Upper Body Myoelectric Powered Prostheses

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Topics

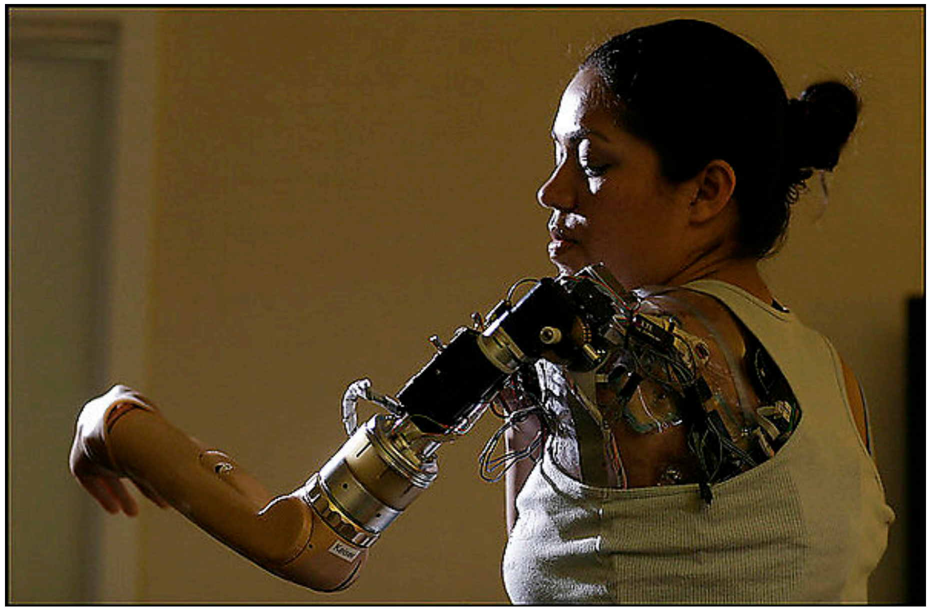
- EMG Acquisition
- Prostheses Training
- Reinnervation: what and why?
- Current Powered Prosthetics

Unpowered solution

Purely Mechanical Hand:

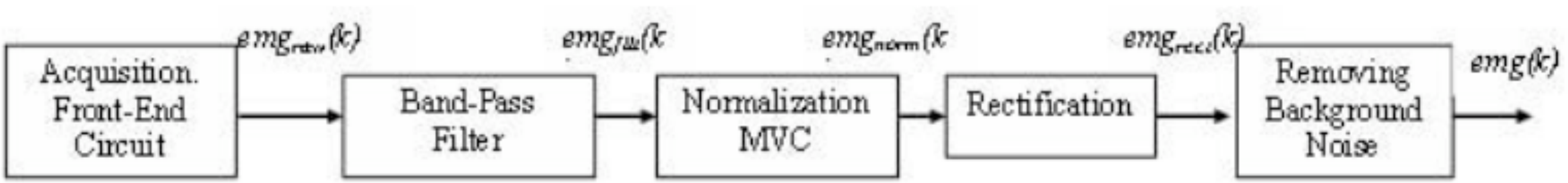
- Easy to attach/detach
- Limited function
- Lacking in Physical appearance

Powered Solution



- Closer in appearance and function to that of a human arm
- Relies off of EMG signals for function

