



Teden  
možganov 2018

**Na sanjah  
svet stoji**

## **ZAZNAVANJE S POMOČJO ROBOTIKE KOGNITIVNA POVRATNA INFORMACIJA V INTERAKCIJI ČLOVEK-ROBOT**

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Univerza v Ljubljani*



**VZAJEMNA**  
zdravstvena zavarovalnica

**FENS**

Federation of  
European  
Neuroscience  
Societies



**TEDEN  
MOŽGANOV**



**SiNAPSA**  
SLOVENSKO DRUŠTVO ZA NEVROZ/ANOST  
SLOVENIAN NEUROSCIENCE ASSOCIATION



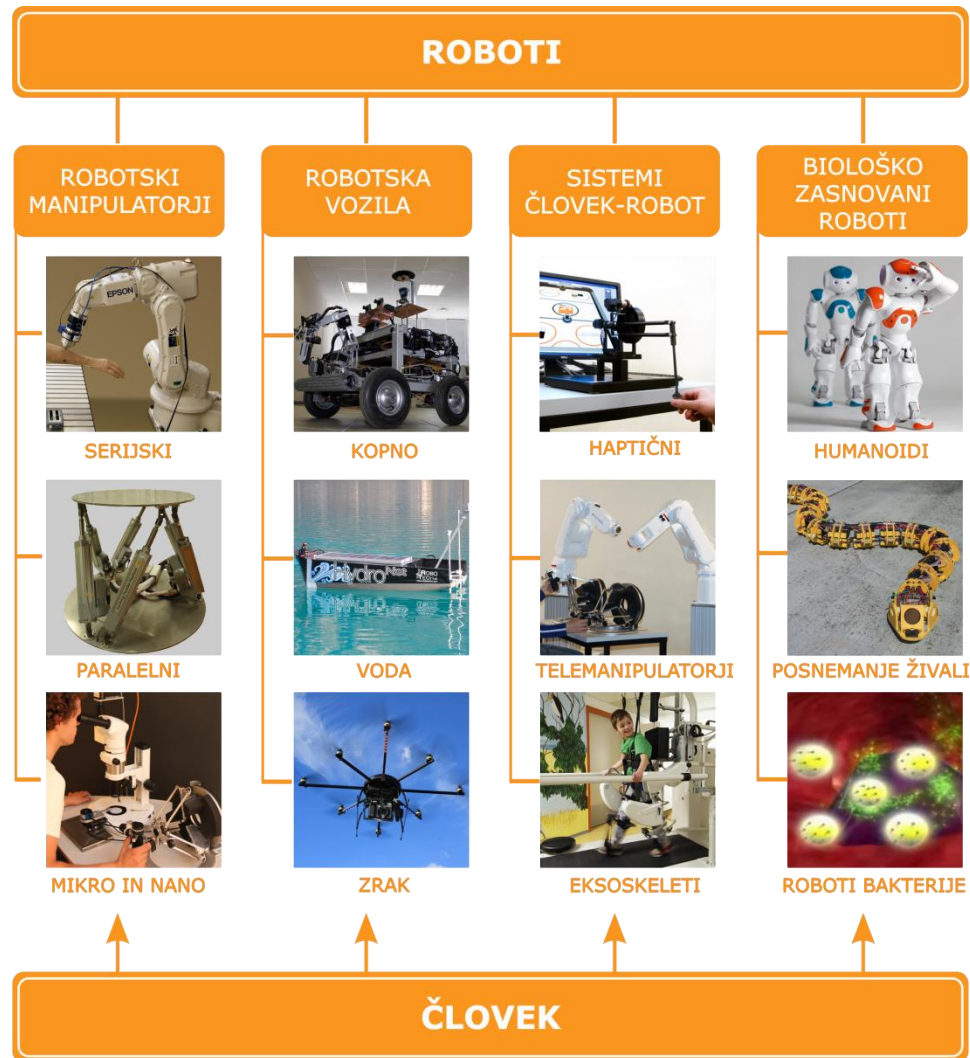
za **možgane**

THE  
**DANA**  
FOUNDATION

12.–18. marec



# ROBOTIKA

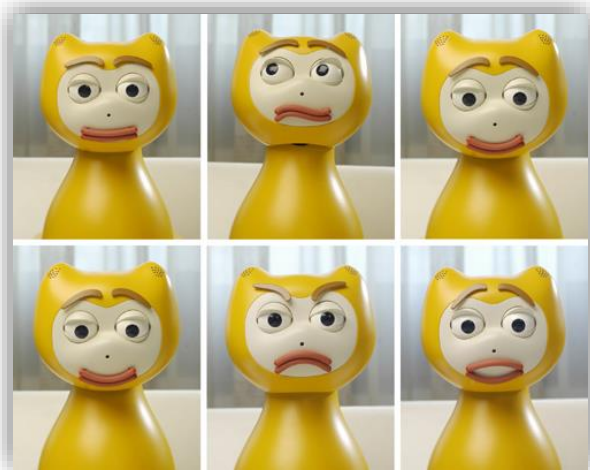


# ROBOTIKA ZA ZDRAVJE IN DOBRO POČUTJE

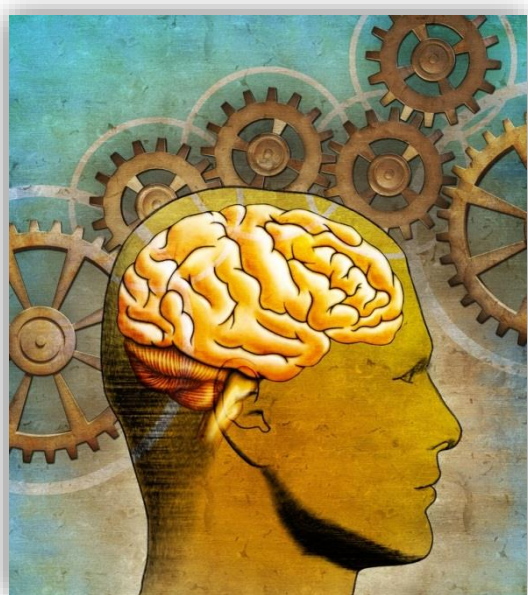




