Mechanisms and Sensors for Robotic Fingers

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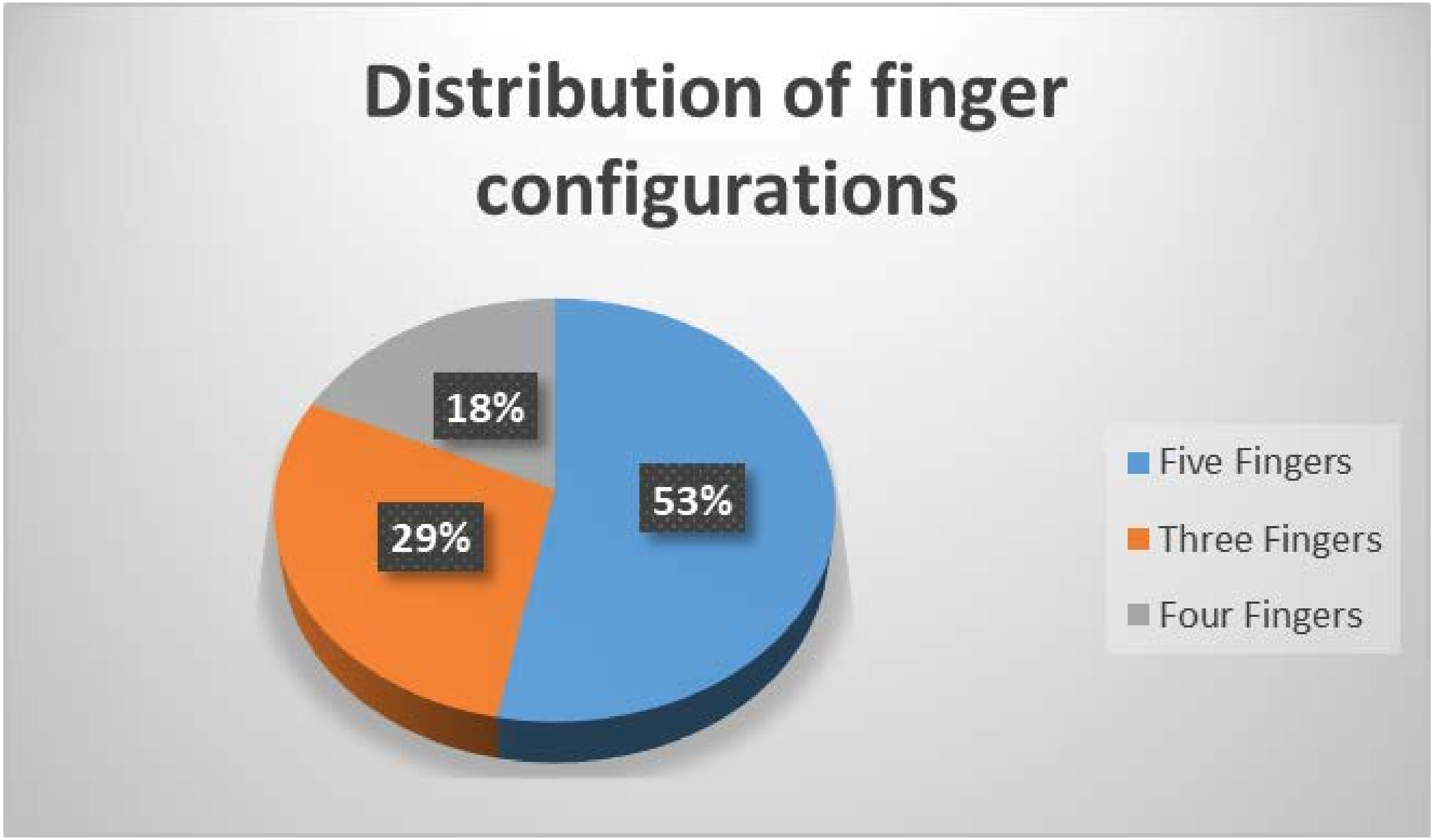
Contents