EMG Acquisition



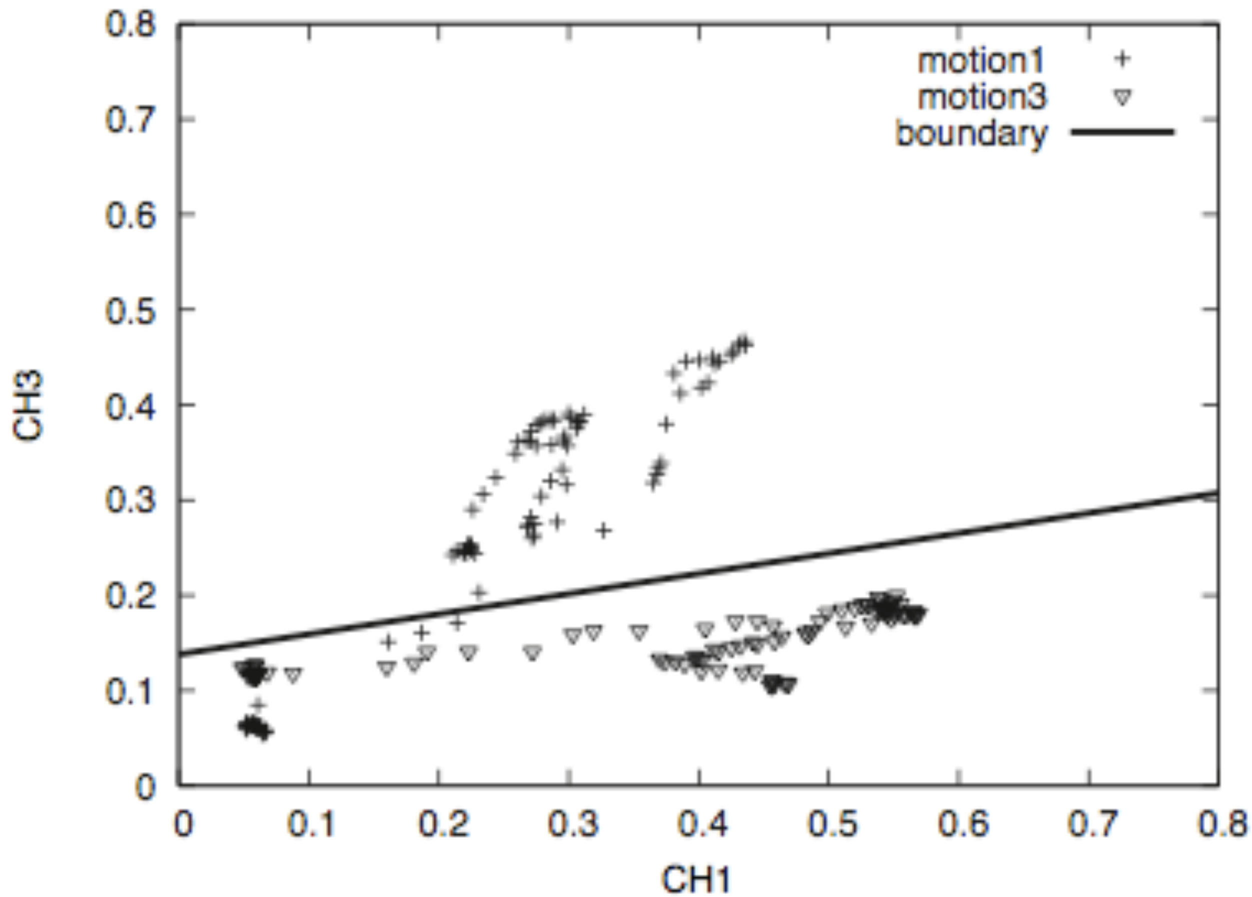
- 6^{th} order butterworth Band Pass (10-500) Hz
- MVC (maximum voluntary contraction or strength) Normalized
- Eliminate background noise using threshold – motors not always on
- Then Apply Algorithms

Filtering Algorithms

- Variance weighted average
  - Multiply each signal by normalized weight dependant upon the variance
- Kalman Filter
  - Instantaneous Variance and Mean are recursively computed and combined to produce final result

(1)