## TRIJE VIDIKI INTERAKCIJE ČLOVEKA Z ROBOTOM



**(socialna)sHRI** – robot sodeluje in komunicira z ljudmi v skladu z vedenjskimi normami, ki jih pričakujemo od ljudi, s katerimi robot sodeluje



**(kognitivna)cHRI** – dvosmerna večmodalna komunikacija in razumevanje



**(fizična)pHRI** – izmenjava sile (moči) preko fizičnega stika in usklajeno fizično delovanje

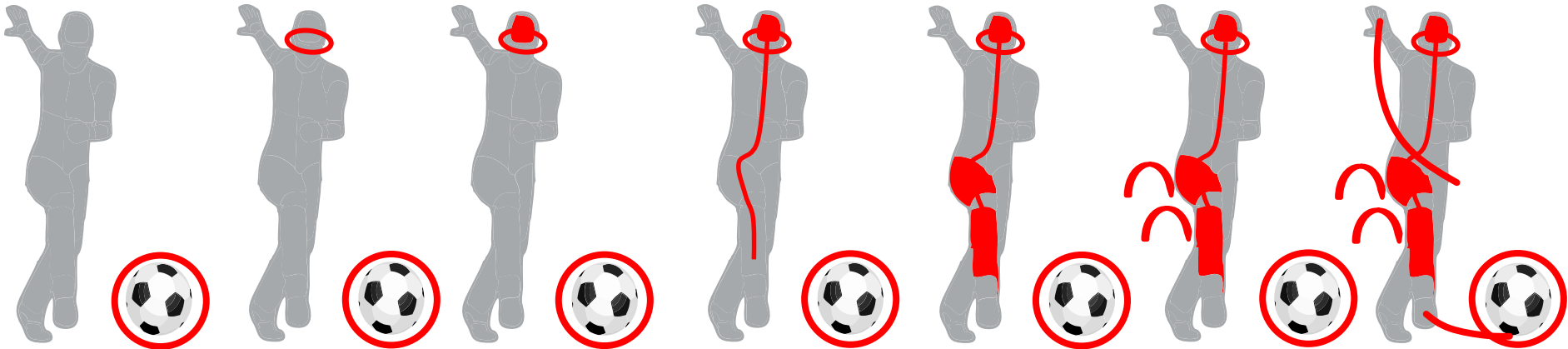
# *KOMUNIKACIJA ČLOVEK-ROBOT: EKSPLICITNA – IMPLICITNA*

- **Eksplicitna komunikacija** je opredeljena kot komunikacija, kjer
  - oseba aktivno podaja ukaze napravi (govor, gibanje, sile) in
  - naprava posreduje povratne informacije v eksplicitni obliki (zvok, slika, sile).
  