Introduction

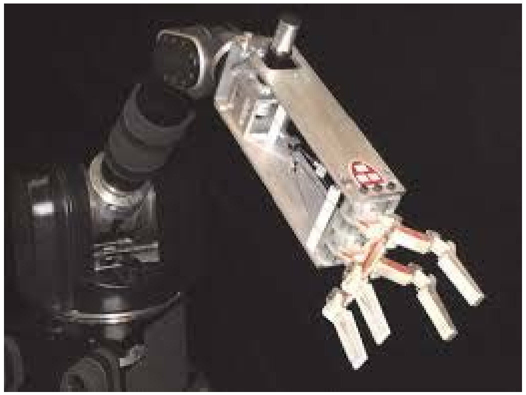
- **The human hand as an inspiration**
- **Goals and application**
  - Making a anthropomorphic hand (anthropomorphic approach)
  - Making an efficient manipulator (minimalistic approach)
- **Key issues discussed here**
  - Number of Fingers
  - Shape of the Fingertips
  - Compliant Joints
  - Built-in or Remote Actuation
  - Transmission System (in case of remote actuation)
  - Sensors
  - Materials and Manufacturing

Number of Fingers



Shape of the Fingertips

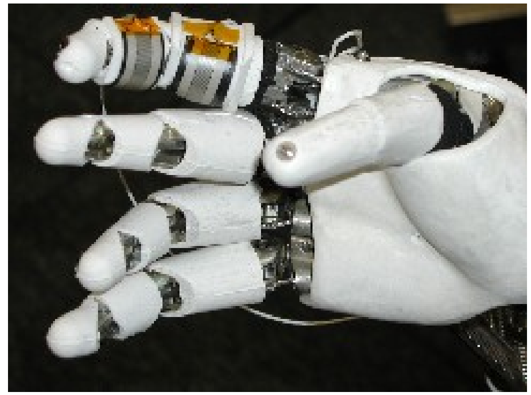
Flat



SDM Hand

Barrett Hand

Anthropomorphic



Robonaut Hand

Shadow Dextrous Hand

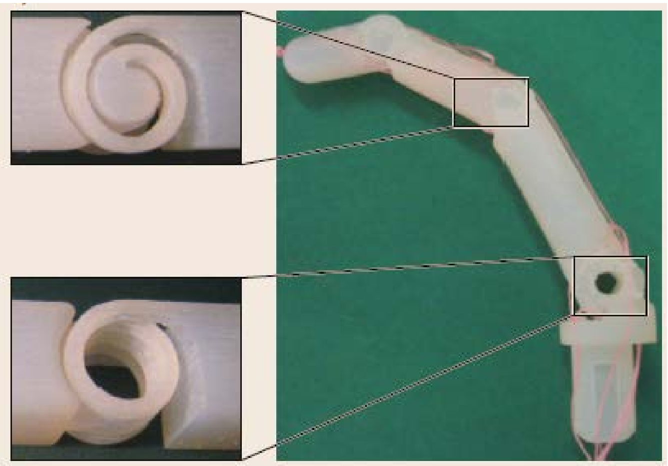
