Electronic Prosthetic Arm

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First agenda

- Overview of the Human Arm Anatomy
  - Bones, Joints, Muscles
- Review Arm Motion
  - Kinematics: types of motion, location of motion, direction of motion, magnitude of motion, and degrees of freedom
  - Kinetics: extrinsic forces, intrinsic forces, force vectors, force of gravity, reaction forces, additional linear forces, and classes of levers
- Overview of the Prosthetic Arm
  - Building the Model
  - Building the Display

Bones of the Upper Extremity

Humerus

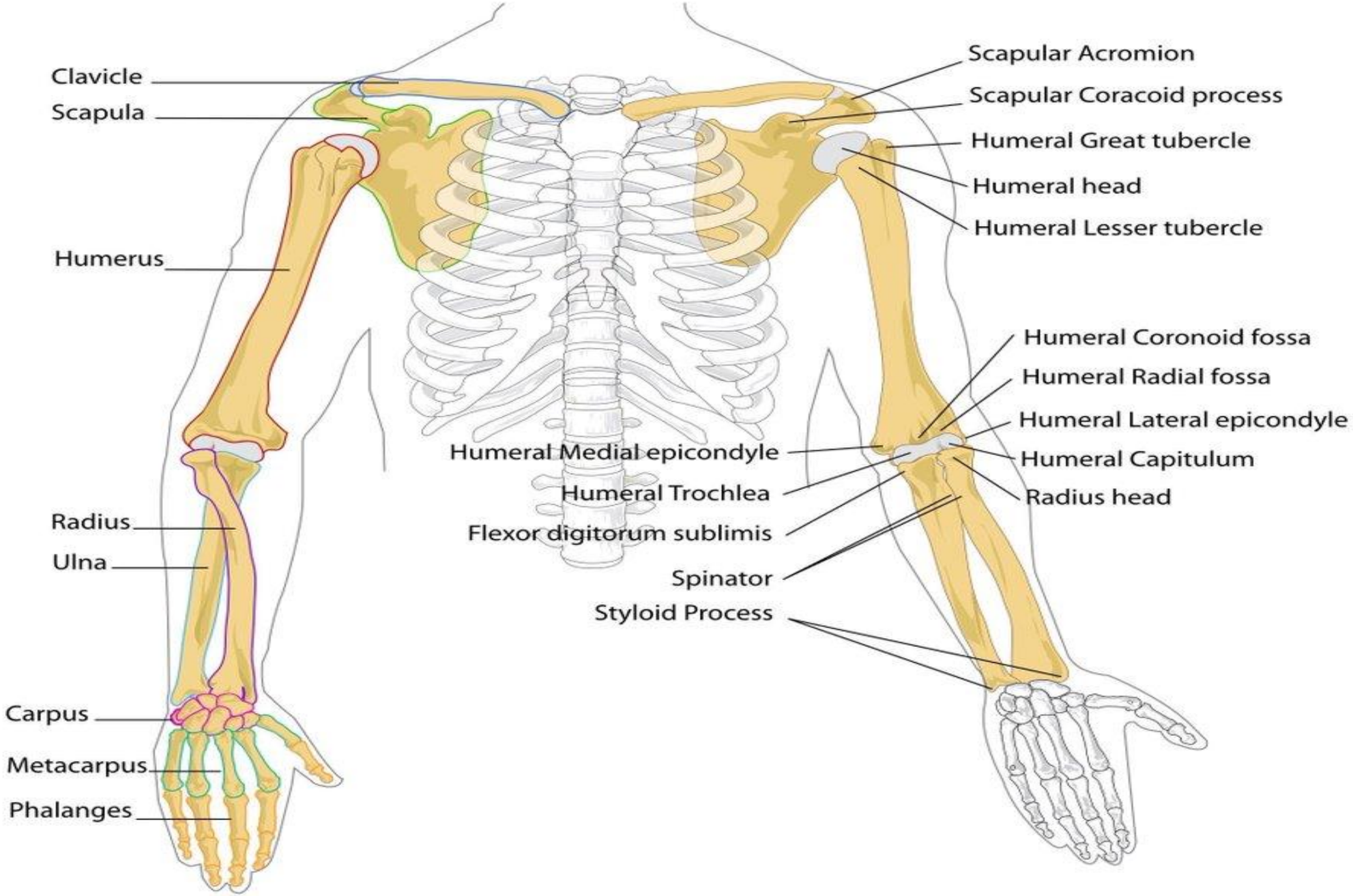
The longest and largest bone in the upper extremity.

Ulna

A long bone in the forearm parallel with the radius; at the proximal is the elbow and the distal end is the wrist.

Radius

The other bone of the forearm, shorter than the ulna.


Clavicle
Scapula
Humerus
Radius
Ulna
Carpus
Metacarpus
Phalanges
Scapular Acromion
Scapular Coracoid process
Humeral Great tubercle
Humeral head
Humeral Lesser tubercle
Humeral Coronoid fossa
Humeral Radial fossa
Humeral Lateral epicondyle
Humeral Capitulum
Radius head
Humeral Medial epicondyle
Humeral Trochlea
Flexor digitorum sublimis
Spinator
Styloid Process