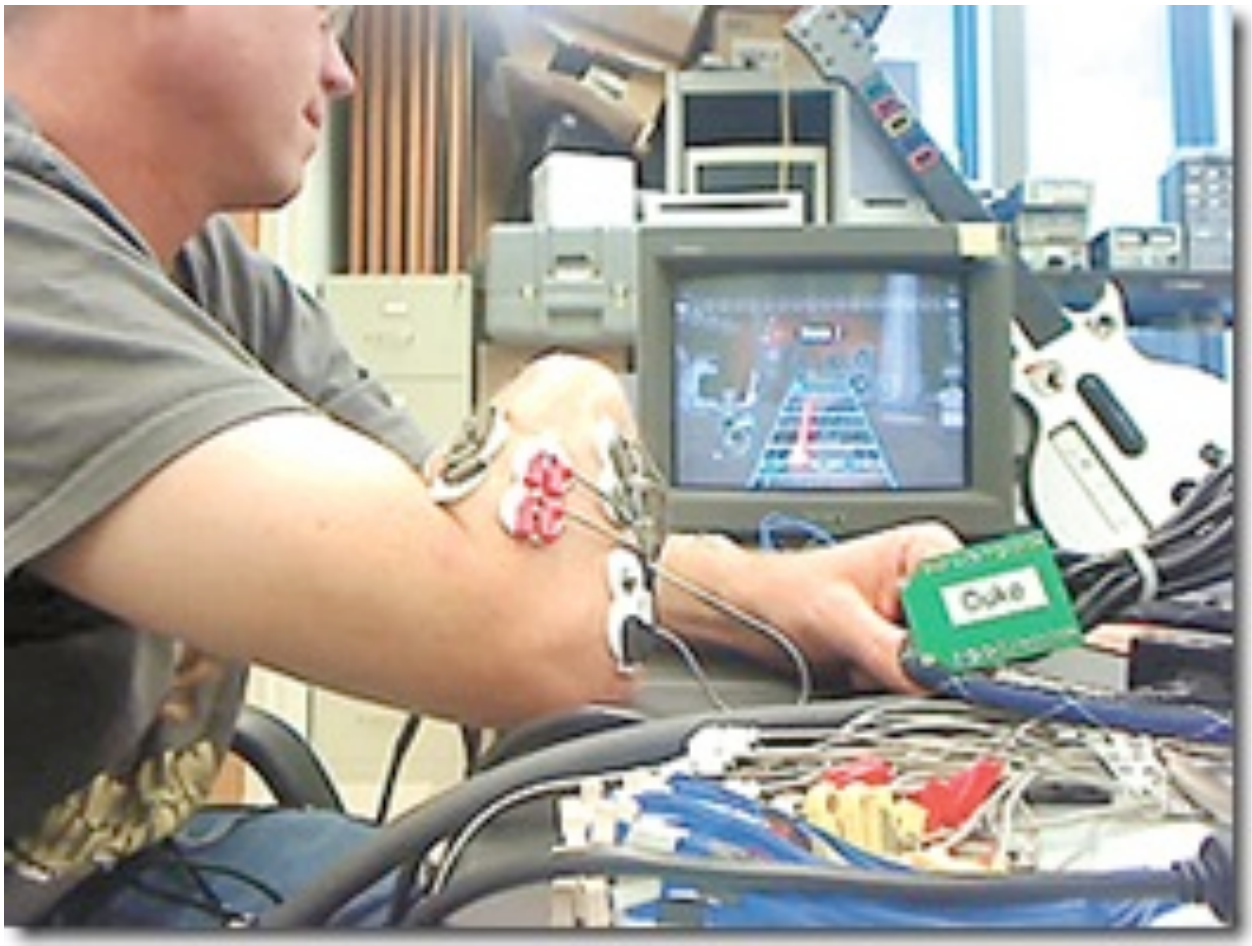
Training



Classifier

- Train on set of disjoint and interlaced data points
- Feed Forward ANN, linear, k-NN

Air guitar hero



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Reinnervation

- Nerves that provided motor control in amputated limb are rerouted to the remaining arm and chest muscles.
- The target muscles are denervated in the surgery so that the transferred nerves can then reinnervate these muscles