Cylindrical

CyberHand

Compliant Joints

The finger is obtained in a single teflon piece

joint compliance is achieved with metallic springs

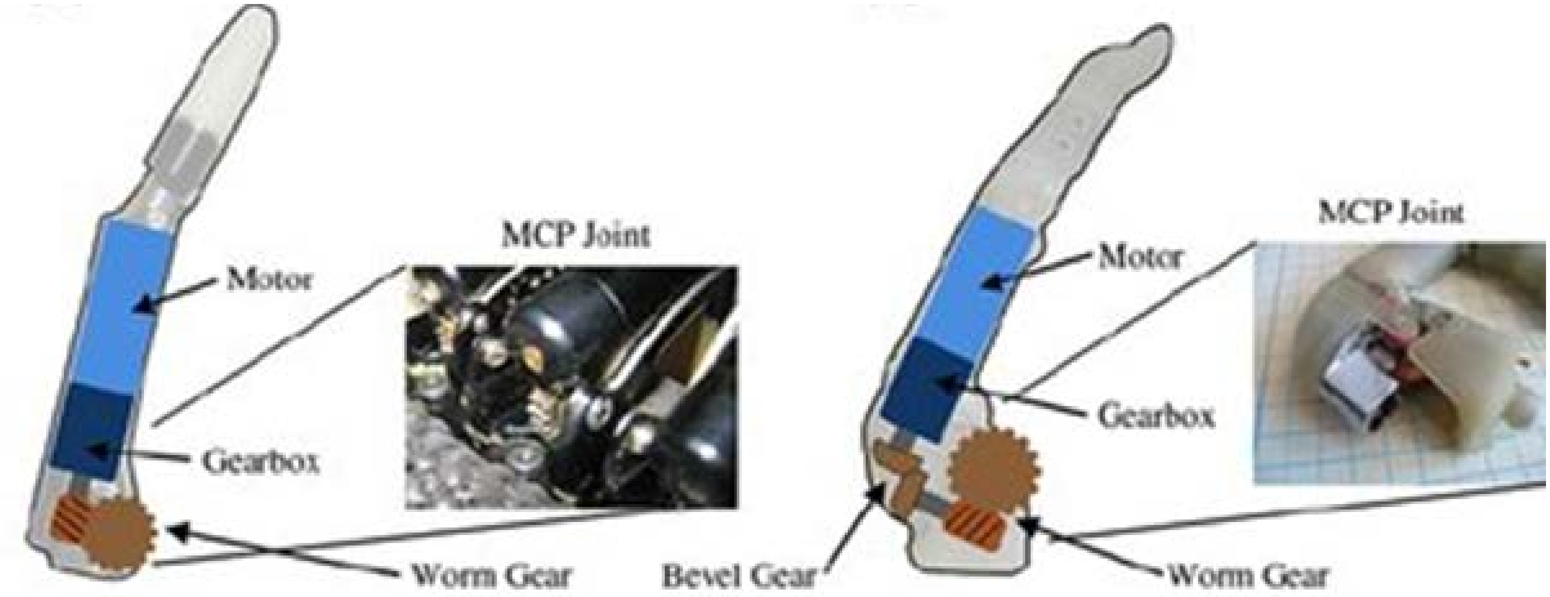


Rapid prototyping allows for different compliant mechanisms as joints

- reduce overall complexity
- withstanding large impacts without damage
- Rapid Prototyping
- Limited range of motion
- Axis Drif
- Stress Concentration

Built-in or Remote Actuation

- **Built-in Actuation:**
  - Simplifying mechanical configuration of the joint
  - Reducing the transmission chain complexity
  - Joint motion is kinematically independent with respect to other joints
  - Motors occupy a large room inside the finger structure



