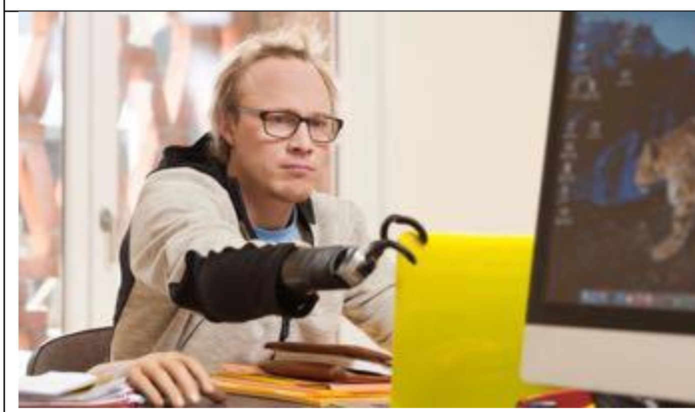
# LECTURES 11-12: TYPES OF PROCETHESIS CONTROL

| | |
|---|---|
|  |  |
| **No control** | **Cable operated (body powered)** |
|  |  |
| **Myoelectric** | **Robotic** |

## 11.1 Control-Cable Mechanisms for Upper Limb

### 11.1.1 Control-cable mechanisms

Body-powered prosthetic limbs use cables to link movements of 1 part of the body to the prosthesis in order to control a prosthetic function. This usually is a movement of the humerus, shoulder, or chest, which is transferred via a Bowden cable (a single cable passing through a single housing) to activate the terminal device of the prosthesis.

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A control cable used to activate a single prosthetic component or function is called a single-control cable, or Bowden cable system.

A dual–control-cable system uses the same cable to control 2 prosthetic functions (such as flexion of the elbow and, when the elbow is locked, activation of the terminal device). This latter control cable setup is accomplished with a single cable passing through two separate cables.

## 11.2 Body movements that are captured for prosthetic control

- **Glenohumeral forward flexion**
- **Biscapular abduction (chest expansion**.
- **Glenohumeral depression/elevation, extension, abduction**

### 11.3 The Terminal Device

The major function of the hand that a prosthesis tries to replicate is grip (prehension). The 5 different types of grips are as follows

- **Precision grip**
- **Tripod grip**
- **Lateral grip**
- **Hook power grip**
- **Spherical grip**

### 11.3.1 Terminal devices generally are broken down into 2 categories:

- **Passive terminal devices**
    - Passive terminal devices fall into two classes, those designed primarily for function and those to provide cosmesis. Examples of the functional passive terminal devices include the child mitt frequently used on an infant's first prosthesis to facilitate

crawling or the ball handling terminal devices used by older children and adults for ball sports. The main advantage of most passive terminal devices is their cosmetic appearance. With newer advances in materials and design, some passive hands are virtually indistinguishable from the native hand. However, most of these cosmetic passive terminal devices usually are less functional and more expensive than active terminal devices.

- **Active terminal devices**
  - Active terminal devices usually are more functional than cosmetic; however, in the near future, active devices that are equally cosmetic and functional may be available. Active devices can be broken down into 2 main categories: hook (and similarly specialized function) terminal devices and prosthetic hands. There are designs of both of these terminal device groups available to operate with cable or externally powered prostheses.

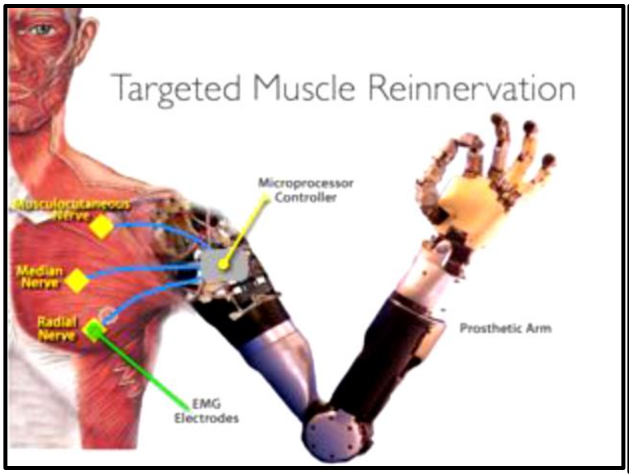
### 11.4 The Myoelectric Prosthesis Control:

- Electrodes pick up microvolts of electricity produced by contractions in the muscles of the residual limb.
- Signals are amplified and thereafter they activate the motor
- In operating a hand there may be two electrodes, one on extensor muscles and one of flexor muscles groups, for opening and closing the hand

