Prosthetic limb prices vary significantly by nation, however a typical prosthetic limb built in a developing country costs between $125 to $1,875 USD, depending on the location in which it is made. When the cost of making a limb in a poor nation is as low as $41 USD (far below the $5,000-$15,000 USD typical cost of a prosthesis in the United States), the expenses of replacements and maintenance over a lifetime can still amount to thousands of dollars. [8]

Replacement and maintenance expenditures can add up to thousands of dollars over the course of a lifetime. This is a significant issue because in rural regions, the average household income is roughly $300 USD per year. Bartering although shopping for items is a normal part of their life, buying a prosthetic limb costs money. It is possible. It may take a decade or more for sufferers to save enough money for a first prosthesis.

1.4 Research Questions

Maximum of prosthetic hand design base on EMG-sensor Technology on Biomedical Terminology, This paper determine right features of accuracy of prosthetic hand best feature in classifying the hand motion. Moreover, this paper describe maximum 4-control movement in hand motion in real time using electromyography signal is tapped using an electromyography (EMG) dry electrode sensor. [9]

Here is my research Question related in my thesis I try to solve

1. Question 1: Is this Design flexible in hand movement?
2. Question 2: Hand control movement take long time.
3. Question 3: why maximum time sensor reject hand movement feedback?

1.5 Research Objectives

- Now day advance technology or automation for the disable people are continuously developed. People and technology are combined invented smart wheelchair, advance health monitoring base one Deep learning and AI, prosthetic arm similar type of Device, which help people in doing daily life activity. But the main problem is if we try to use this type of Prosthetic Arm, we spend huge cost for this Prosthetics arm and this is not fair for our lower-developed country in case if we need this advance technology Prosthetic arm not affordable for our poor people and this paper propose low cost friendly movement user friendly design for upper limb disable people.

- Some of paper we find affordable, friendly and features able design but this design implementation hand movement is not friendly and not fast, if we develop this product around fast sensory movement and user friendly, this product is most useful for our lower-income country people.

- It is the focus of our thesis paper and implement sensory feedback using multi-degree of freedom, Arm controlling using real time EMG sensor feedback. [10]

1.6 Research Scope

Bangladesh is a lower middle-income country in the South Asian area with a population of over 167 million people, about 60% of whom are employed. Because the bulk of jobs is physically demanding, such as agriculture or construction, occupational injuries (as well as motor vehicle injuries) are widespread, leading to lower limb amputation. Traumatic injury has far-reaching consequences for both the individual and their family, and public and social health care in Bangladesh is not organized in the same way that it is in OECD nations like Australia. After amputation, there is a lack of focus on comprehensive rehabilitation therapies, as well as inadequate allied health care.

From 2021 to 2028, the worldwide prosthetics and orthotics market is predicted to rise at a CAGR of 4.2 percent, from USD 6.11 billion in 2020 to USD 6.11 billion in 2028. The worldwide market is expected to be driven by an increase in sports injuries and traffic accidents, a rise in diabetes-related amputations, and an increase in the prevalence of osteosarcoma throughout the world. Many regulatory authorities and non-governmental groups responded to the shifting situation during the epidemic. For example, on March 19, 2020, the National Association for the Advancement of Orthotics and Prosthetics (NAAOP) sent an open letter to all state governors, requesting that Prosthetic and Orthotic Care services be maintained as part of the essential health benefits that patients must have during the pandemic. More individuals are turning to sports as a professional option these days. The yearly sports injury rate in the United States was roughly 8.7 million in 2018, according to the American Physical Therapy Association (APTA). This aspect is expected to boost demand, resulting in market expansion throughout the forecast period. One of the primary reasons of rising amputation instances is an alarming increase in the frequency of traffic accidents. [11-12]

Injury of a hand due to congenital, surgical, or disease-related reasons has psychological, sociological, and ergonomic consequences. However, as compared to a low-limb prosthesis, the active upper-limb prosthesis, which is regarded the best contemporary palliative option, has significant rates of rejection estimated to be between 25% and 50%. Indeed, it has been more than 70 years since Reinhold Reiter initially proposed the notion of a myoelectric prosthesis, and still no acceptable enough solution at a fair price has been developed. The difficulties in designing an upper limb prosthetic reflect the human hand's complexity. In addition, the poor acceptability of currently existing technologies drives further study. In fact, establishing effective and intuitive myoelectric control might not only benefit those who have had limbs amputated, but it could also open up new ways for humans to sense the environment and control other systems. [14]

The most common cause of amputation in the developed country is vascular disease, while in wartorn countries of the world such as Cambodia, Iran, and Afghanistan, 80 to 85 percent of amputees are land mine survivors (Dillingham et al., 2008). These mines are responsible for 26,000 amputations per year and have produced 300,000 amputees worldwide. Land mines have claimed more lives and caused more injury in the second half of the 20th century than both nuclear devices exploded in Hiroshima and Nagasaki combined

Artificial limbs have become considerably more comfortable, efficient, and lifelike in recent years because of technological advancements. Future breakthroughs are expected to be determined by the intersection of three significant forces: amputee needs, surgical and engineering advancements, and enough healthcare financing to support the development and use of technology solutions. [15]

1.7 Thesis Organization

In my thesis paper I organized by many chapter in methodology and result & discussion In chapter 2 literature review, describe in paper wise previous work. In chapter 3 methodology, prosthetic hand design, mechanical design, degree of freedom dimension table, materials of prosthetic hand, controller design, controlling of prosthetic hand. In chapter 4 result & discussion, experimental prosthetic hand and finally result and discussion.

CHAPTER 2

LITERATURE REVIEW

The evolution of prosthetics began with Egyptians who saw the technology's bright future. After losing his hand in a fight in 1508, German mercenary Gotz von Berlichingen received an iron hand with advanced technical benefits. Some historians discovered evidence of artificial hands capable of creating sensations, but these claims were never validated. Prosthetic hand research dates back to the 1960s, when persons who had their arms amputated utilized plastic or wooden arms. There was no movement or automation at all. The basic operation of an ideal prosthetic hand has stayed the same since then. Although, as technology progressed, it got more dependable and advanced. There has been some study with robotic arms that could be controlled from a distance close to actual prosthesis. [10]

Our limbs are no exception to the fact that the human body is a magnificent piece of biological technology. When a person loses a limb due to accident or disease, the functionality the limb formerly provided is also lost. As a result, prosthetic limbs are extremely beneficial to amputees, as their replacement with an artificial body part can help them regain some of their lost abilities. The human leg has a wide range of complicated functions and degrees of mobility. These numerous functions of the human leg cannot be perfectly replicated by any mechanical device. However, in recent years, tremendous progress has been made in the field of active prosthetic legs. One researcher discovered that his limbs consumed 25% less energy than those of a healthy runner running at the same speed. These super prosthetic legs, on the other hand, are incredibly sophisticated and expensive for ordinary people to utilize, especially in Third World nations. [13]

