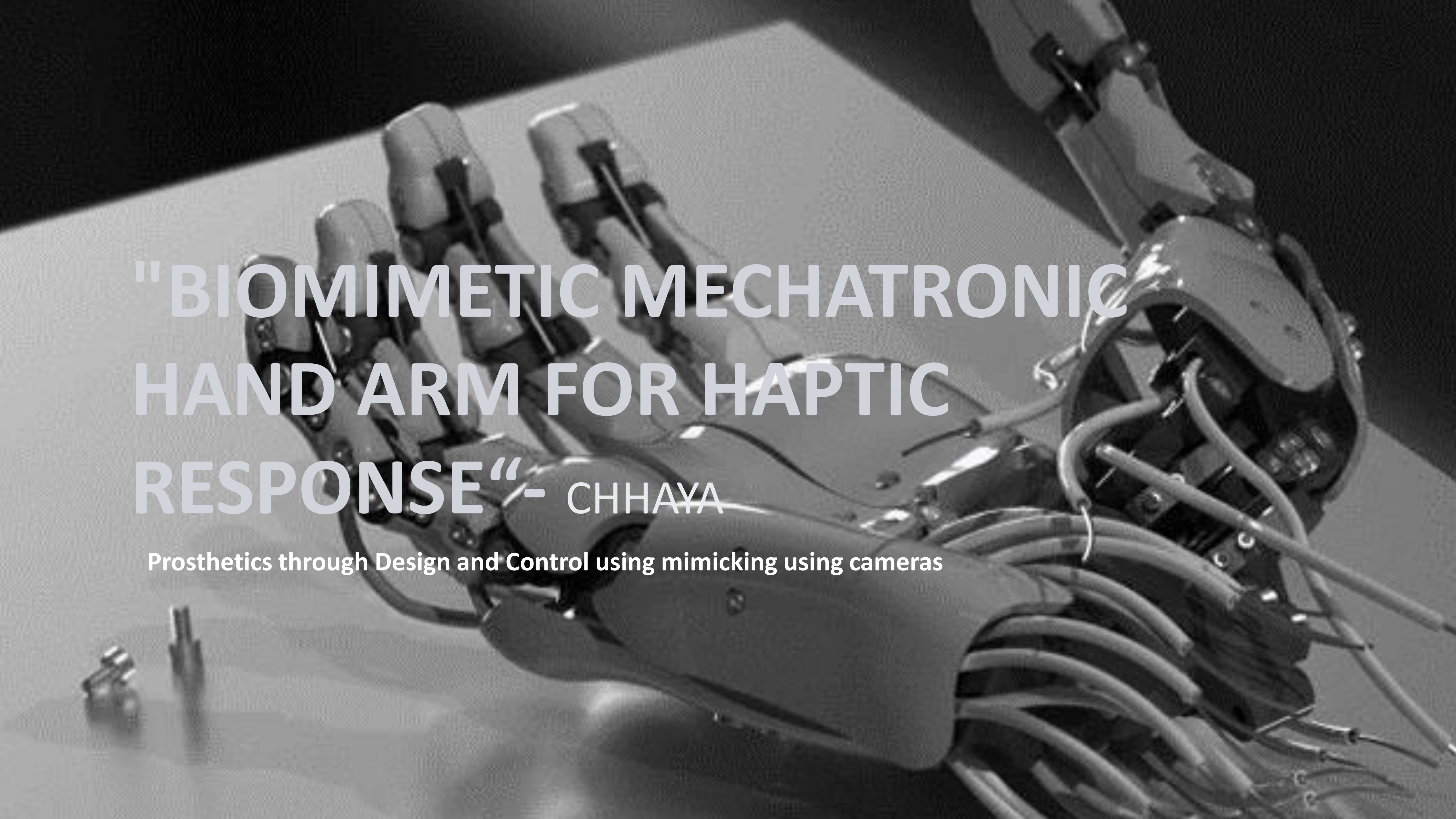