Vincent Finger Drive Mechanism

iLimb Finger Drive Mechanism

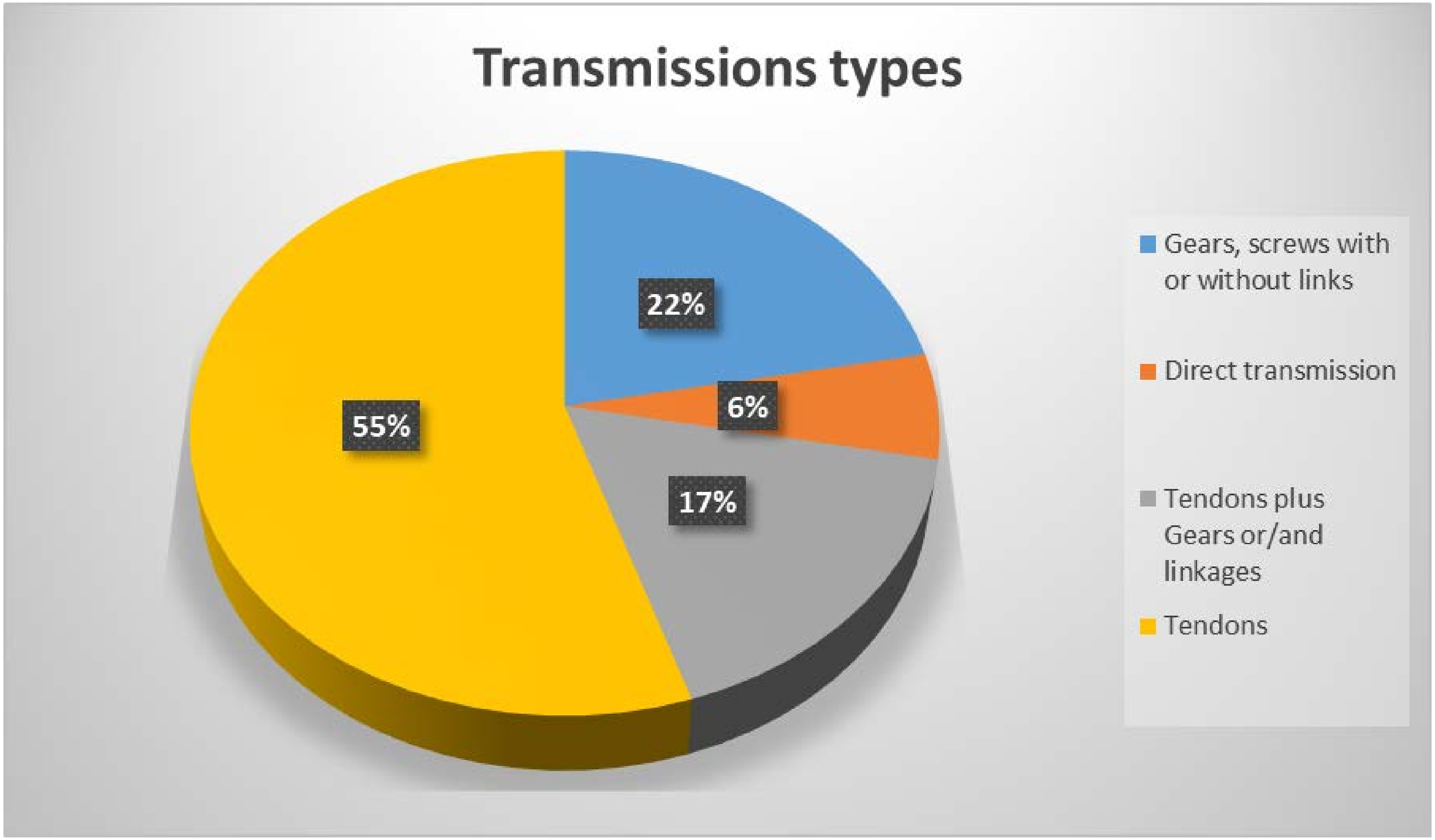
Transmission

- **Flexible Link Transmission**
  - pulley-routed flexible elements (tendons, chains, belts)
  - sheath-routed flexible elements (mainly tendon-like elements)