2.2 Review the 1st Point Related to this Research

Upper limb amputation statistic increase day by day, there are 2 million people living with limb loss or approximately 1 in 200 peoples, Traumatic amputations of the upper limb occur at a rate of 3.8 per 100,000, with finger amputations being the most prevalent at 2.8 per 100,000. Amputations of the hands due to trauma occur at a rate of 0.02 per 100,000. Three the most common upper limb amputations, aside from finger amputations, are traumatic transradial and transhumeral amputations. [16]

The number of people living with a limb loss is predicted to more than double in the next 45 years, from 1.6 million in 2005 to 3.6 million in 2050. The aging population and the increasing rates of dysvascular diseases among older persons are driving the rise in prevalence. Vascular disease (54 percent), including diabetes and peripheral arterial disease, trauma (45 percent), and cancer are the leading causes of limb loss among persons who have lost a limb (less than 2 percent). Amputation-related hospital expenditures totaled more than $8.3 billion in 2009. [3]

Between the years 2000 and 2004, a review of the National Trauma database found that upper limb amputations were more common in motor vehicle incidents than lower limb amputations. Lower limb amputations were more common in motorcyclists and pedestrians. There are a variety of hand prosthetics on the market, each with its own set of benefits and drawbacks. Some recent commercial prostheses have weights that are similar to or more than the weight of a human hand, bringing discomfort and stress to the patient who chooses to employ this technology. High-tech hand prosthetics, on the other hand, are prohibitively expensive for the vast bulk of the population. The goal of this work is to show a low-cost, hydraulic, lightweight, and myoelectric prosthetic hand design and prototype. [17]

2.3 Review the 2nd Point Related to this Research

The most common causes of traumatic upper limb amputations include machinery, power tools explosions, self-inflicted injuries, and attacks. Men are at a far higher risk of traumatic amputation than women, with a rate of 6.6 times that of women for small finger and hand amputations. There are three primary causes of limb loss, the most frequent of which is vascular disease, which affects 54 percent of the population. Diabetes, peripheral arterial disease (PAD), and thrombosis are among conditions that can cause decreased blood circulation to the limbs. This can result in discomfort, tissue injury, and wounds that do not heal properly, which can lead to amputation over time. Because of an elevated risk of obesity and PAD, black Americans are up to four times more likely than white Americans to need an amputation are. [18]

Amputation is a circumstance in which a limb is amputated, generally due to accident, disease, or surgery. When a newborn is born without part or all of a limb, it is known as congenital limb deficit. Amputations are caused by vascular disease 82 percent of the time, trauma 22 percent of the time, congenital 4 percent of the time, and tumors 4 percent of the time in the United States. Amputations affect around 1.2 million people in the United States, with 185,000 done each year. Such as peripheral vascular disease (also known as PVD), diabetes, deep vein thrombosis, or septic arthritis. Particularly of the arms. Fracture is responsible for 75% of upper - limb amputations. Tumors in the bones and muscles are removed. [22]

2.4 Review the 3rd Point Related to this Research

In this [10] paper describe two type of controlling prosthetic hand one is muscle signal and another is voice control prosthetic hand, both are connected in this hand processor if muscle sensor is failed to take command form muscle then other system active in voice controlling system. In this paper [19] describe, Commercial prosthetic hands have advanced in sophistication. Sensors and actuators are installed in the fingers, allowing them to be motorized and perform gripping actions. However, automated prosthetic hands are costly and not available to all socioeconomic classes. The most prevalent prosthetic hands are usually passive, with the purpose of replacing the human hand more aesthetically than functionally. Body-powered and externally-powered prosthetic hands are the two types of powered prosthetic hands.

Individual fingers or joints cannot be manipulated since most prosthetic hands are controlled by a single input. Electrical signals from two antagonist muscle contractions are typically used in prosthetic hands based on EMG. They allow movement in two different directions: flexion and extension; one is for grabbing and the other is for extension. The most common EMG-controlled prosthetic hands use surface EMG. [20]

Now day most of the prosthetic hand use 3d printing demo and it's more reasonable for middle income country people but in commercial production is more expensive for middle income country people, in this [21] paper showing design is human anatomy base prosthetic hand. The use of a prosthetic hand is one option for solving this problem. There are many different types of prosthesis on the market today, ranging from basic ones with simply an aesthetic purpose, which are generally made of silicone to simulate the skin, to bionic prostheses, which have functionality closer to that of a human hand,[23] world-leading German prosthetic-technology company Otto bock build new functional prosthetic hand [24] and we see there are more complex and feature able, user friendly prosthetic hand [25]. They're all rather pricey. A cosmetic arm and hand, for example, might cost $3,000-$5,000, according to a white paper from the Worcester Polytechnic Institute's Bio Engineering Institute Center for Neuroprosthetic. A myoelectric prosthesis for partial amputation of a hand costs $18,703 and up to the middle of the lower arm costs $20,329, according to a Department of Veterans Affairs research.[23]

2.5 Review the 4th Point Related to this Research

In prosthetics hand grasping functionality use two type of power one is Body power and other is battery power, in body power prosthetics person use grasping movement in prosthetic hand by Bowden cable, Bowden cable is transmitted force to prosthetic actuator [26]. Four blocks in a cascade may be used to explain the overall design of giving sensory feedback: detecting transduction, decoding algorithm, encoding algorithm, and controlling transduction. Describe in figure-1.1

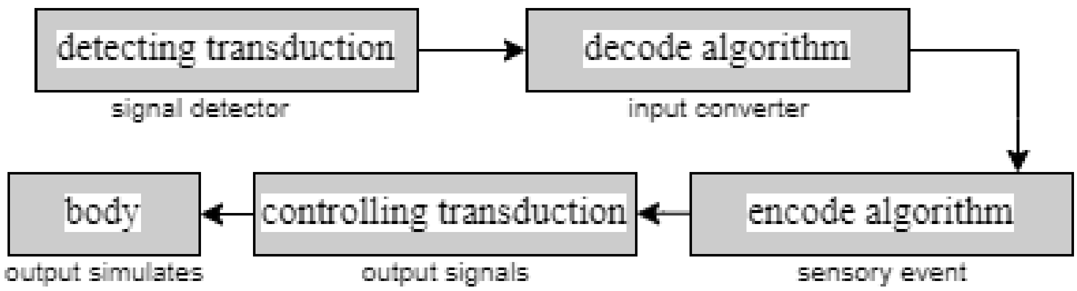


Figure 1: Algorithm flow in Prosthetic

In terms of range, specs, and characteristics, an overview of sensors for prosthetic arms offered. Because of the advancement of prosthetic arms with many degrees of freedom that need finger synchronization into various positions, there is an increasing demand for sensors. Closed-loop control can be used in a prosthesis with sensory feedback [27]. There are more possible sensing option integration prosthetic hand like contact, force, pressure, position, slip and temperature [28].

2.6 Review the 5th Point Related to this Research

This study delivers a summary of the major works and technologies used to deliver sensory feedback to upper limb amputees. The focus is on sensory replacement and modality-matched input, with the main characteristics, benefits, and drawbacks of each technique given [26]. In recent years, a slew of research articles on robotic hands have been published, each of which employs a different set of methodologies and technology. For example, in one of the articles, a grasping force measuring approach based on machine learning was developed for controlling a three-finger hand robot with an air pressure sensor attached to its fingertip. The end effector was created using Robotic's 3-finger robot [29]. The actuator's force moves the finger in response to the force sensor signal provided by the tendon moment. A simplified cantilever beam model for prosthetic hands can approximate the resulting behavior [30].