## 11.5 Robotic Prosthesis Control:

- Peripheral invasive

- Targeted muscle reinnervation

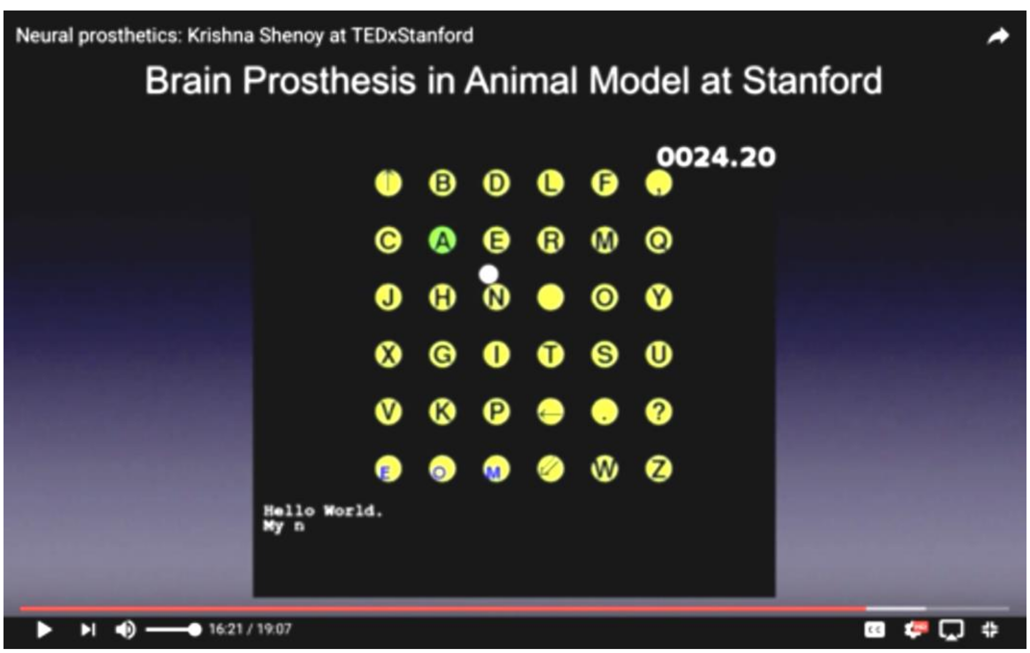




- **Targeted muscle reinnervation**
  - Provides an **organized** afferent pathway
  - Offers strong causal link between sensation and perception
  - Minimizes need for CNS plasticity
  - Provides a **natural** afferent pathway
  - Near-normal thresholds for temperature, light touch, sharp/dull and pressure have been demonstrated
  - Yet, there are many challenges and unknowns:
  - Density and types of mechanoreceptors in reinnervated skin unknown

- No evidence of kinesthetic sensing
- Relevance to proprioception unclear
- Sensation of finger pads has not been reported
- Relationship to reinnervated muscle unclear

- **Brain implant**



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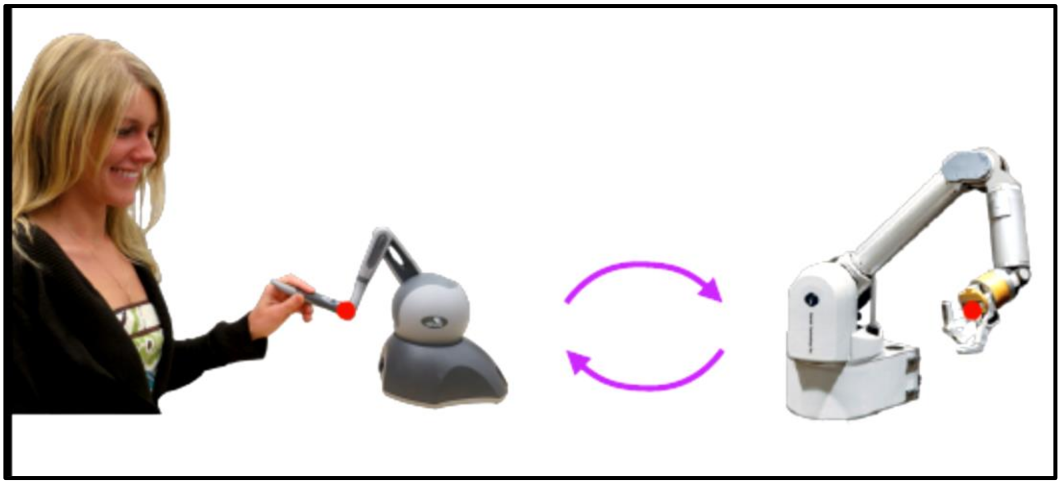

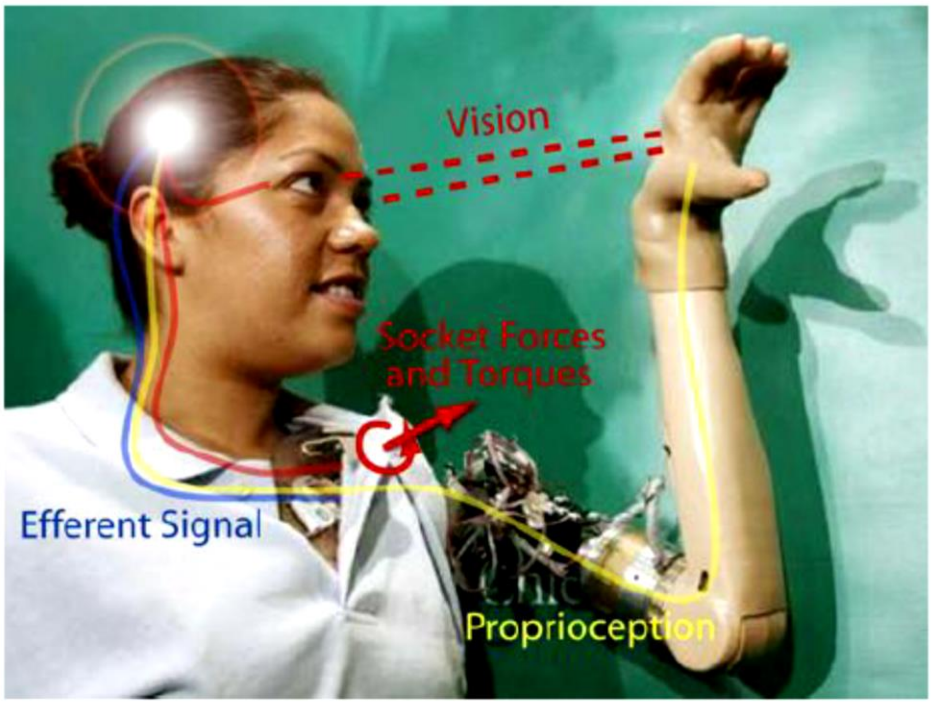

- **Role of vision and proprioception**