Bones of the Hand

Carpals

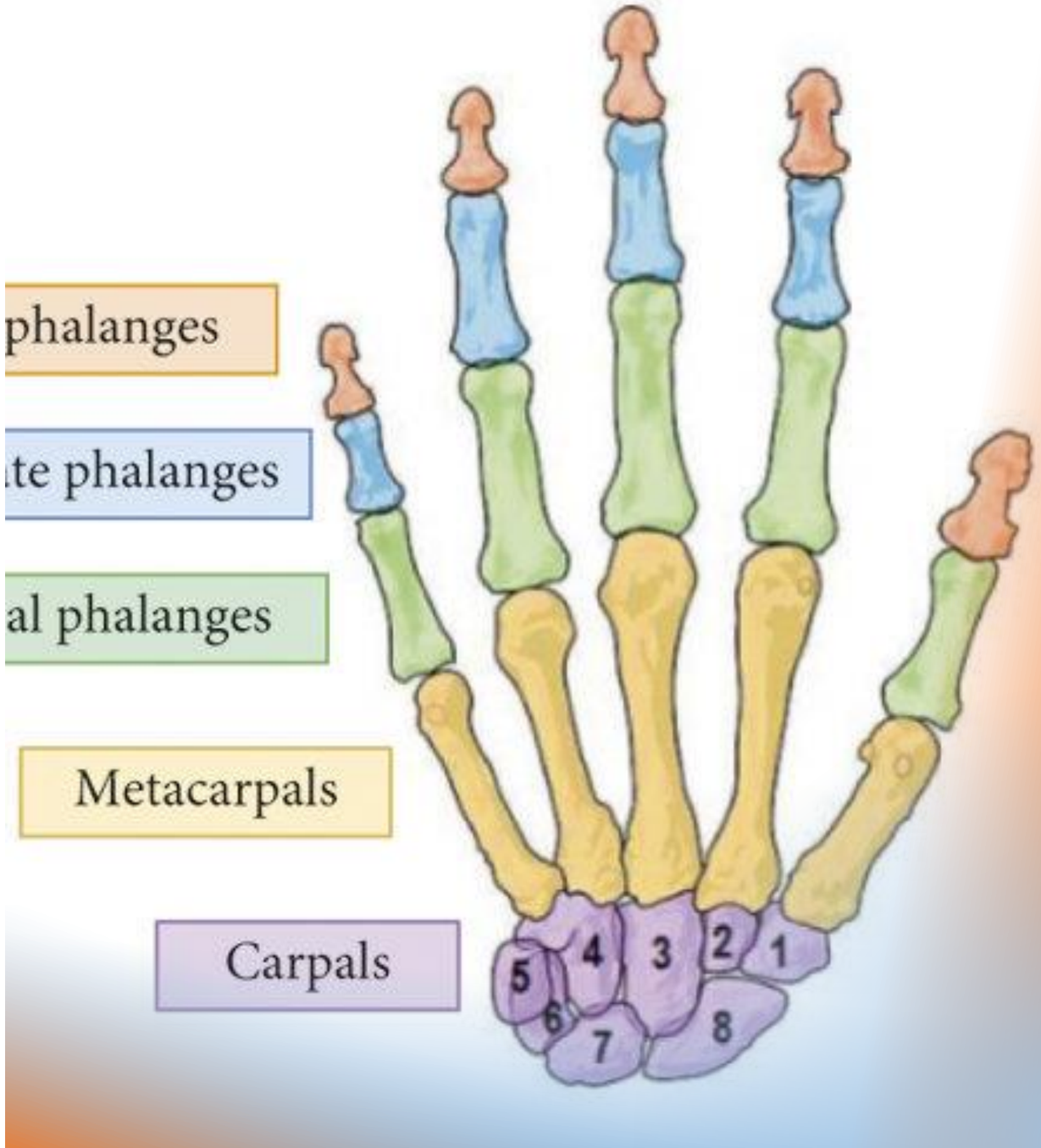
The wrist is composed of 8 separate carpal bones.

Metacarpals

The intermediate part of the hand skeleton that is between the carpals and the phalanges (up to the knuckles); 5 metacarpal cylindrical bones

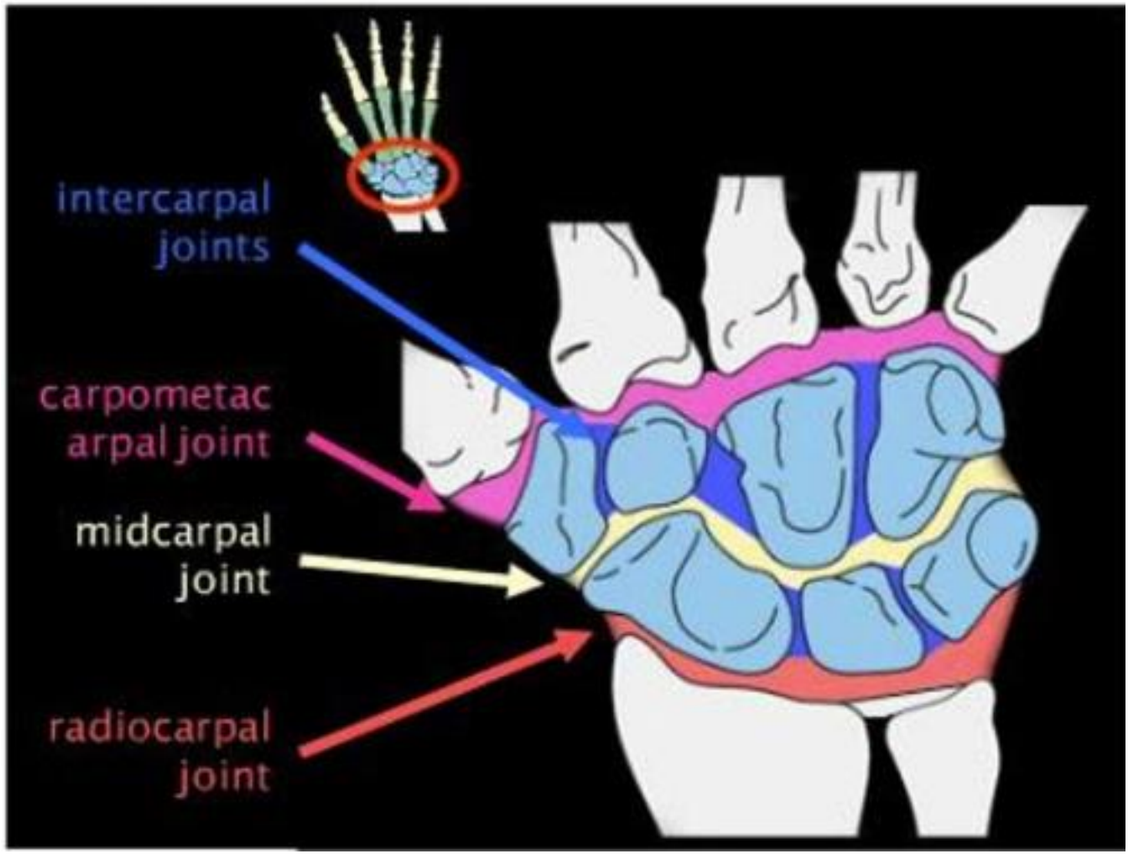
Phalanges

The fingers of the hand contain 14 digital bones.