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Design the System Model Related to this Research

Our designed prosthetic hand System design is shown in figure no 2, The System design was started to 3D Design. We use solid work for 3D design. And 3D printing Creality 3D printer and Material use PLA Filament. The shape of Prosthetic hand is Human hand Shape. In order to have the space 2 servo motor one for thumb and another for four finger controlling. And it could function as the human arm. After that, at each finger joint a cut has been added to have fourteen degree of freedom similar to human hand.

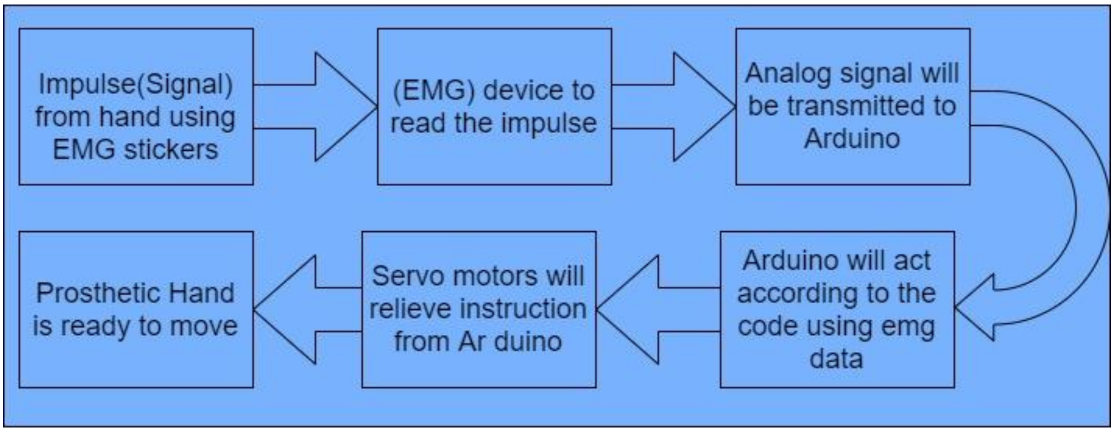


Figure 2: working system of prosthetic arm

3.2 Material used in Prosthetic hand

We only need a few simple materials to make a prosthetic hand, which can be found almost anywhere. Usually for 3D printing we find 3 type of filament are PLA, ABS and PETG ABS filament is one of the most widely used 3D printing materials today. ABS (Acrylonitrile Butadiene Styrene) is a thermoplastic that may be readily shaped and hardens uniformly when cooled. ABS filament is utilized in traditional production in a range of sectors, as well as by 3D printing enthusiasts, because it can assume different forms and maintains its quality.

PLA, or polylactic acid, is one of the most extensively used materials in desktop 3D printing. Because it can be produced at a low temperature and does not require a heated bed, it is the default filament for most extrusion-based 3D printers. PLA is an excellent initial material to use while learning about 3D printing since it is simple to print, affordable, and produces components that can be used for a number of purposes. It's also one of the best biodegradable filaments on the market right now. Crops such as corn and sugarcane are used to make it. But we use **PLA filament** for low cost, stiff and good Strength Quality, Good dimension accuracy and good shelf life but thing is PLA filament derive from crops and sugarcane. Here table of finger width, length and how many filament need for full prosthetic hand

Table 1: finger width, length and filament weight

fingers	Length	Width	filament
Index	69.4 mm	12.1 mm	4g
Middle	100.0 mm	15.0 mm	8g
Thumb	60.0 mm	17.0 mm	6g
Ring	90.0 mm	14.0 mm	6g
Pinky	65.0 mm	13.0 mm	4g
Plam	98.9 mm	96.8 mm	67.6g
Mechanical Part	181.4 mm	122.1 mm	93g
Sensor part	116.7 mm	105.1 mm	92g

3.3 3D designing in prosthetic hand

Prosthetic hand can provisional function of missing hand. Such as grasping and holding object. In this section, we describe the designing part. At first we measurement in sketch to natural hand and this is our final design

3.3.1 Designing software SolidWorks

SolidWorks is computer-aided design (CAD) software owned by Dassault Systèmes. It uses the principle of parametric design and generates three kinds of interconnected files: the part, the assembly, and the drawing. Therefore, any modification to one of these three files will be reflected in the other two. SolidWorks is a solid modeling program that allows you to create three-dimensional designs. In most cases, 2D profiles are sketched first, and then solid shapes are created using processes like as extrusion and lofting.

Figure 3: 3D Designed hand

3.4 Sensor

A sensor is an electronic device that detects changes in the environment and reacts to some other system's output. A sensor turns a physical event into a quantifiable analog voltage (or, in certain cases, a digital signal), which is then displayed or sent for analysis or further computation.

Sensors are ubiquitous in our daily lives. The typical mercury thermometer, for example, is an extremely old sort of temperature sensor. It depends on the fact that colored mercury in a closed tube exhibits a constant and linear reaction to variations in temperature. We can look at the thermometer and see what the temperature is by marking the tube with temperature values. Because of the visible size of the scale markers, the accuracy is reduced, although it is enough for its intended function.

3.4.1 Myoelectric Sensor v3-kit(Muscles Sensor)

Muscles sensor is electrical device that is taking muscles activities from muscles. When our brain orders our muscles to flex, our muscles get an electrical signal to begin recruiting motor units (the bundles of muscle fibers that generate the force behind our muscles). The more motor units that are coordinated to create higher muscular force, the harder we flex. The electrical activity of our muscle grows as the number of motor units coordinated increases. The muscle sensors will examine this electrical activity and generate an analog signal indicating how forcefully the muscle is flexed.

Myoelectric Sensor v3-kit

An EMG sensor, like any other voltmeter, monitors the extremely small electrical impulses created by our muscles, but instead of a steady voltage, these signals are waveforms (called the raw EMG signal) that resemble audio noises. This waveform is quite valuable and includes a great deal of information. However, we must interpret the data further in order to determine how strongly the muscle is flexing. All of this processing is handled by the MyoWare, which provides a voltage that depicts the amount of muscle activity (also known as the EMG Envelope), as indicated in purple above [31].