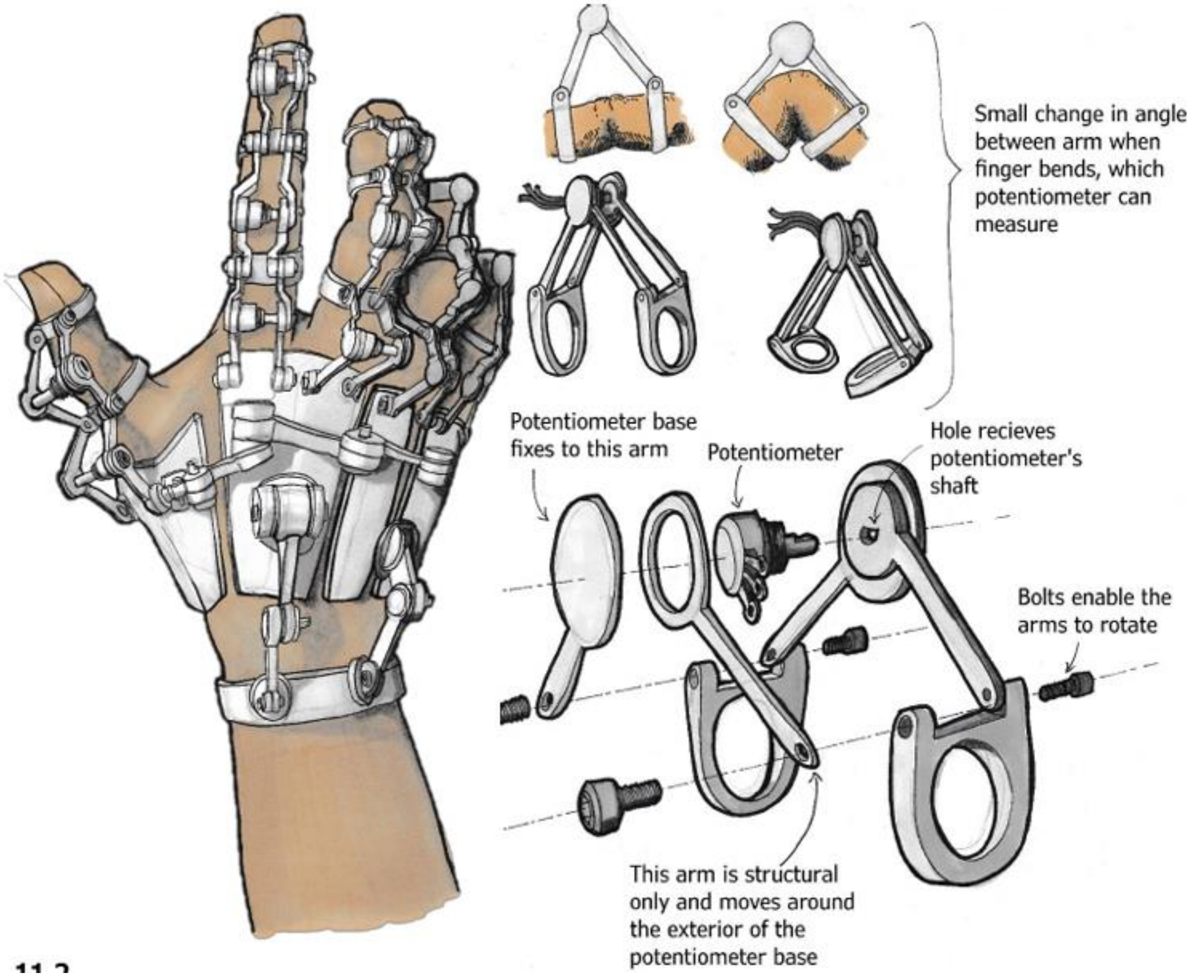