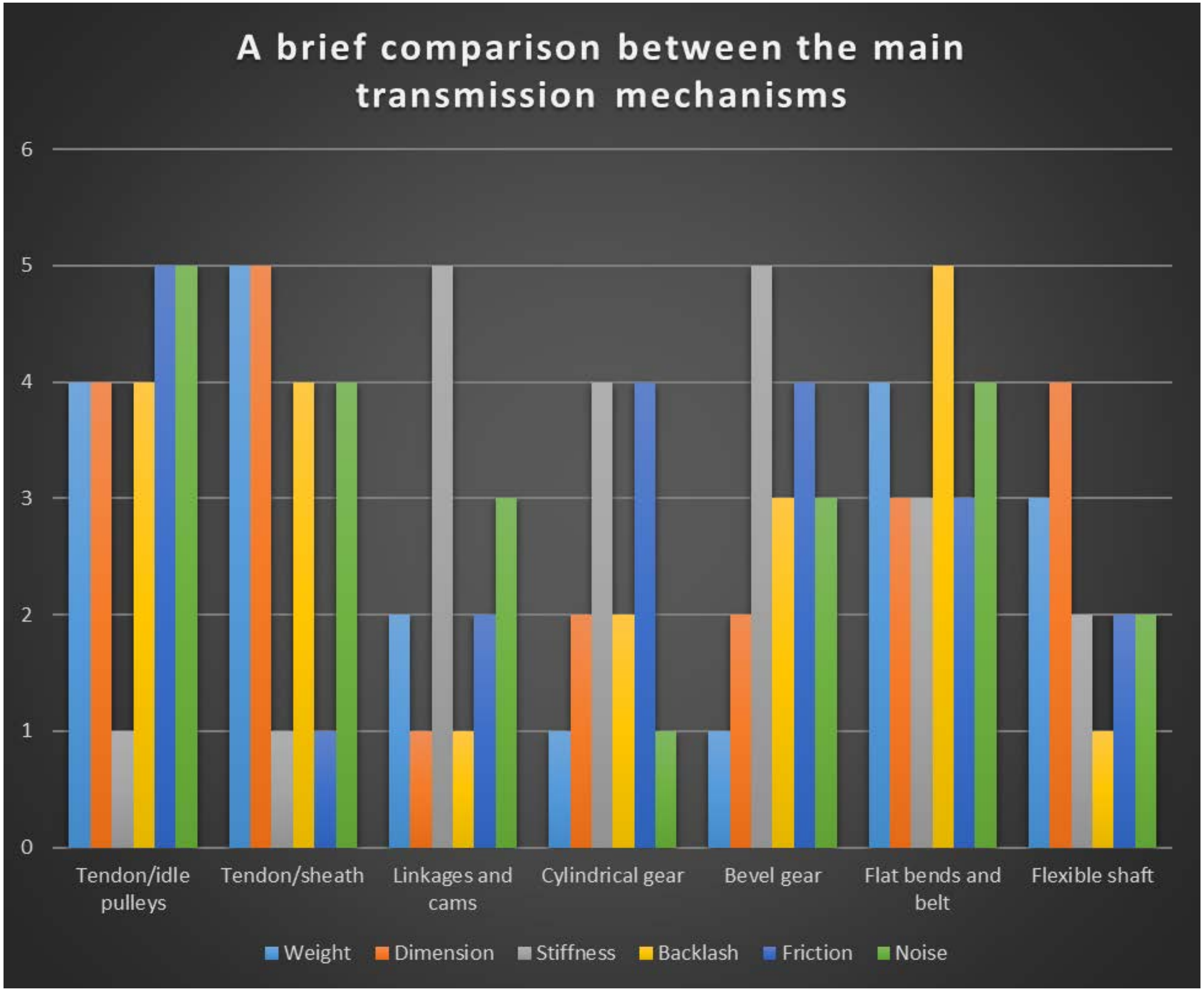
  - Actuators located remotely from joints
  - Achieving two-way control requires a pair (increased complexity)

- **Rigid Link Transmission**
  - best stiffness proprieties to the transmission
  - low maintenance
  - bidirectional control of the joint

Transmission



Transmission



Sensors

- **Proprioceptive Sensors**
  - Measures physical information related to the **state** of the device itself (e.g., position, velocity, and so on)

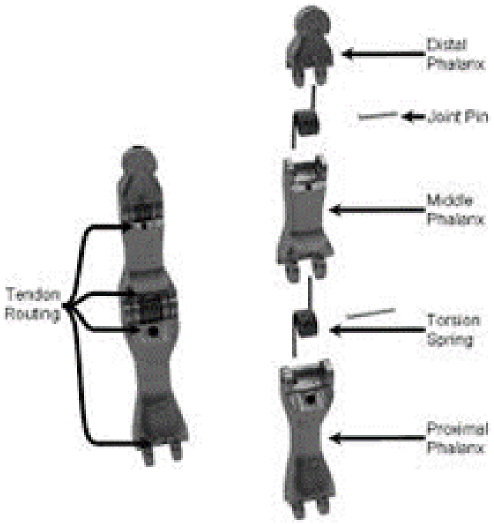
- **Exteroceptive Sensors**
  - Measures the data related to the **interaction** with objects/environment (e.g., applied forces/torques, friction, shape, and so on)

- **Tactile Sensors**
  - It provides information about forces of interaction and surface properties at **points of contact** between the robot fingers and the objects.
  - The types of information that may be obtained from a tactile sensor are: Contact, force, simple geometrical information, main geometrical features of the object, mechanical properties and slip condition

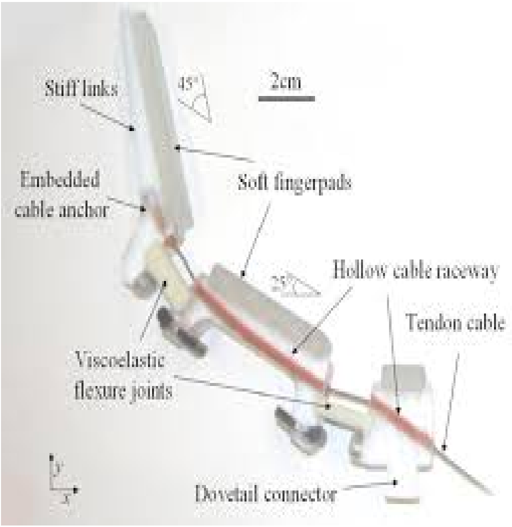
Materials and Manufacturing

- Traditional machinery techniques is a rather long and expensive process
- Rapid prototyping techniques provides several advantages
  - The chance to develop parts with complex geometry