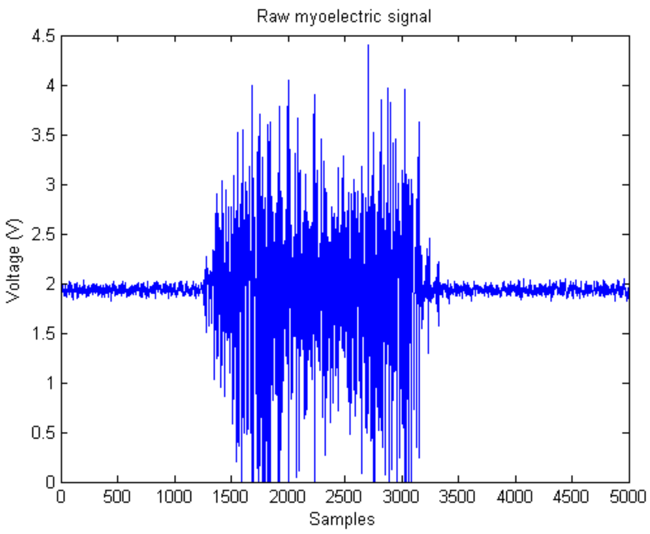


Figure 4: Raw myoelectric signals

Line interference from power lines (50 or 60 Hz), fluorescent lights and electrical devices originate from the electromagnetic radiation that is pervasive in all environments. While this is generally not a concern with modern technology, line interference may in some cases contaminate EMG recordings. The SNR is the best measure of the quality of the EMG signal. It indicates the ratio of the EMG signal during muscle contraction versus the unwanted electrical signal recorded when the muscle is at rest [32].

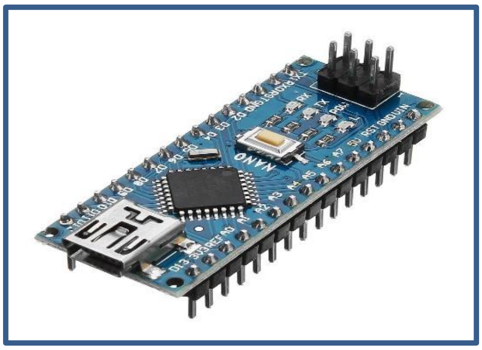
Table 2: Electrical specification of V3-kit

Parameter	Min	TYP	Max
Power supply Voltage(vs)	±3.5V	±5V	±18V
Gain Setting, Gain = 207*(X /1 kΩ)	0.01 Ω (0.002x)	50 kΩ (10,350x)	100 kΩ (20,700x)
Output Signal Voltage (Rectified & Smoothed)	0V	--	+Vs
Differential input voltage	0 mV	2-5 mV	+Vs/Gain

3.4 Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.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.

In this project, we use Arduino Nano for space complexity, if we use Arduino Uno it is take more space in our prosthetic hand mechanical part. However, mechanical part is so small, we utilize this part in so many wire, and battery that’s why we use Arduino Nano for space utilize where same specification in this two board.



The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and one (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer, in Table 1.4 describe in technical specification

Table 3: Pinout for Arduino Nano

Pin Number	Pin description
D0 - D13	Digital input / Output pins
A0 – A7	Analog input / Output pins
Pin # 3, 5, 6, 9, 10, 11	Pulse width modulation(PWM) pins
Pin # 0(RX), pin # 1(TX)	Serial Communication
Pin # 10, 11, 12, 13	SPI Communication Pins.
Pin # A4, A5	I2C Communication Pins.
D2 & D3	External Interrupt Pins.
Pin # 13	Built-In LED for Testing.

Input and Output. Each of the 14 digital pins on the Nano can be used as an input or output, using pin Mode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms.

Table 4:Technical Spaces for Arduino Nano

Microcontroller	ATmega328
Architecture	AVR
Operating Voltage	5V
Flash Memory	32 KB of which 2 KB use by bootloader
SRAM	2KB
Clock speed	16MHz
Analog I/O pin	8
EEPROM	1KB

DC Current per I/O pins	40mA
Operating Voltage	5volt
Input voltage	7-12 Volt
Digital I/O pins	22
PWM Output	6
Power Consumption	19 mA
PCB size	18 x 45 mm
Weight	7 g

Arduino Nano has a total of 36 pins. Out of these 8 are analog input pins and 14 digital input/output pins (of which 6 can be used as PWM outputs). Nano has a 16 MHz SMD crystal resonator, a mini USB-B port, an ICSP header, 3 RESET pins and, a RESET button.

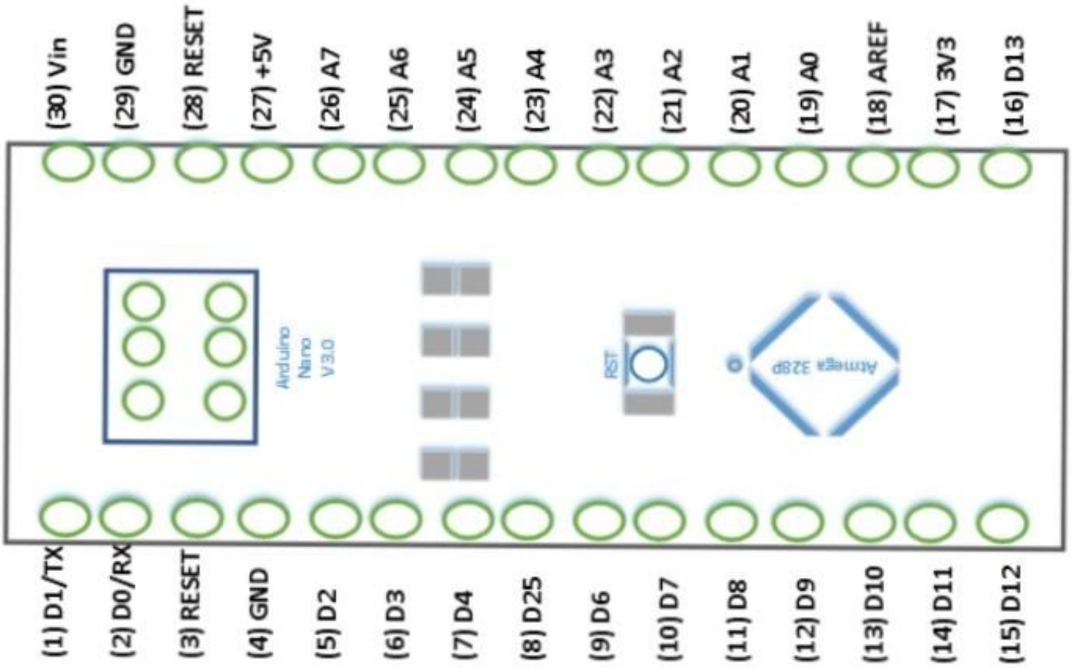


Figure 5: pin diagram for Arduino Nano

3.5 Servo motor (MG995)

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors [33]. Here showing MG995 servo motor

Figure 6: Servo Motor

How does a servo motor work?

A servo have three wires coming out of them, two of them use for power(positive and negative) and another wire use for signal that is to be use for MCU. All servo motors work directly with your +5V supply rails but we have to be careful on the amount of current the motor would consume if we are planning to use more than two servo motors a proper servo shield should be designed.

A servomotor is an electrical device that uses voltages and currents to create torque and acceleration. A servomotor is part of a closed - loop system system that provides torque and velocity as directed by a servo controller and is closed by a feedback device. The feedback device provides information to the servo controller, which modifies the motor action based on the requested parameters, such as current, velocity, or position.