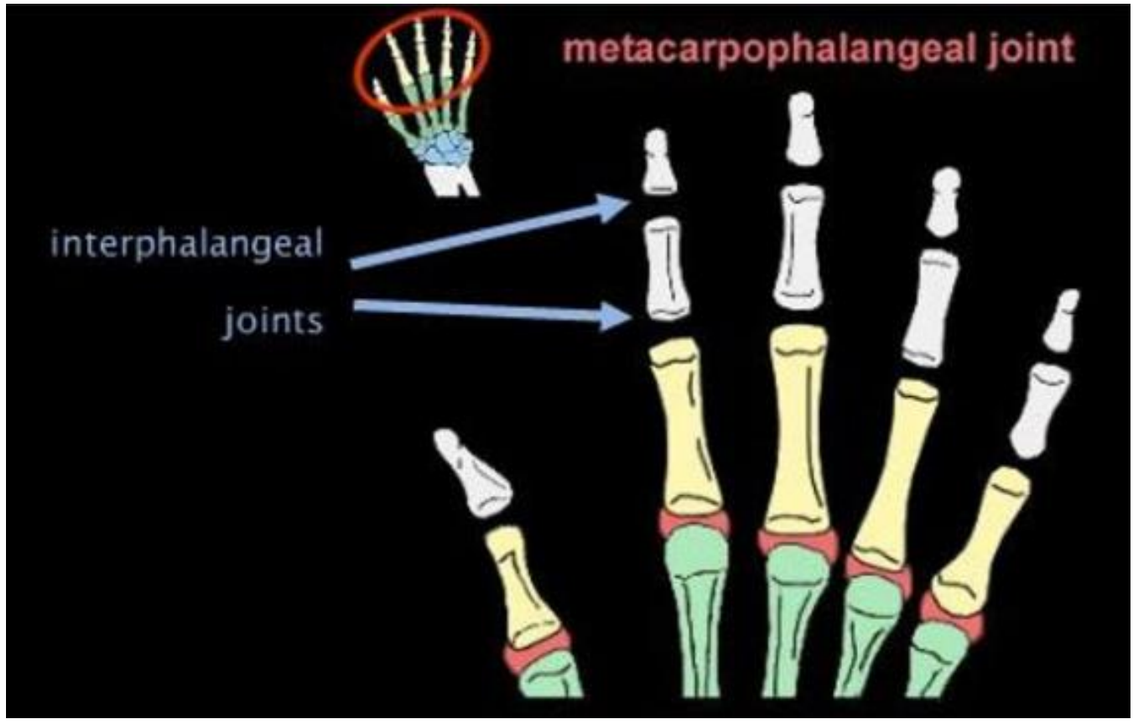


Joints

- Elbow Joint/Complex
  - Humeroulnar Joint - simple hinge-joint
  - Humeroradial Joint - arthrodial joint allowing gliding and sliding motions
  - Proximal Radioulnar Joint - pivot joint
- Wrist Joint
  - Radiocarpal joint
  - Carpometacarpal joints
  - Intercarpal joints



- Metacarpophalangeal Joints
- Interphalangeal Joints

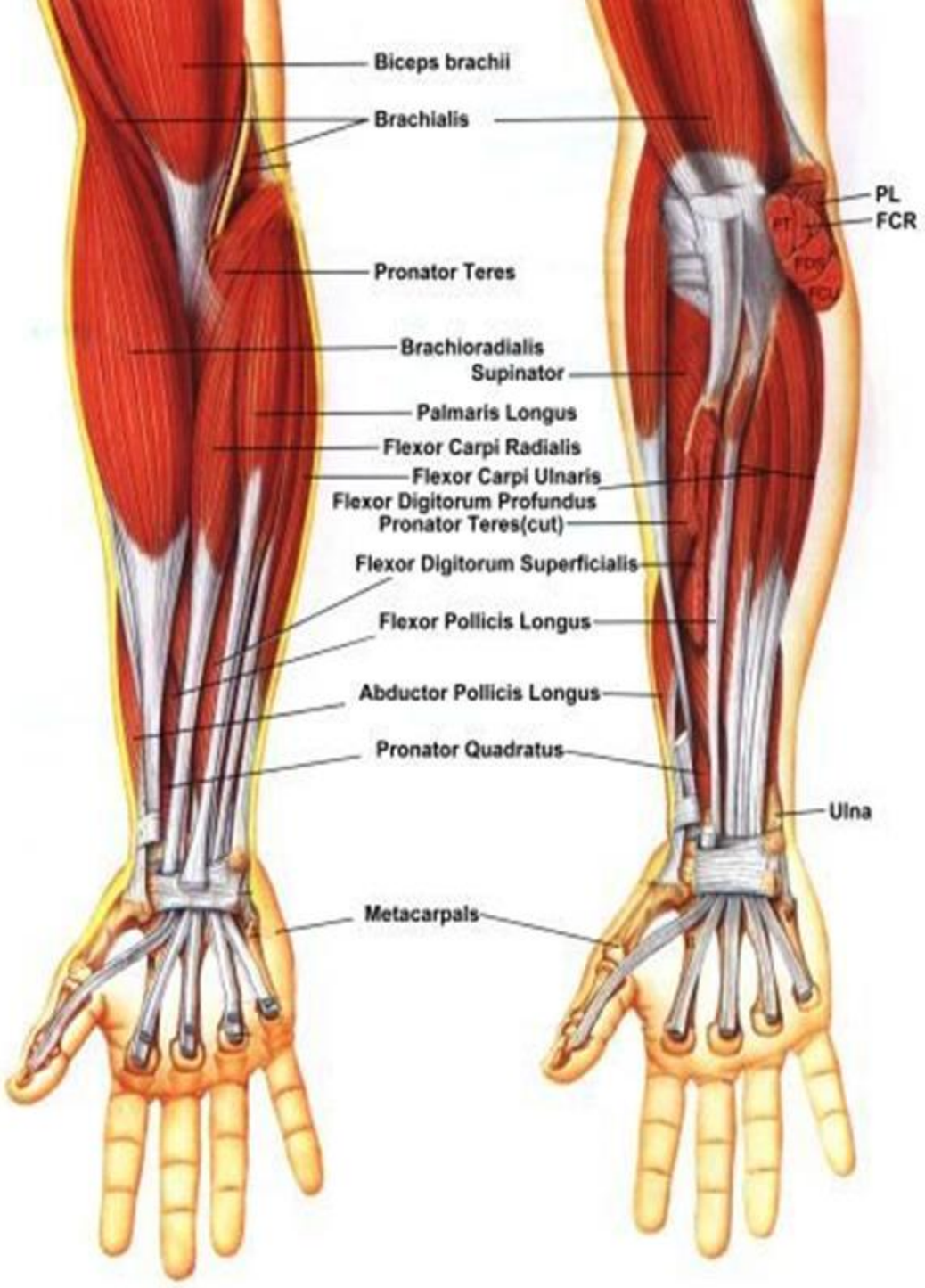


Movements

- Flexion: decreasing joint angle such as bending
- Extension: increased joint angle such as stretching
- Abduction: movement that draws limb away from sagittal plane
- Adduction: movement which brings limb closer to the sagittal plane
- Supination: palm faces up
- Pronation: palm faces down
- Circumduction: combination of flexion, extension, abduction and adduction

muscles

- Upper Arm
  - Biceps brachii, brachialis, coracobrachialis
- Forearm
  - Flexor-pronator and extensor-supinator
- Hand
  - Thenar, hypothenar, interosseous, lumbrical