Selective Laser Sintering (SLS)



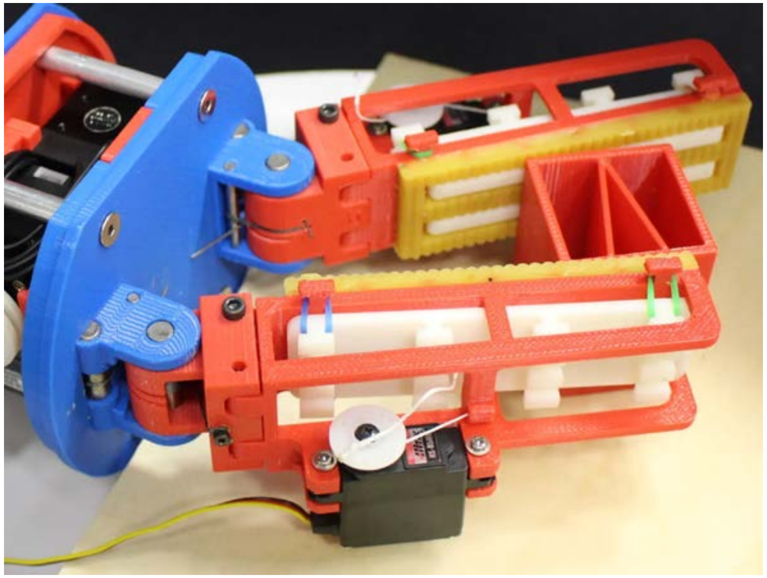
high-strength, nickel-coated thermoplastic



polymer-based Shape Deposition Manufacturing (SDM)

Future Trends

- Development of artificial skins with denser spatial resolution and a multitude of sensor modalities.
- Using soft and compliant materials like when the hand is used to interact with humans

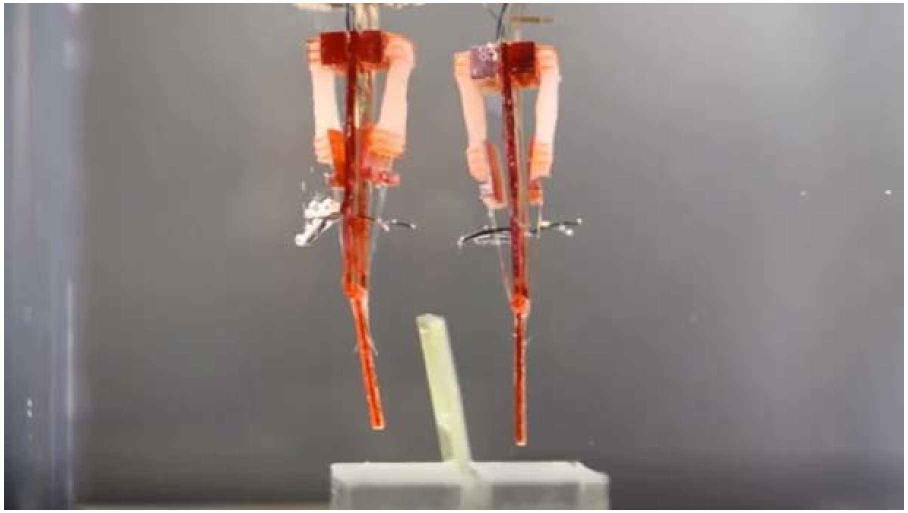


Robotic finger with both high and low friction surfaces

Bio-inspired sensor skin

Future Trends

- Sensors employed in smartphones will be employed by the artificial hands driving costs down and increasing reliability
- Biohybrid robotics
- Standardization



Integrating living muscle tissue
into robots

Conclusion

- The human hand as an inspiration
- The crucial role of robot fingers
- Key Issues in choosing suitable configurations
- Standarization

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