The angle of rotation of a servo motor is regulated by the duration of the applied pulse to its Control PIN, which operates on the PWM (Pulse width modulation) principle. Servomotors are made comprised of a DC motor and certain gears that are controlled by a resistor. Gears transform the high-speed force of a DC motor into torque. We know that WORK= FORCE X DISTANCE, and that in a DC motor, the force is smaller and the distance (speed) is greater, but in a servo, the force is more and the distance is shorter. The Servo's output shaft is attached to the potentiometer, which is used to compute the angle and stop the DC motor at the desired angle. Here showing Key specification on table 1.6

Table 5: key specification of MG995 (servo motor)

Model	Towerpro servo MG995
Dead band	0.100ms
Control system	+Pulse width control
Working frequency	20ms period
Operating voltage	4.8 ~ 6.0 direct voltage
Operating speed	.200sec/60 deg
Stall torque	9.4kg/cm
Gear type	Brass & aluminum gears
Motor Type	Brushed Motor
Weight	55 grams

In this figure we show MG995 pin wires diagram

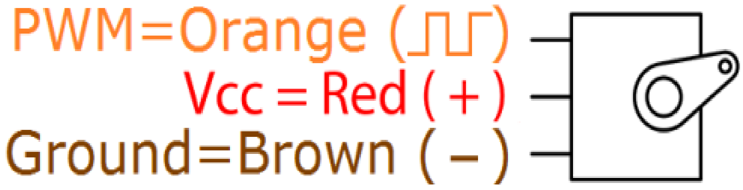


Figure 7: pin out for MG995

3.6 Battery

Modern World step forward by Power. In this world, we do not think any electronics Device without electricity. Every electrical device and system power by electricity. We discover or invent new things in every day and need power for this device. Without power, we do not exist in modern world. Same as our prosthetic arm controlled by human muscles signal but this arm power need, that's why we use direct power supply for testing purpose, In industrial assemble we need battery power.

As requirement of our major sensor(muscles sensor) myoelectric sensor v3-kit operating voltage need maximum 18 voltage battery and servo motor, Arduino Nano and other component need minimum 5 voltage that's why we use two 9 volt li-ion rechargeable battery for power supply.

Figure 8: 9V rechargeable Battery

Input: DC 5V/1.5A ; Output: 150mA*2 Max. No Load Power Consumption:1W MAX, Full Load power consumption:5W MAX. Battery Charge Rate:>90%. Size:90mm x 60mm x 38mm ; Weight:46g. Improved low self discharge makes it still maintain 75% of capacity after 3 year of non-use. Batteries are comes with recharged, no memory effect, could be used at any time. Recommended for smoke alarms, professional audio and medical devices. Professional service provide technology support by 24hours.

3.6 Wires

A jump wire (also known as a jumper, jumper wire, jumper cable, DuPont wire or cable) is an electrical wire, or group of electrical wires in a cable, with a connector or pin at each end (or sometimes without – simply "tinned"), that is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are connected by slipping their "end connectors" into slots on a breadboard, a circuit board's header connector, or a piece of test equipment.

In this project we use two type jumper wires one is male to male another is male to female in case if any need we use male to female or female to male jumper wire basically those both are same just end connector are different

Figure 9: Jumper wire

3.7 breadboard

A breadboard is a common tool for designing and testing circuits. When utilizing a bread board to build a circuit, you don't have to solder wires and components together. It is simpler to mount and reuse components. Because the components are not soldered, you may alter your circuit design at any time. It is made up of a series of conductive metal clips contained in a white ABS plastic box, with each clip insulated by another clip. The plastic box has a number of holes that are organized in a certain pattern. Two sorts of regions, sometimes known as strips, make up a conventional bread board pattern. Strips for busses and sockets Bus strips are commonly used to give power to circuits. There are two columns in it: one for power voltage and the other for ground.

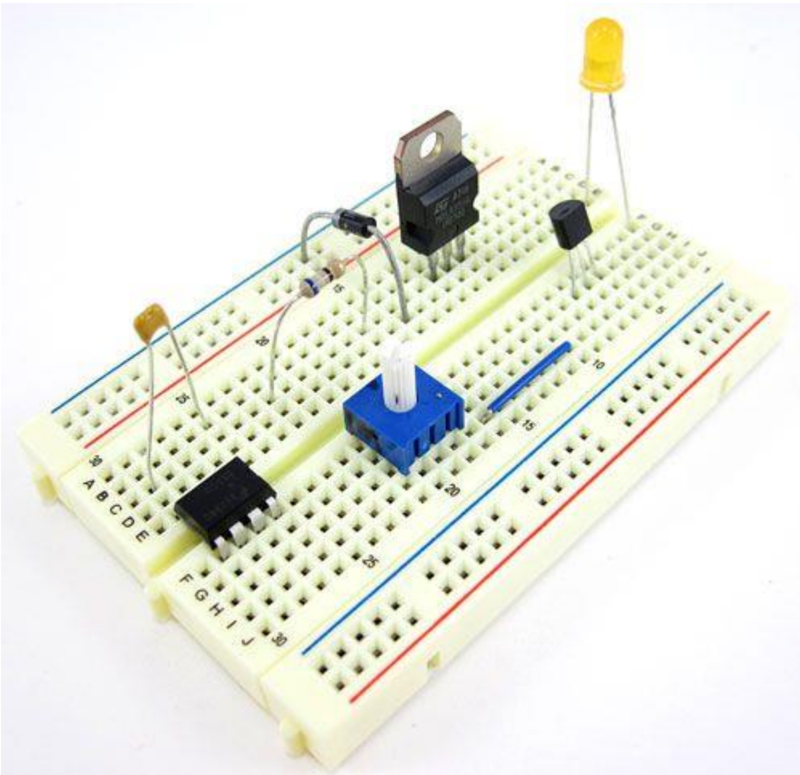


Figure 10: breadboard

3.8 Circuit diagram

A circuit diagram also called an electrical diagram, elementary diagram or electronic schematic is a simplified graphical representation of an electrical circuit. In this circuit diagram we use online free provided software name digikey.com

We find so many free circuit diagram website such like Circuit-diagram.org, digikey.com, online.visual-paradiagram.com, endrawmax.com, circuitLab.com and many more. But we use digikey.com because I think this web site functionality and responses is good for me, that why we using this website. In this figure we show circuit diagram for Prosthetics arm