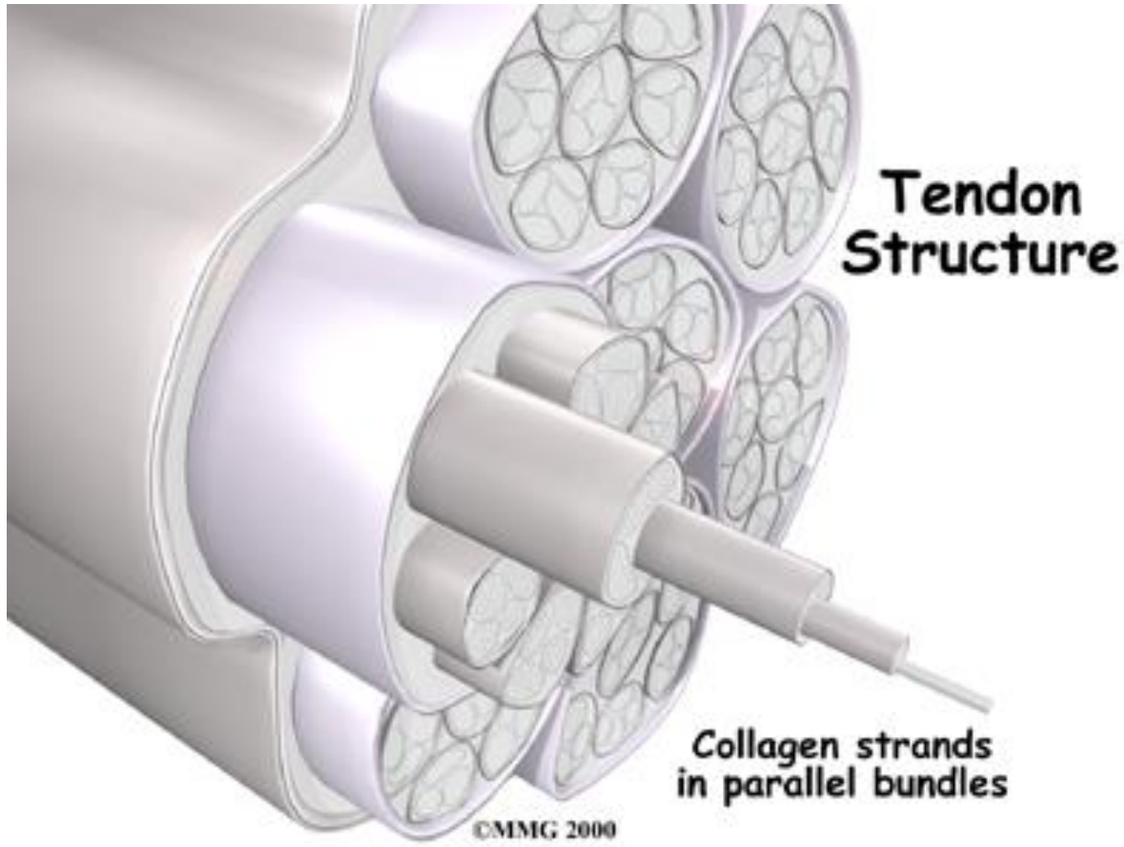
Arm Muscles and Their Functions

Muscle	Location	Function
Biceps brachii	Anterior Arm (humerus)	Flexion and supination of the elbow
Brachialis	Anterior Arm (humerus)	Flexion of elbow in all positions, but especially when the forearm is pronated
Triceps brachii	Posterior Arm (humerus)	Extension of the elbow
Brachioradialis	Posterior/Anterior Forearm (superficial)	Flexion of elbow; also pronation and supination, depending on position of forearm
Pronator teres	Anterior Forearm (superficial)	Pronation of forearm; flexion of the elbow
Pronator quadratus	Anterior Forearm (deep layer)	Pronation of the forearm
Flexor carpi radialis	Anterior Forearm (superficial)	Flexion and abduction of the wrist
Palmaris longus	Anterior Forearm (superficial)	Flexion and abduction of the wrist
Flexor carpi ulnaris	Anterior Forearm (superficial)	Flexion and abduction of the wrist
Flexor digitorum superficialis	Anterior Forearm (superficial)	Flexion of the fingers
Flexor digitorum profundus	Anterior Forearm (deep layer)	Flexion of the fingers
Flexor pollicis longus	Anterior Forearm (deep layer)	Flexion of the thumb
Supinator	Posterior Forearm (deep layer)	Supination of forearm and wrist
Extensor carpi radialis longus	Posterior Forearm (superficial)	Extension and abduction of the wrist
Extensor carpi radialis brevis	Posterior Forearm (superficial)	Extension and abduction of the wrist
Extensor carpi ulnaris	Posterior Forearm (superficial)	Extension and adduction of the wrist
Extensor digitorum	Posterior Forearm (superficial)	Extension of the fingers
Extensor digiti minimi	Posterior Forearm (superficial)	Extension of the fingers
Extensor pollicis brevis	Posterior Forearm (deep layer)	Extension of the thumb
Extensor pollicis longus	Posterior Forearm (deep layer)	Extension of the thumb
Abductor pollicis longus	Posterior Forearm (deep layer)	Extension and abduction of the thumb

Tendons

➢Tough bands of fibrous connective tissue that connects muscles to bones.

- Capable of withstanding tension
- Function to transmit force
- Function as springs

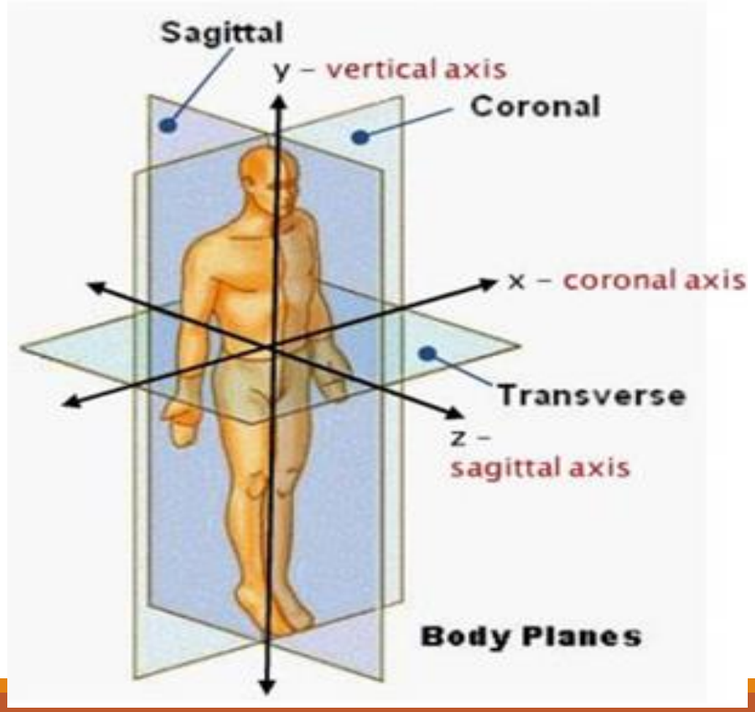


Arm Motion – Kinematics

- Types of Motion
  - Translatory: all parts move toward same direction
  - Rotatory/Angular: around a fixed axis
  - General: combination of translation and rotation
- Location of Motion
  - Transverse or Horizontal Plane
    - Superior and Inferior
  - Coronal or Frontal Plane
    - Anterior and Posterior
  - Sagittal plane
    - Medial and Lateral

Axis of rotation	Direction of motion	Perpendicular to
Sagittal axis (anterior posterior axis)	Horizontally from front to back	Coronal plane
Coronal axis (frontal axis)	Horizontally from side to side	Sagittal plane
Vertical axis	Perpendicular to ground	Transverse plane

Rotatory motion occurs around a fixed axis.