"BIOMIMETIC MECHATRONIC HAND ARM FOR HAPTIC RESPONSE"- CHHAYA

Prosthetics through Design and Control using mimicking using cameras

INTRODUCTION - CHHAYA

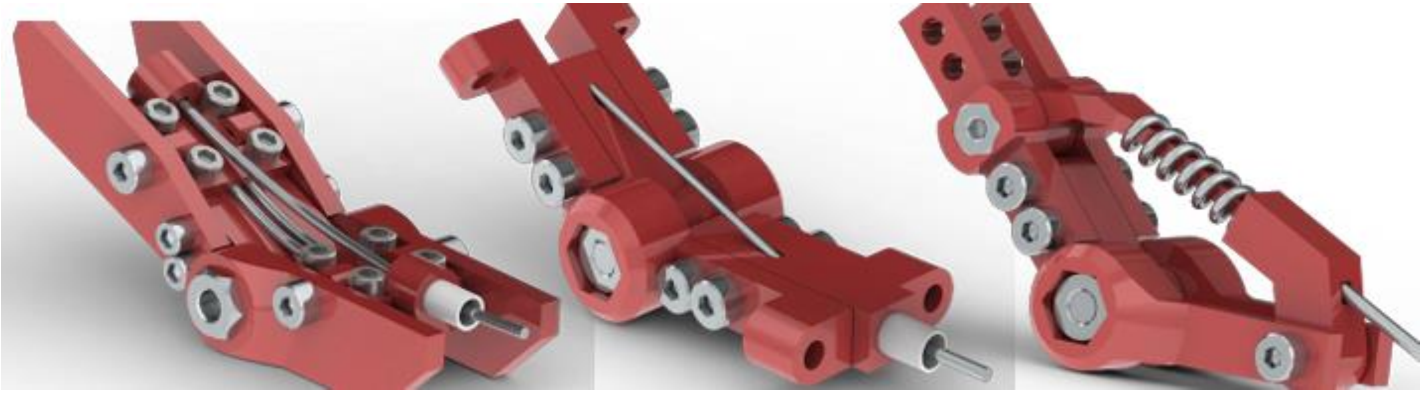
- The Biomimetic Mechatronic Hand Arm project Chhaya represents a groundbreaking initiative to redefine the capabilities of bionic hands.
- Current bionic hands face significant limitations in both control methods and functionality, often restricting users to basic movements such as simple opening and closing actions



OBJECTIVES

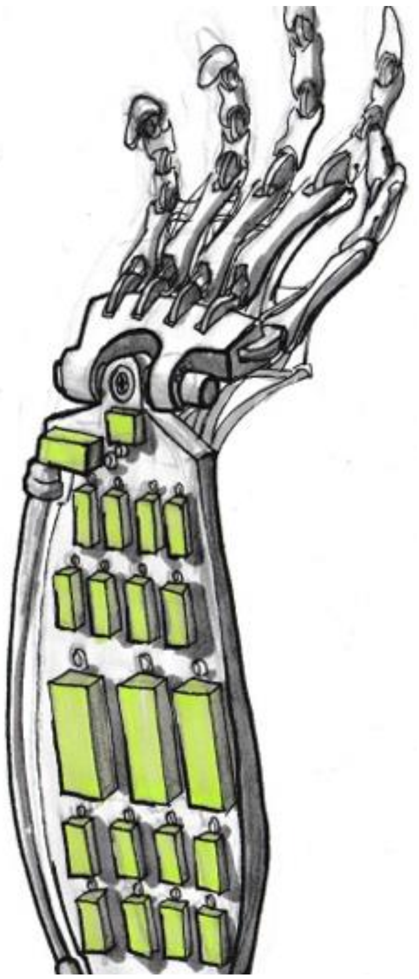
Main objective: develop a bionic hand with real human-like movement, speed, dexterity, and fluidity using open source image tracking to copy hand movement with minimum noise.