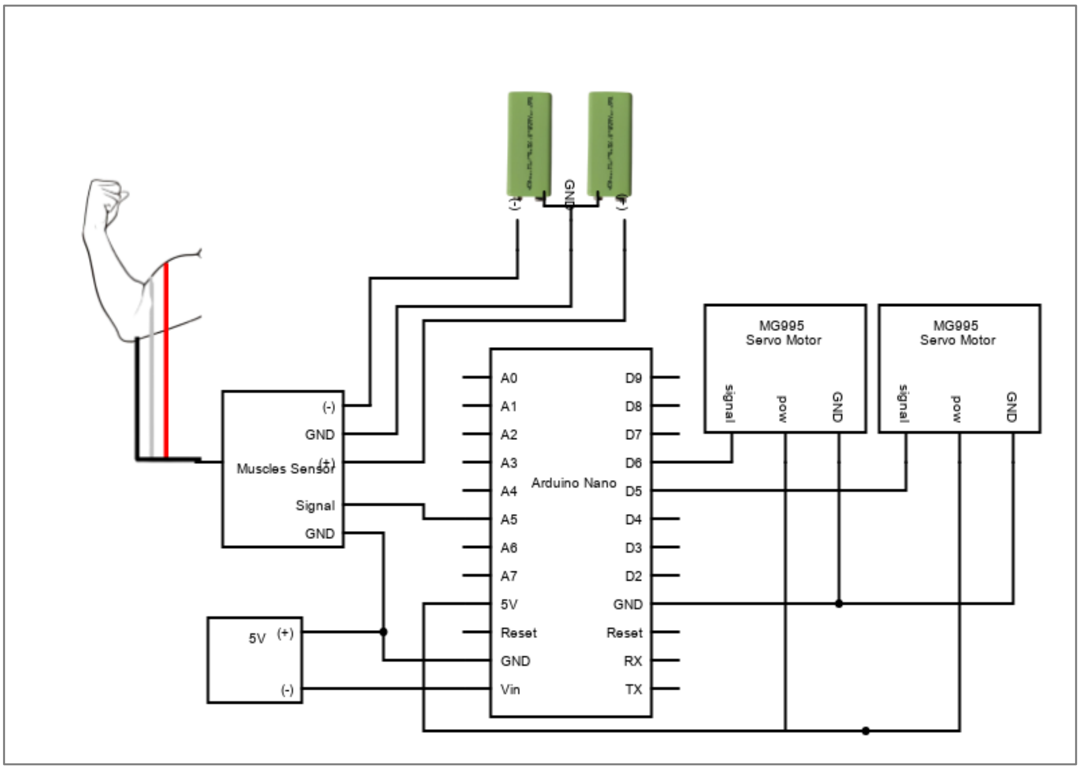


Figure 11: System circuit diagram

This circuit diagram we use Arduino Nano this MCU is total 36 pins. Out of these 8 are analog input pins and 14 digital input/output pins which 6 can be use as PWM output, this MCU has 2 GND and 2 Reset pin.

And we use two servo motor one is MG995 another is SG90, two different mechanical Servo use first one is High-torque and another is High speed both servo are connected in serially fist one signal with digital pin 6 and second one signal connected in digital pin 5. Two servo motor gain power in Arduino Nano 5 volt pin.

For Arduino power supply we use 5 bolt battery because Arduino Nano operating voltage need 5 volt. We can use 18 bolt battery for Arduino power but Arduino Nano is maximum 12 volt. That why external 5v battery use for Arduino Nano power.

For muscles sensor v3-kit power we use two 9 volt battery in series connection battery positive side connect in sensor positive port and battery Negative side connect in sensor Negative pin and sensor power GND connected in 18volt Battery series connection pin. Muscles sensor signal pin connected to Nano Analog pin 5 and GND connect to Arduino Nano GND pin.

This data processing use decomposition algorithm. This process is complex owing to the variability in shape of the action potentials generated by the same motor unit and the overlapping in time and frequency of action potentials generated by different motor units. The changes in shape of action potentials are usually limited for isometric constant force contractions of short duration. For longer recordings, however, it is usually necessary to update the templates by averaging the last N identified action potentials to account for changes due to fatigue [34].

3.9 Flow Chart

A flowchart depicts the individual phases of a process in a logical sequence. It is a general tool that may be used for a wide range of applications and can be used to describe a number of processes, including manufacturing, administrative and service processes, and project plans.

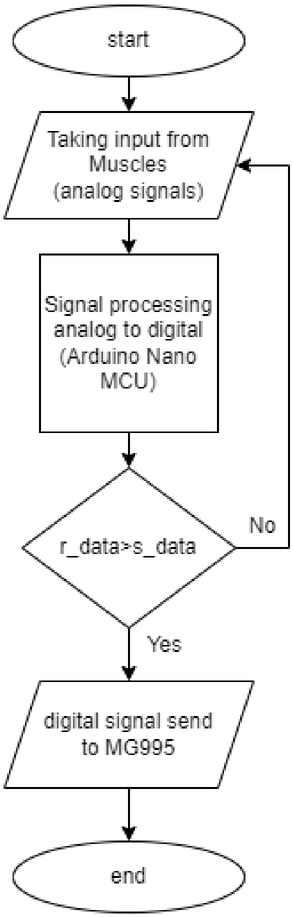


Figure 12: flow chart diagram

This flow char diagram showing which process work our prosthetics arm. First of all we connect all of device this system properly, then we power on of this system. And muscles sensor randomly taking input from user muscles and send this analog input data to Arduino Nano MCU. This processor convert analog input data to Digital input data, after complete data processing this data checking logic/condition which is predefine. And finally is condition is matched then visualize in prosthetic Arm movement.

3.10 Final Implementation

At first we design for our future prosthetic hand using 3D design software, and then we analysis which sensor, module, wires, MCU use for implement this arm. Overall all details about every element collect and then we printout our 3D design prosthetic hand, and then every printed finger we joint using elastic band and another sting call fishing sting for hand griping or normal phase.

We use our muscles sensor with Arduino Nano using breadboard and wires, here is our prosthetics arm muscles sensor.

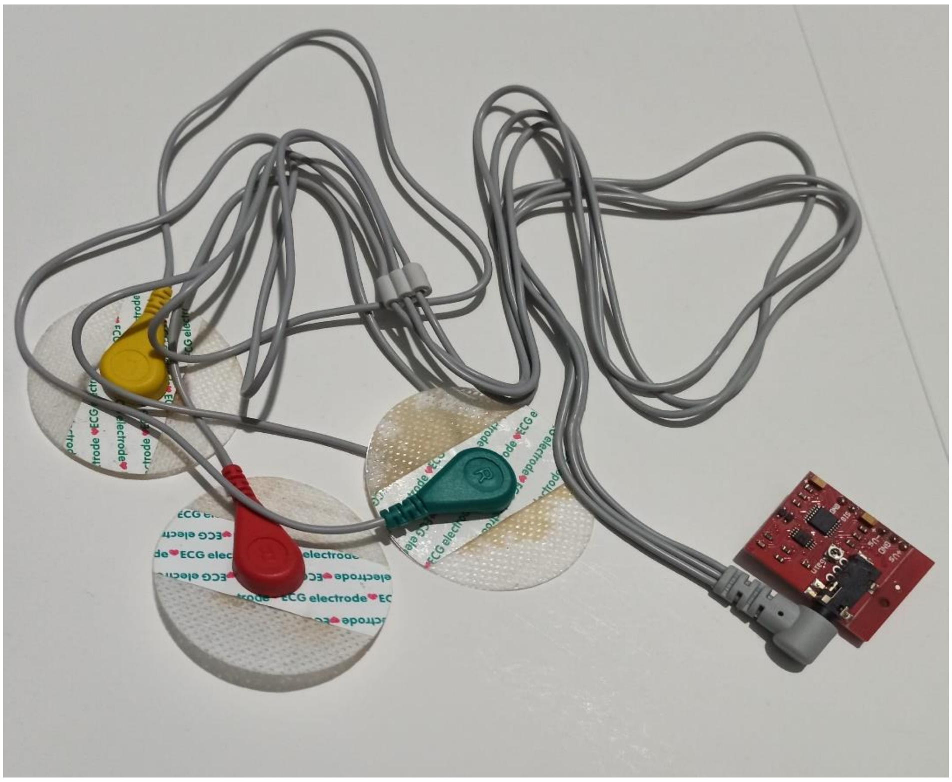
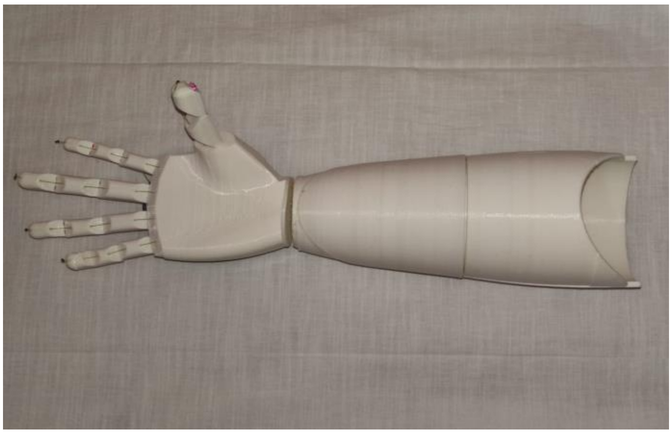