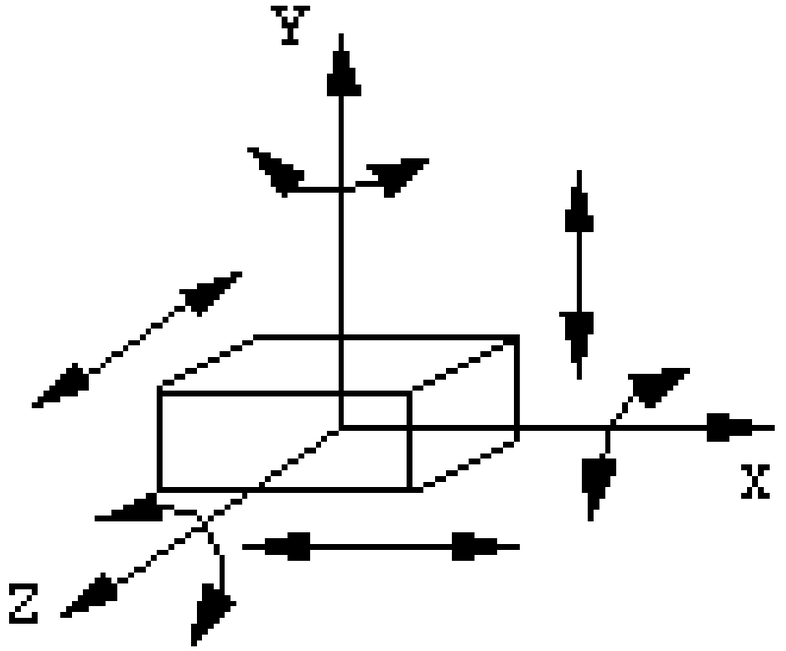


Degrees of Freedom

- 3 translatory motions along the x, y, and z axes and

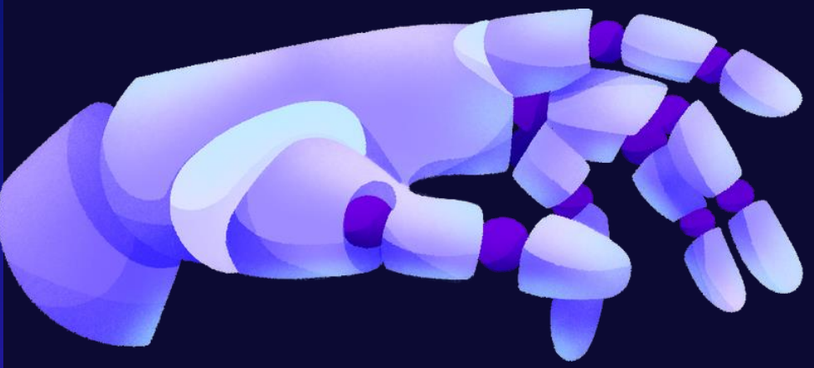
  3 rotatory motions around the x, y, and z axes

- 6 DOF of a rigid body
  - Moving up and down
  - Moving left and right
  - Moving forward and backward
  - Tilting forward and backward (pitch)
  - Turning left and right (yaw)
  - Tilting side to side (roll)