Secondary objective: design and develop a wearable controller for haptic feedback demonstration which can include touch and temperature sensing



CURRENT LIMITATIONS IN PROSTHETICS

1. *Control Methods:* Current models often rely on myoelectric technology, utilizing electrodes to detect nerve signals. This method can be restrictive and limits the range of motion and dexterity.
2. *Functionality:* Existing designs struggle to match the intricate and natural movements of a real human hand, resulting in reduced speed, range of motion, and fluidity.
3. *Haptic Response:* The lack of effective haptic feedback further hinders the user's ability to interact with the artificial hand and its surroundings in a nuanced manner.



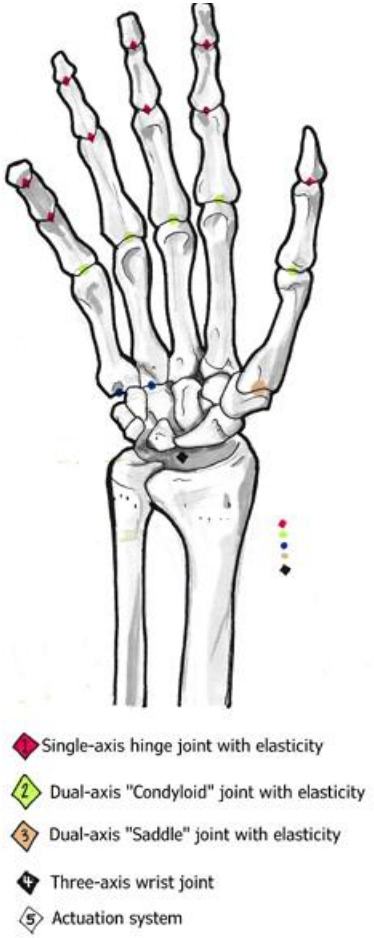
BIOMIMETIC MECHATRONIC HAND

- Most manufacturers of prosthetic hands limit their designs to have a much lower number of degrees of freedom because of considerations about power, space, weight and control, but as a biomimetic mechatronic hand, this project should aim to imitate the hand as closely as possible. We can approach this design by 2 different approaches
  - Cable Operated Bionic Hand Concept Servo
  - Integrated Motor Hand Design

  I would like to proceed with cable operated bionic hand with servo and utilize another integrated feedback system integrated within the knuckles

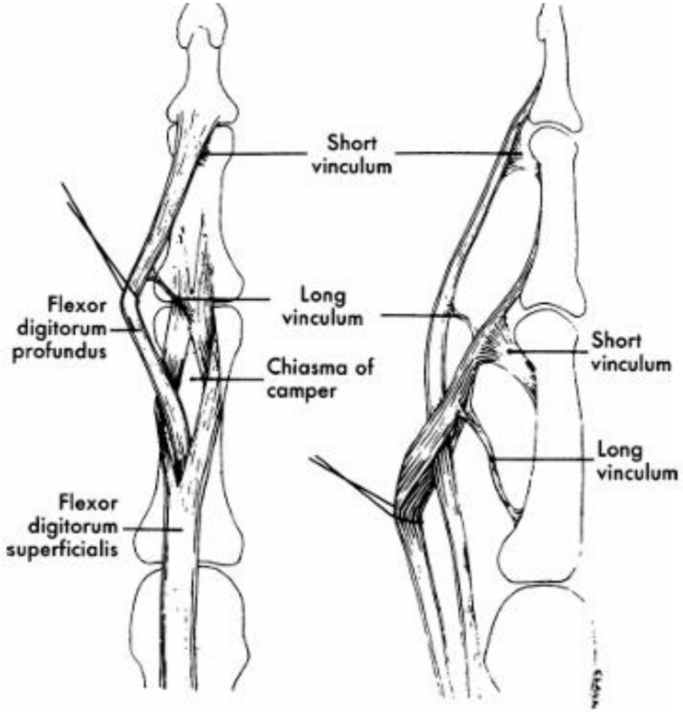
HUMAN HAND ANATOMY

- At the start a diagram of a human skeleton can be referenced to summaries the range of different joint types that needed to be designed.
- The human hand has 27 degrees of freedom: 4 in each finger, 3 for extension and flexion and one for abduction and adduction; the thumb is more complicated and has 5 DOF, leaving 6 DOF for the rotation and translation of the wrist. There are a total of 27 bones with 36 articulations and 39 active muscles