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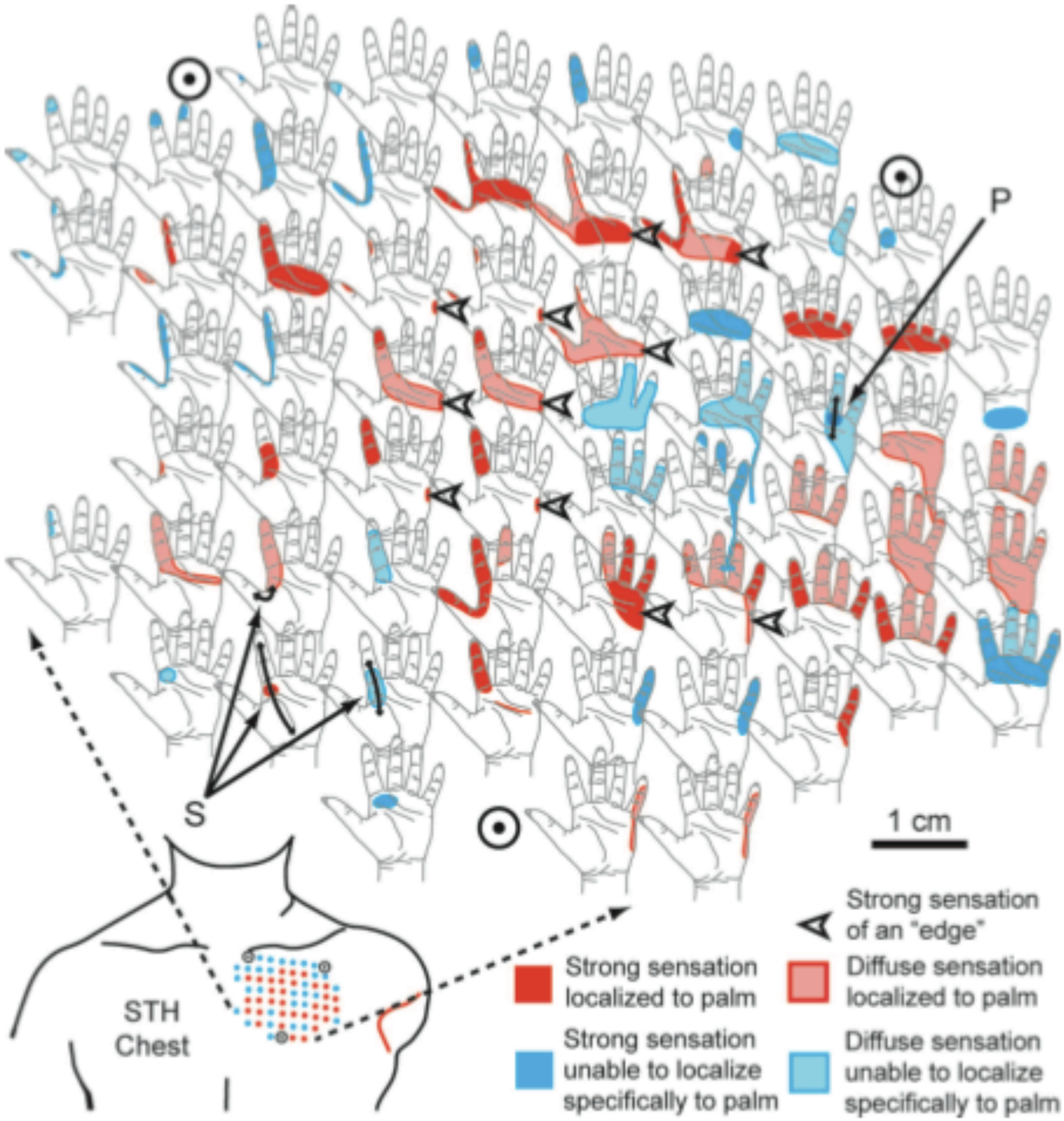
P
S
1 cm
STH
Chest
Strong sensation of an "edge"
Strong sensation localized to palm
Diffuse sensation localized to palm
Strong sensation unable to localize specifically to palm
Diffuse sensation unable to localize specifically to palm