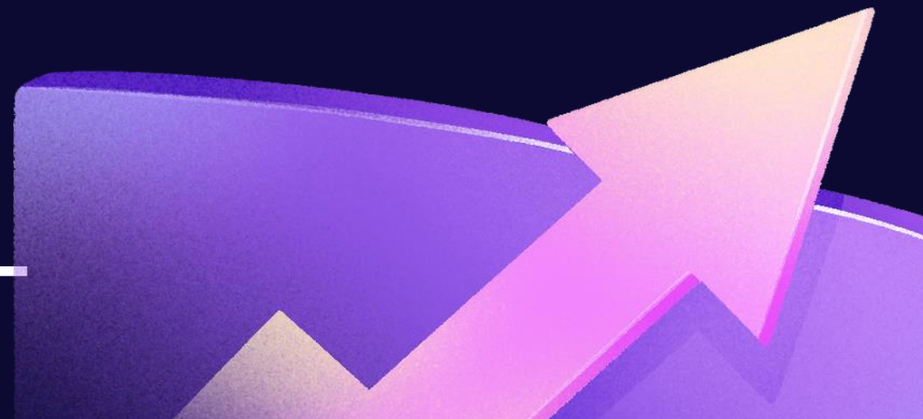
Arm Motion - Kinetics

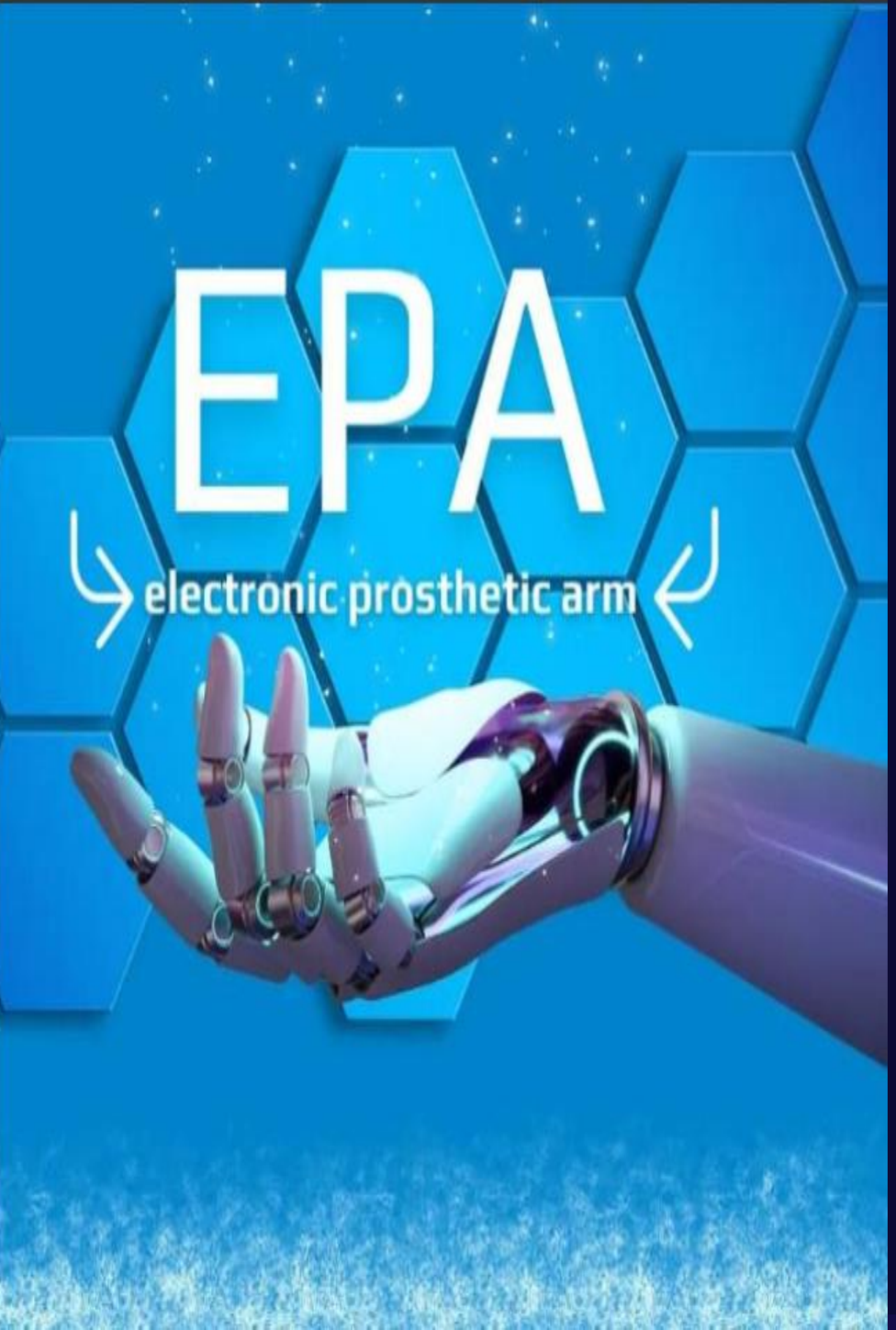
- Extrinsic Forces
- Intrinsic Forces



Second agenda

- Introduction
- History and Development
- Anatomy and Function
- Methodology
- Results and Achievements
- Future direction





Introduction to Electronic Electronic Prosthetic Arm Arm

Advanced robotic arms restore function for limb loss or difference, mimicking natural movements for greater independence and improved quality of life.

History and Development of Prosthetic Prosthetic Limbs

1

Early Prosthetics

Prosthetic limbs have been used for centuries, with some of the earliest known examples dating back to ancient Egypt and Greece.

2

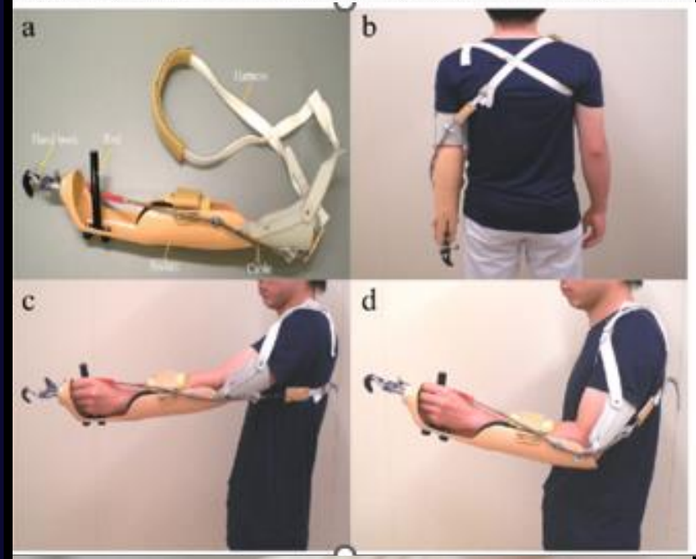
Modern Advancements

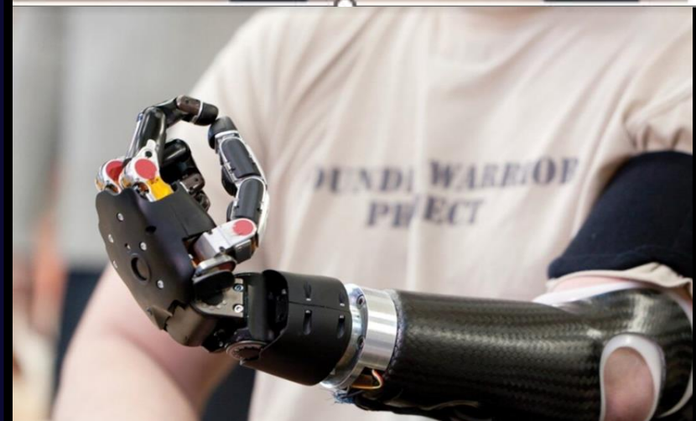
In the 20th century, the development of new materials and technologies led to significant improvements in prosthetic design, design, allowing for greater functionality and comfort for users. users.

3

Electronic Prosthetics

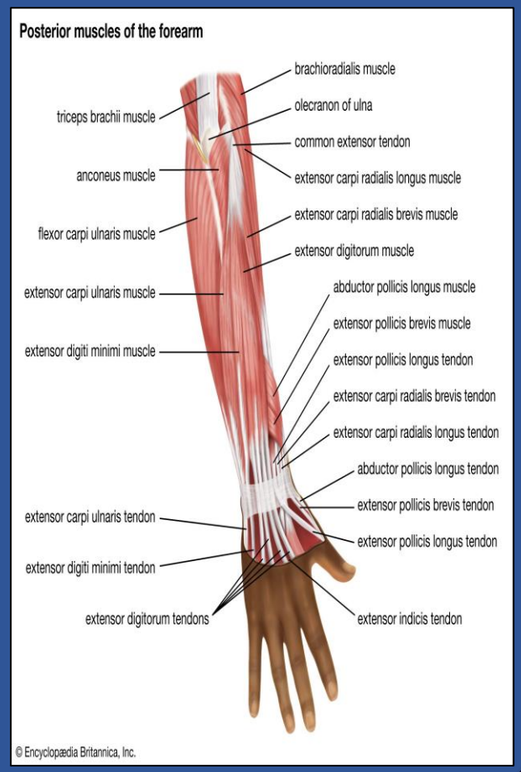
The integration of electrical and computer systems in the late 20th late 20th century revolutionized prosthetic limbs, enabling more more natural and intuitive control through sensors and advanced advanced control algorithms.





Anatomy and Function of the Human Arm

Skeletal Structure



Nervous System

Muscular System

Principles of Electrical Engineering

1 Sensors

Prosthetic arms utilize a variety variety of sensors, such as force, pressure, and position position sensors

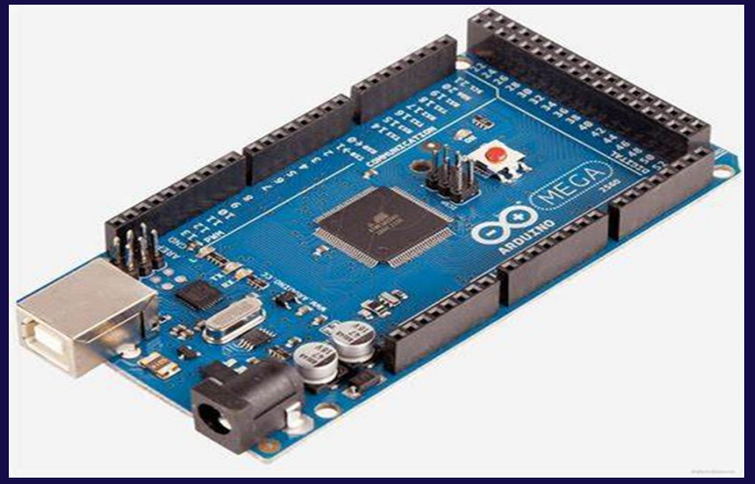
2 Actuators

Electromechanical actuators, actuators, like motors are responsible for translating the the control signals into physical physical movements of the prosthetic limb.