- **Implicitna komunikacija** je opredeljena kot komunikacija, kjer
  - naprava samodejno zaznava aktivnosti in stanje osebe ter
  - posreduje povratne informacije osebi na intuitiven naraven način.

# IMPLICITNA KOMUNIKACIJA – OD ČLOVEKA K ROBOTU



# IMPLICITNA KOMUNIKACIJA – OD ČLOVEKA K ROBOTU



**T-10 s**  
(Okoljski kontekst)

**T-1 s**  
(Opazovani dogodki)

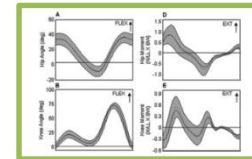
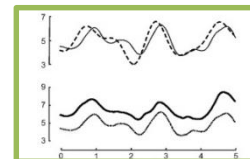
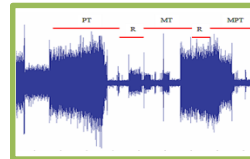
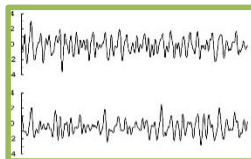
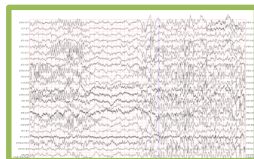
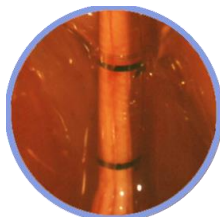
**T-300 ms**  
(EEG aktivnost)

**T-150 ms**  
(ENG aktivnost)

**T-100 ms**  
(EMG aktivnost)

**T-50 ms**  
(Navor)

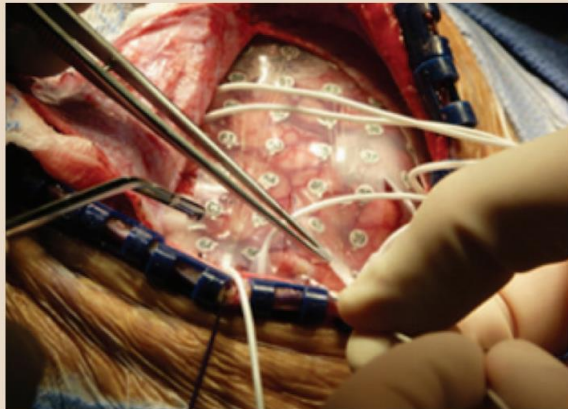
**T-0 ms**  
(Gibanje)



**Vira:** „How to Build a Bionic Man“, *Channel 4 dokumentarni film*, 2013 in  
„Introducing the worlds first Myo-controlled prosthetic arm“, *Johns Hopkins Applied Physic Lab in Thalmic Labs Inc.*



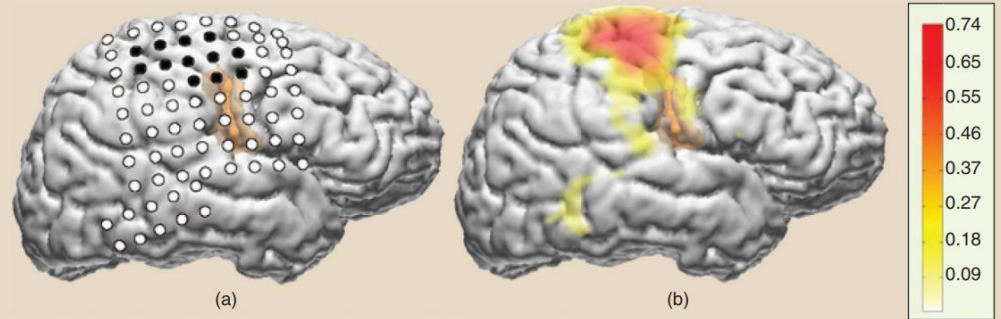
# ELEKTROKORTIKOGRAFIJA



(a)

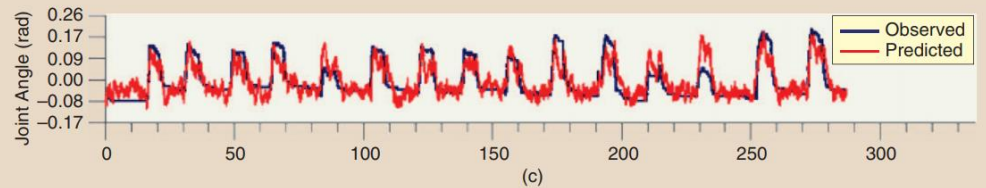


(b)