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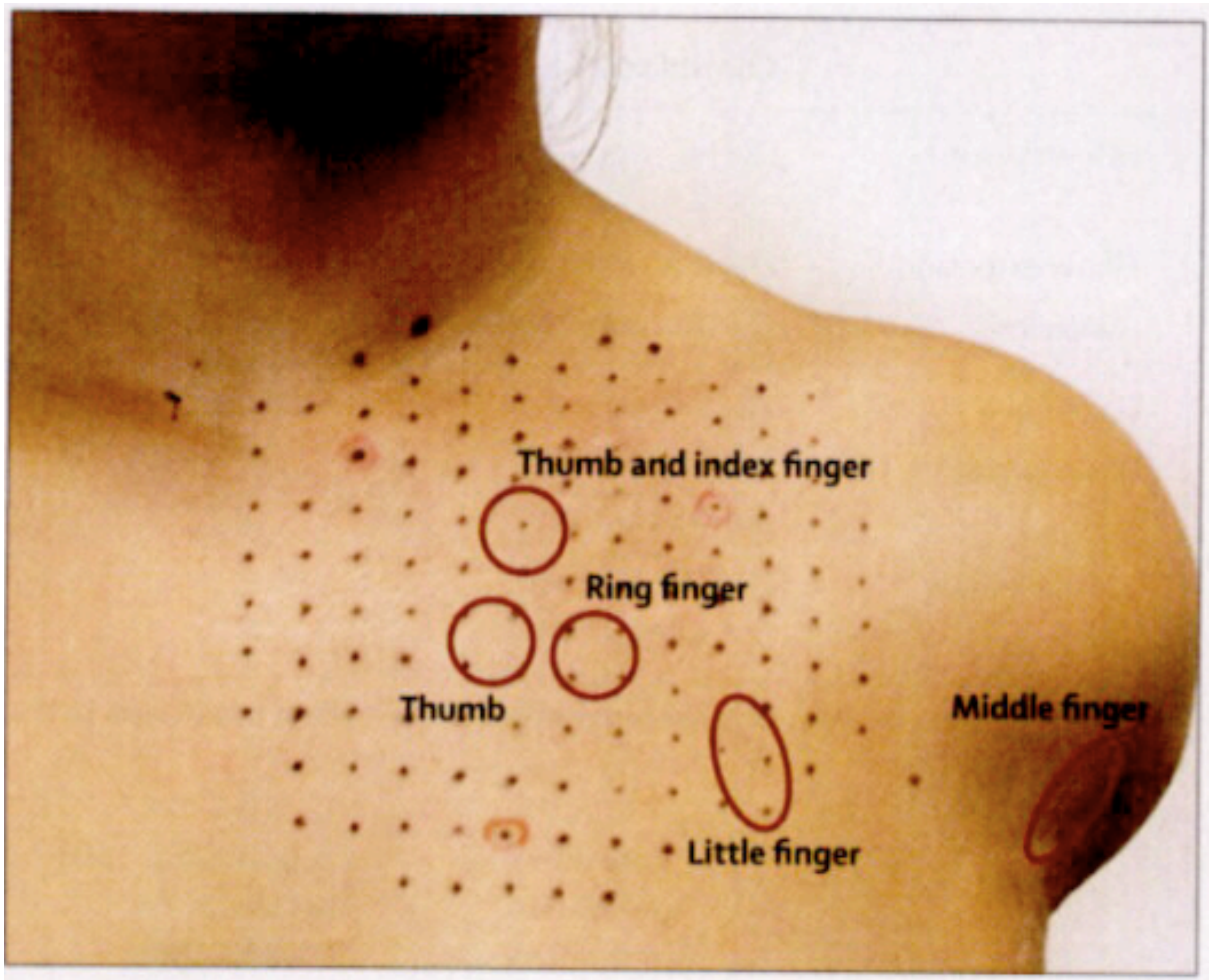
Results

- Sensory reinnervation 3-4 months after surgery
- Cold and warm sensation in reinnervated area