Figure 13: Muscle sensor v3-kit

The Muscle Sensor can assist you in achieving this goal. This sensor detects the electrical activity of your muscles using EMG (electromyography). It then transforms that to a changing signal that can be detected on any microcontroller's analog input pin.

Positive and negative voltage power supplies are required. Two 9V batteries will be used to produce them. Everyone understands what a positive voltage power source is (for example, a standard battery), but how can we make a negative voltage power supply? When two batteries are connected in series (for example, the positive terminal of battery 1 is connected to the negative terminal of battery 2), the voltage measured from the negative terminal of battery 1 and the positive terminal of battery 2 is equal to the sum of the voltages of battery 1 and battery 2.



3.11 Summary

In this chapter, we discuss about Methodology of our prosthetic arm. How we implement in every steps by steps, which method or techniq we use in prosthetic arm implementation, which sensor we use why this sensor and how many voltage need this sensor every details part by part describe in this chapter.

Finally, we showing our prosthetic hand. Next chapter we will discussion about our prosthetic arm result and analysis. How perform this hand? How many friendly for user? Finally, we describe this prosthetic hand how improve in future.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Result

The design of the finger channels has proven to be a significant one Many amendments are needed to issue and achieve acceptance Performance. Initially it was planned to loop the tendon once Around each joint, leading to different diameters The functionality of the proximal segment is first followed by the median And the last part. However, the exciting tense has taken hold The joint allows too much extra movement too forcefully Remote part. When the tendon was run straight Sheath, the function of the finger begins at the tip of the finger Before moving to the middle and proximal segments. Currently, the hand weighs 250g. The hands are almost there Perfect weight compared to the average human hand.

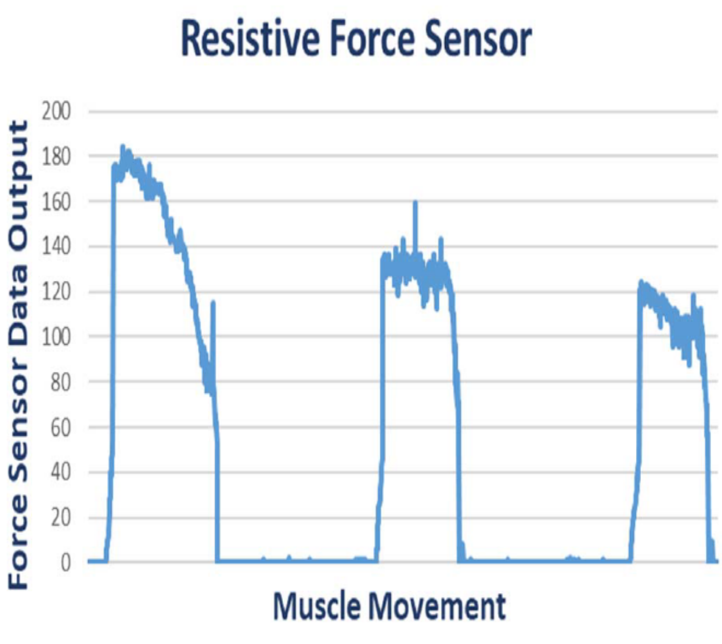


Figure 14: Resistive Force Sensor data output during muscle contraction

4.2 Resistive force

Figure 8 depicts the data generated from a resistive force sensor, which is read by human muscles during each contraction. The horizontal axis depicts muscle movement when the body is in motion. When the patient contracts a muscle, the Resistive Force Sensor detects it. begins reading data and transmitting it to the Arduino controller. After then, the Arduino controller compares the data received from the sensors. the intended data for the resistive force sensor If the information is correct, The data from the Resistive Force Sensor is higher than the data from the computer. It initiates the five servo motors, which then move. The five fingers swell. On the other side, when data is received, is less than the data that has been entered into the Arduino controller not stimulate the servo motors, which would cause the fingers to tremble. continue to be stretched Figure

4.3 Experimental Result

Regular items have been chosen to pick up in order to see how effectively this plastic soft prosthetic hand connects to diverse objects with its kind. The prosthetic hand has undergone several tests with various sizes and shapes of water bottles in order to assess its functioning and capacity to grasp items. During the test, the number of times the prosthetic hand successfully grabbed each type of water bottle, as well as the number of times the prosthetic hand failed to take the water bottle, was observed and tallied. Those picked things of various sizes have varying weights. In the table below, we've included the results of this experiment:

Table 6: Types of Bottles used in the Test

Volume of Water Bottle	N times fails/N	N times succeeded/20
0.25L	5	15
.5L	8	12
1.0L	13	7

4.3 DISCUSSION

Lack Excess weight can limit user fatigue, increase Its usability. To change the weight of the hand and wrist, print A different infill concentration and some can be printed Materials optimized to reduce the amount of material The required infill concentration plays an important role Care should be taken so that the mechanical strength of the hand is not lost Decrease the infill concentration to a level that can affect Mechanical performance of the hand. Currently no amputation arm is examined. There are plans to find out Volunteers to test hands by next month Identify its effectiveness and compare it with Prostheses Currently in use. It is known from literature that able Dr. Physical examination subjects create fair examination subjects in EMG research Although non-amputees tend to score well in the pattern Recognition studies that replicate their mutilation. For example, it Somewhere amputee needs to be tested on test subjects Guarantee the performance of weapons in the near future and do any Necessary changes. Competent physical examination subjects have been used Initially to deal with the usability of the arm and continue Initial performance tuning. The test has been satisfactory Performance on the EMG control side, albeit completely haptic The response system has not yet been tested. Operational Mode varies from rate mode to force control in software Mode though is planned to make this change possible for the user.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Findings and Contributions

During the venture, it was demonstrated that it is conceivable which to plan and make an ideal prosthetic arm gives a sensible scope of movement and control for an appendage. Albeit the gadget was tried with skilled body test things, there were no issues with arm control in all guineas pigs when the anodes were set accurately.