Principles of Electrical Engineering

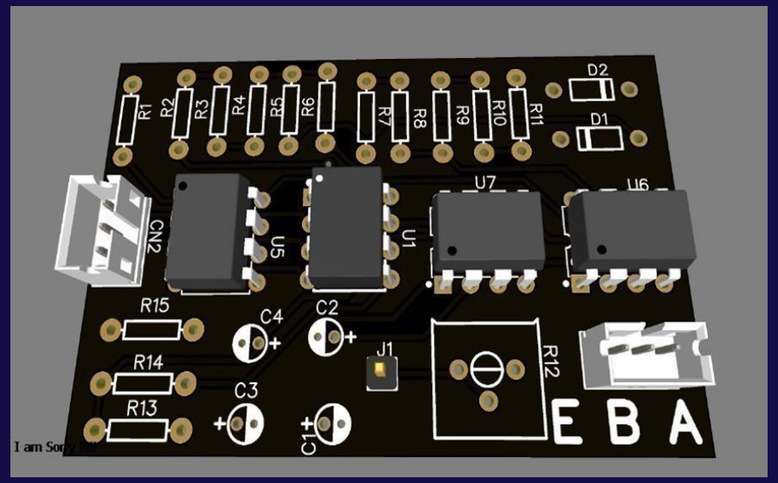
3 Power and Control

Onboard microcontrollers and power power sources enable the prosthetic prosthetic arm to function autonomously.

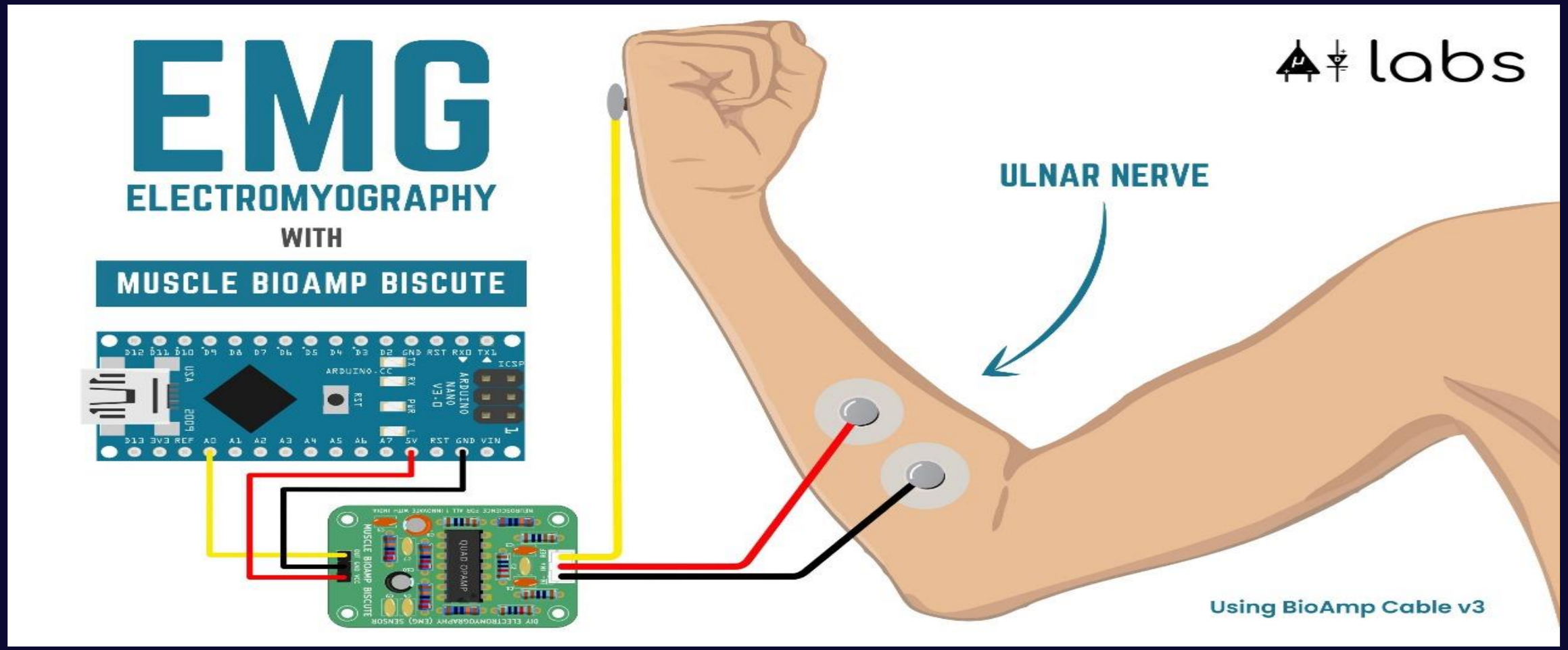


4 amplification & filtration circuit

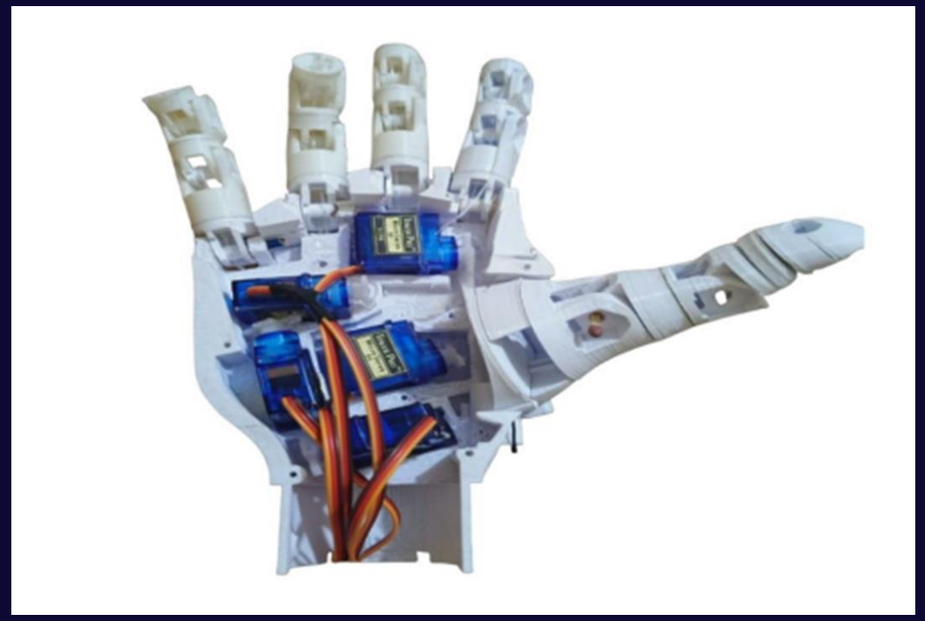
Amplification and filtration circuits circuits enhance signals for improved improved sensing and motor control control in electronic prosthetic arms. arms.