Thumb and index finger
Ring finger
Thumb
Middle finger
Little finger

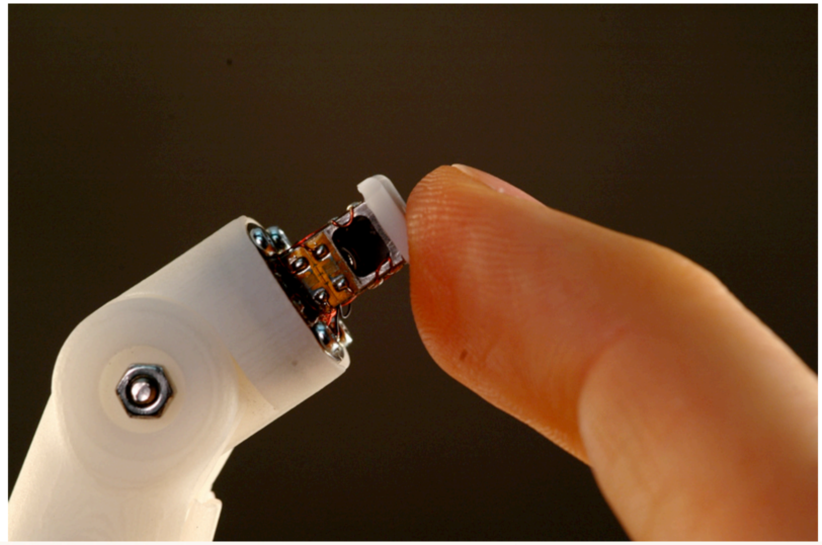
(10)

Purpose

- Allow more room for electrode placement
  - More degrees of freedom can be achieved
- Sensory feedback
  - Use of “Tactor” sensor enables:
    - Pressure and texture
    - Prevent slippage of grasp and crushing
      - Also possible by measuring current of motors (2)

Tactor

Input Sensor



Output sensor

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Implantable Myoelectric Sensors

- Low crosstalk, high impedance
- Allow more electrodes = more degrees of freedom
- Electrodes will not have to be added when prostheses is put on

(8)

- Electrodes:
  - 8 bit resolution @ 1000 samples/second
  - Powered by 121-kHz magnetic field
- Telemetry Controller
  - Receives and process electrode data
  - Placed within prosthetic socket with power coil

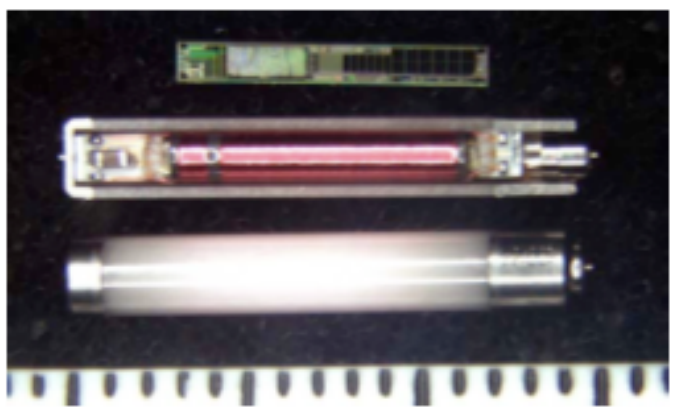

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Fig. 5. Photograph of IMES components in three assembly states. (Top) IMES silicon chip. (Middle) Sectioned IMES capsule containing IMES subassembly. (Bottom) Completed IMES implant. Shown next to 1 mm scale.

Current Prosthetics

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- Weight = 6kg
- 4-5/day hours of use
- 6 degrees of freedom

“Luke” arm

“Luke” arm

- 3.6 kg (average female arm weight)
- 18 degrees of freedom (human has about 25)
- Foot pedal controls
- Goal :
  - 18 hour battery life
  - 22 degrees of freedom
  - Myoelectric control with implantable electrodes

(9)

APL Myoelectric hand

(9)

Summary

- Using EMG signal for prostheses
- Training
- Reinnervation
- Developing prosthetics

Bibliography

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