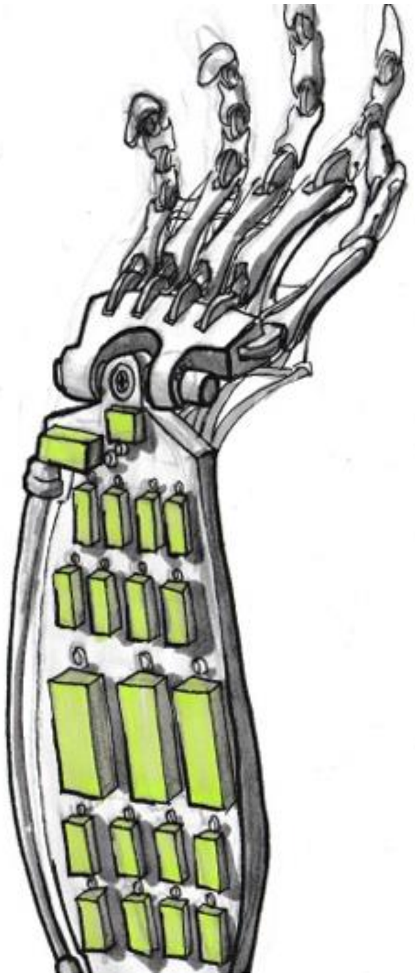
FINGER MECHANICS

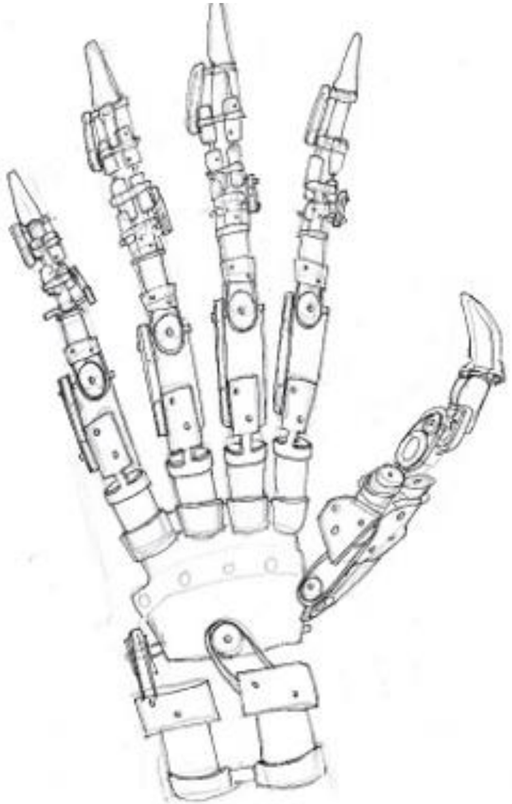
- Tendons for Flexion and Extension: The hand's flexion (bending) and extension (straightening) are enabled by tendons. These tendons allow for the movement of each finger segment, facilitating intricate hand motions. Flexor tendons decrease the angle between bones during bending, while extensor tendons increase the angle during extension.
- Extrinsic Extensor Muscles: The hand possesses nine extrinsic extensor muscles, crucial for finger extension. Notably, the extensor digitorum extends all fingers, the extensor digit minimi targets the little finger, and the extensor indicis focuses on the index finger. These muscles collectively contribute to the hand's dynamic range of movements.