A programmed alignment The capacity is important to consider the diverse muscle mass Clients who had various clients and less strong weapons Issues accomplishing a portion of the limits expected to switch The mode gadget is not difficult to produce, simply required Admittance to a side interest level 3D printer and a modest number close by The all-out print time for the Tools project is around 22 Of hours (counting hardware) with a commonplace gathering time Around 40 hours.

5.2 Recommendations for Future Works

Much change is required for future redundancies. There will be an adjustment of the cast from the pin jointed finger Polyurethane elastic joint that will assist ease with controlling The fingers of the hand ought to be moved distinctly in a bowed position Polyurethane elastic will give the fundamental spring Power the finger to stretch out to its resting position.

In elastic joints Likewise permit the fingers to contort around their long hub, Permitting them to be more steady with the state of the item Being gotten Touchy touch sensors will likewise be incorporated at the fingertips In a delicate polyurethane elastic. Elastic will improve The touch sensor will consider more noteworthy when the clench hand Ball control instead of current control. The wrist activation was initially made arrangements for the model however Acknowledged because of time limitations. Plans were made for the wrist PCB is controlled by means of server however wrist mechanics The truth was rarely figured it out.

The following model will have a PCB where the impression will be diminished To permit a more extensive scope of trans-outspread handicapped people to suit The arm current makes the four level framework function admirably however as it were The utilization of two layers can take into consideration a four layer board where More reduced hardware and marginally expanded expenses. Extra EMG channels will likewise be remembered for this new one PCB to utilize current difference design acknowledgment Control engineering.

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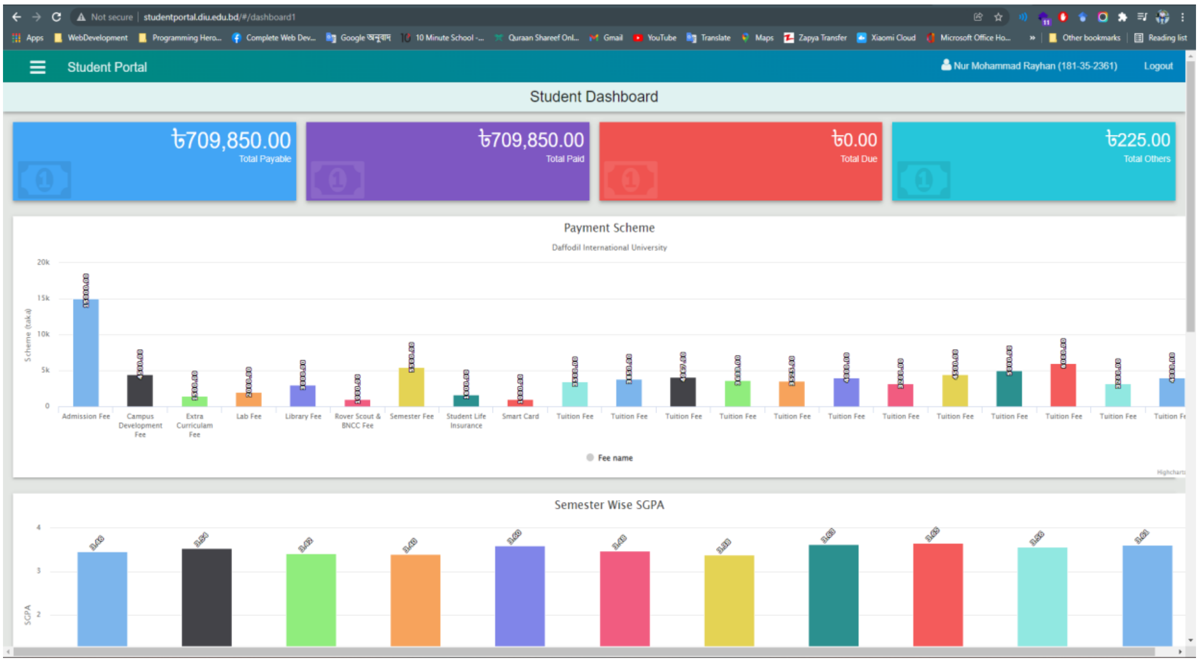
Appendix-A

Student Portal Clearance



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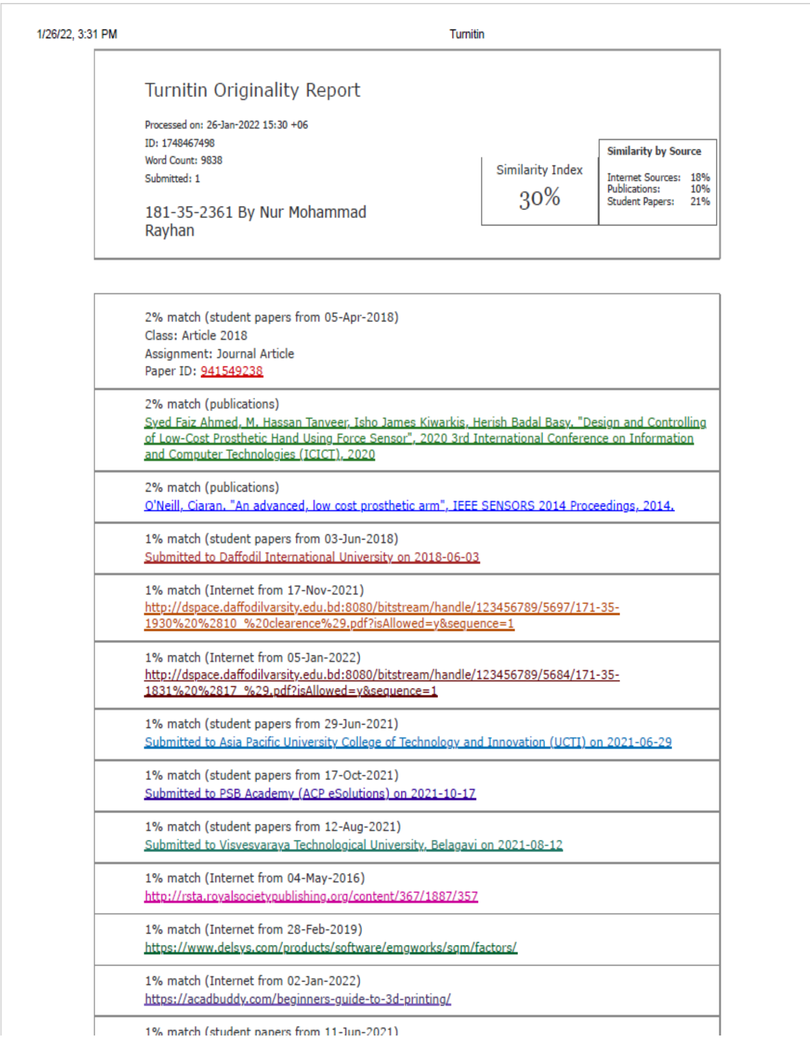

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