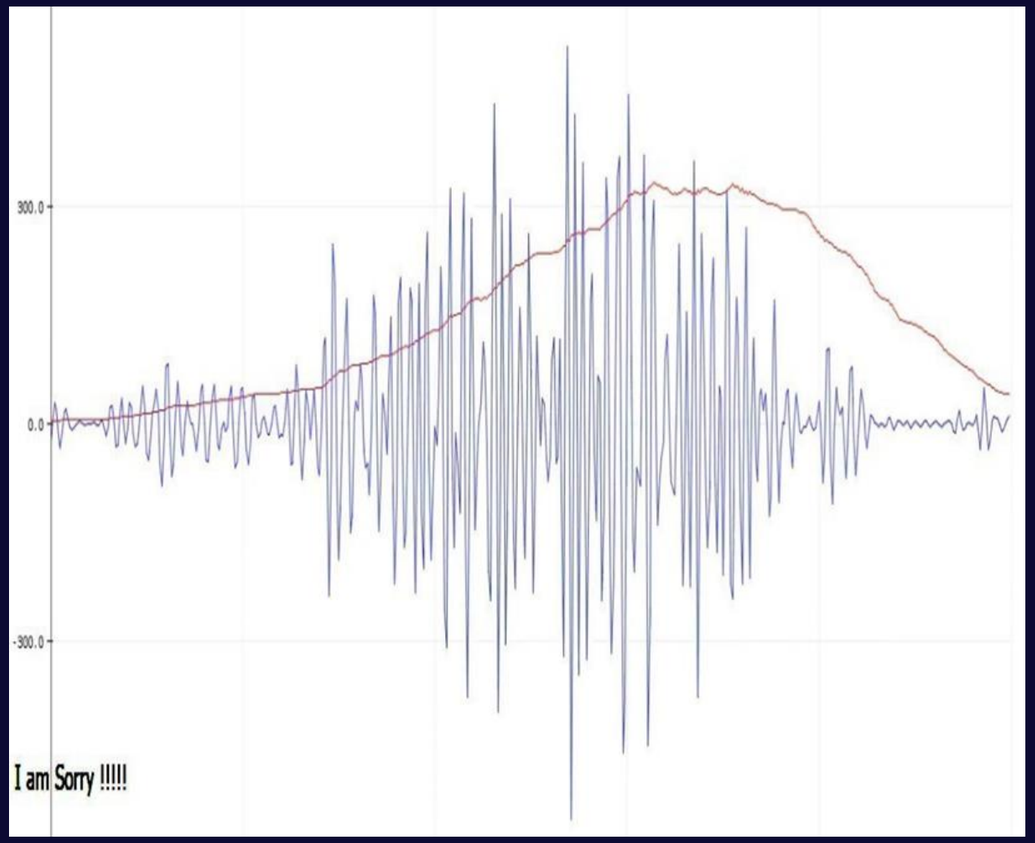
Block diagram of a hand with wires attached to a circuit board

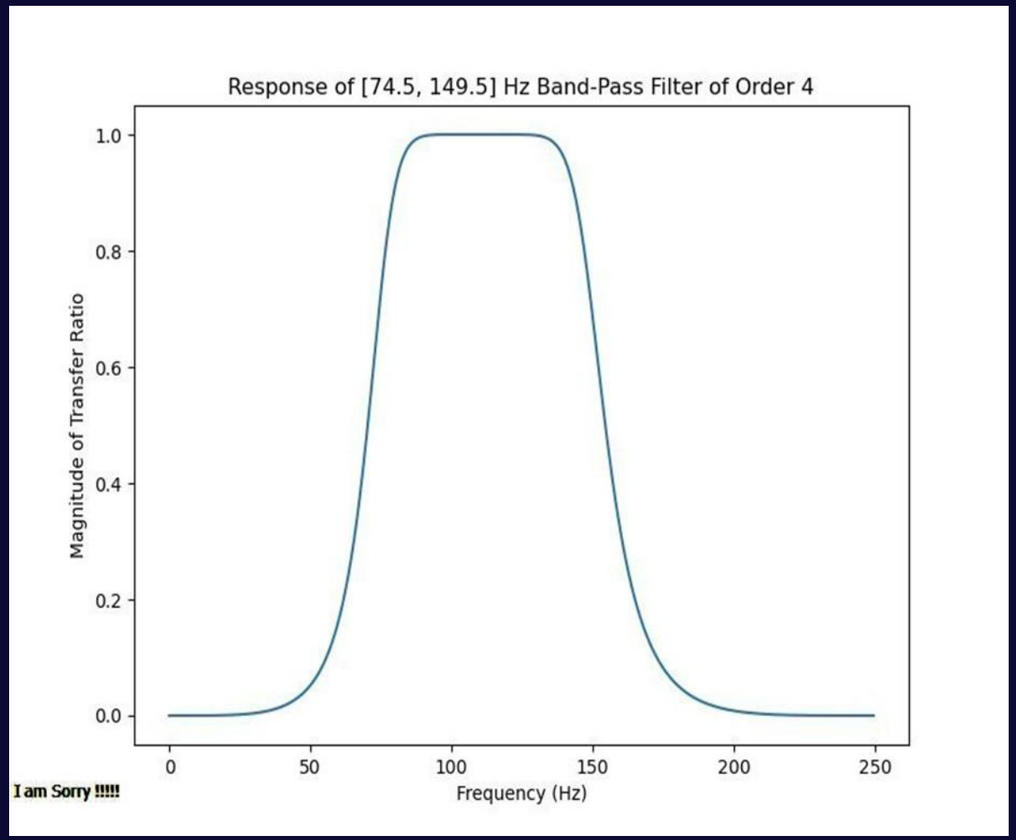


Results and Achievements



Recorded EMG signal





Challenges and Limitations

1

Cost

2

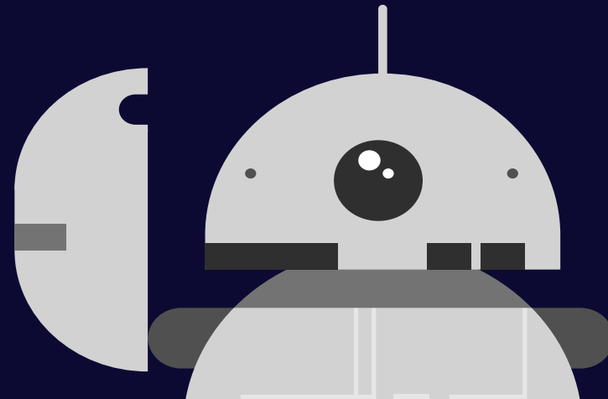
Weight and and Comfort Comfort

3

Limited Functionality

4

Sensor Feedback



Future direction

- Miniaturization and wearable technology
- Wireless connectivity for remote monitoring
- Advancements in signal processing algorithms