DEVELOPMENT PROCESS

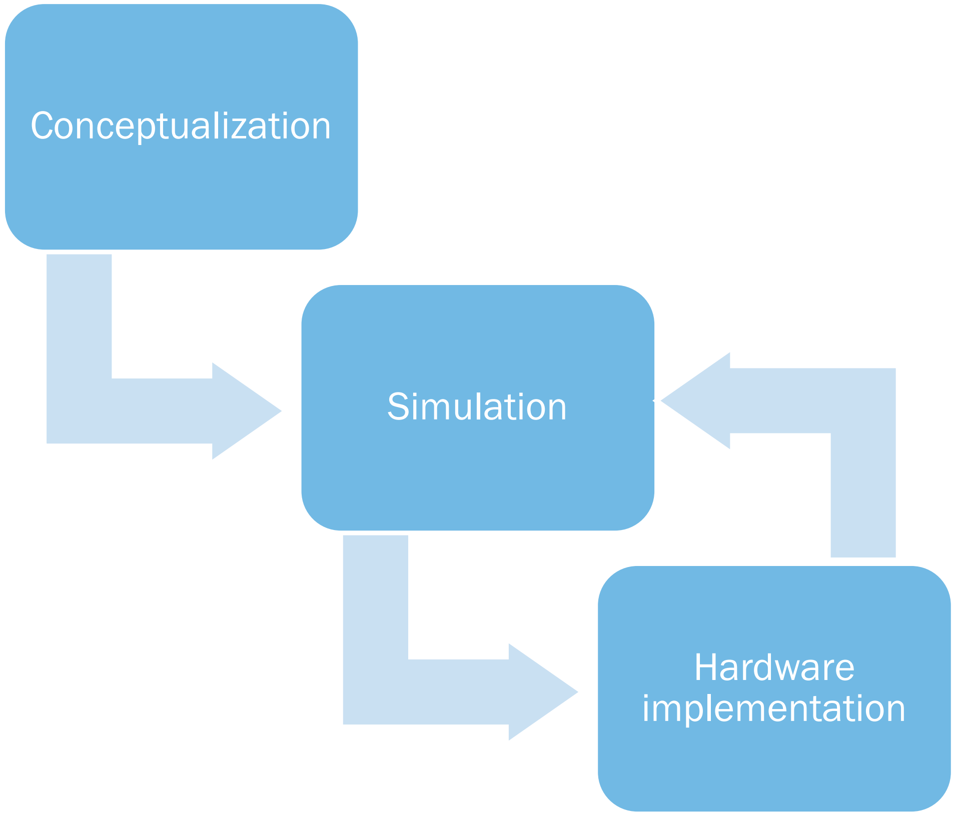
1. *Conceptualization:* Initial design concepts inspired by anatomical and biomechanical principles.
2. *Simulation:* Utilization of gazebo and simulations to test and refine the conceptual designs virtually, ensuring feasibility and functionality.
3. *Prototyping:* Transitioning from virtual models to physical prototypes through cad designing and implementation of 3D printing for rapid testing and adjustments.





DESIGN APPROACH

- The design process places a strong emphasis on anatomical and biomechanical principles to replicate the intricate structures and movements of the human hand.
- I want to utilize the pre-existing inmove hand and improving its feedback and haptic sensing
- The feedback loop between simulation, prototyping, and refinement ensures the final product is both efficient and biomimetic.

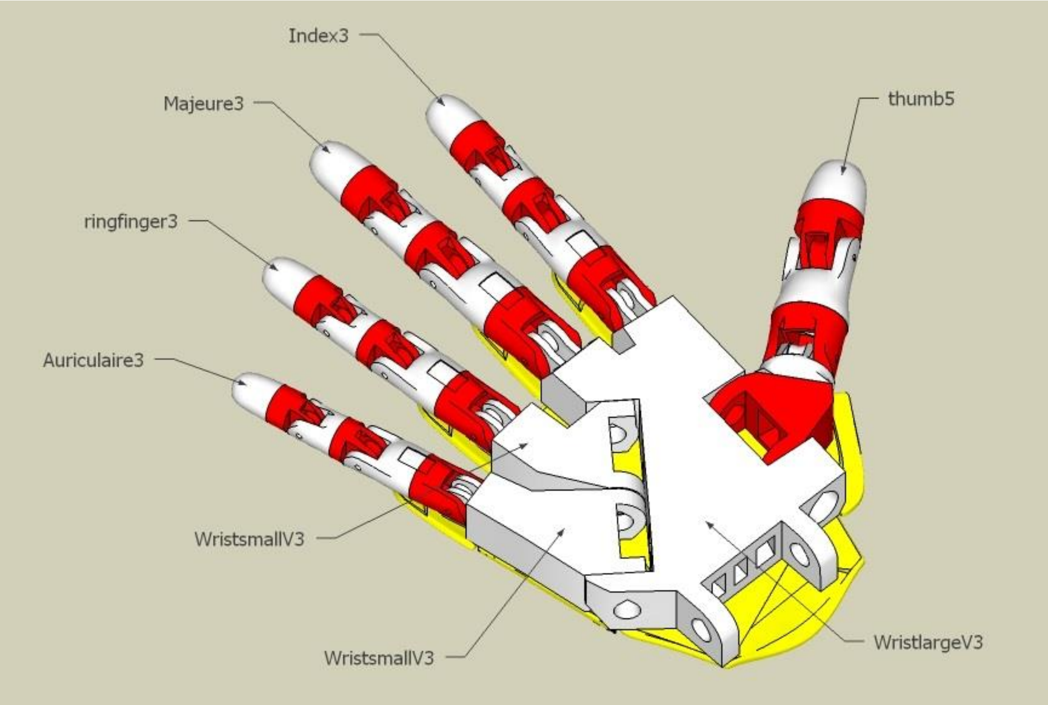


HAP-HAND CONTROL GLOVE

- **Control of Bionic Hand:** Hon's Hap-hand Control Glove serves as a sophisticated interface designed to control a bionic hand effectively.
- **Haptic Feedback Integration:** The glove is equipped not only for controlling the bionic hand but also for providing haptic feedback to the user.
- **Remote Robotics Control:** The main application of the Haphand Control Glove is in remote robotics control environments.

IN MOOV BIONIC HAND

- InMoov 3D Printable Hand: The InMoov is an open-source hand design, entirely 3D printable, making it affordable and accessible. Servos located in the forearm control finger movements via tendons. This innovative approach allows for a cost-effective yet functional biomimetic mechatronic hand, advancing prosthetics with servo-driven precision.



FUTURE DIRECTIONS

1. *Enhanced Sensory Integration:* Integrate advanced sensors for improved feedback, allowing the user to sense temperature, pressure, and texture through the artificial hand.
2. *Neural Interface Development:* Explore more advanced neural interfaces for seamless communication between the user's nervous system and the mechatronic hand, enhancing control and responsiveness.
3. *Miniaturization and Weight Reduction:* Work towards miniaturizing components and reducing overall weight, improving user comfort and wearability.
4. *AI Integration:* Investigate the incorporation of artificial intelligence for adaptive learning, allowing the hand to adapt its movements based on the user's behavior and preferences.
5. *Extended Range of Motion:* Research and implement mechanisms that expand the hand's range of motion, approaching the complexity and versatility of natural human hand movements.

REFERENCES

1. Nilheim Mechatronics Will Cogley 2018
2. Chappell, P, H (2016) Mechatronic Hands. London: The Institution of Engineering and Technology Plagenhoef, S., Evans, F.G. and Abdelnour, T. (1983) Anatomical data for analyzing human motion. Research Quarterly for Exercise and Sport 54, 169-178.

TIMELINE

Weeks	Tasks
Week 1, 2,	Conceptualization
Week 3, 4, 5, 6,	Simulation Implementation
Week 7, 8, 9,	Hardware conceptualization/ hardware acquiring
Week 10, 11, 12, 13, 14,	Hardware
Week 15.	Presentation / final changes

PRESENTATION FOR B.TECH. PROJECT TO BE IMPLEMENTED IN ACADEMIC WINTER AND SUMMER SEMESTER OF 2024, PRESENTED BY

KUMAR RISHAV