(a)

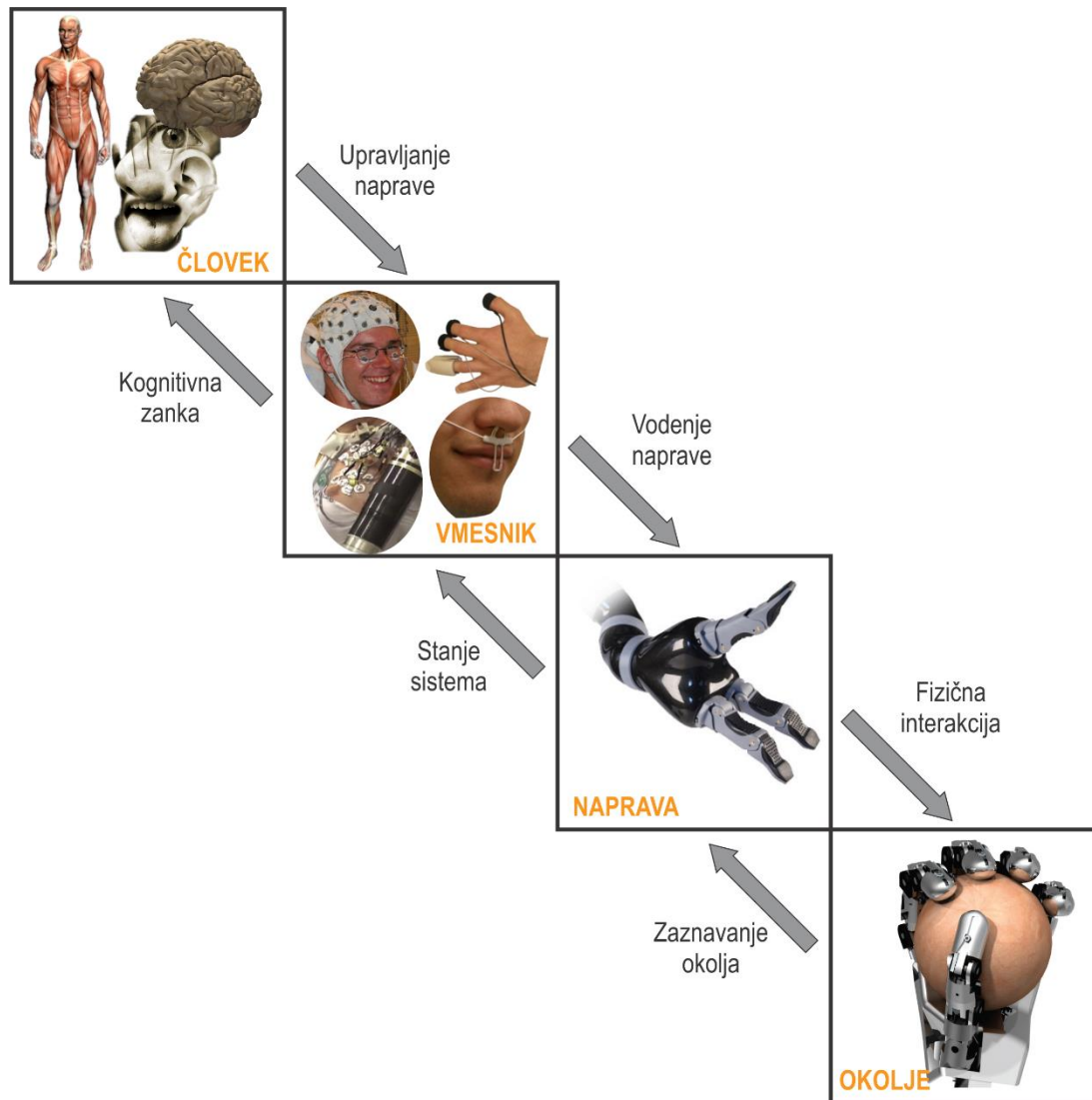
(b)



(c)

M. S. Fifer, S. Acharya, H. L. Benz, M. Mollazadeh, N. E. Crone, Nitish V. Thakor, „Toward Electrocortical Control of a Dexterous Upper Limb Prosthesis: Building Brain-Machine Interfaces“, *IEEE Pulse*, 2012

# INTERAKCIJA ČLOVEK-ROBOT - „ČLOVEK V ZANKI“



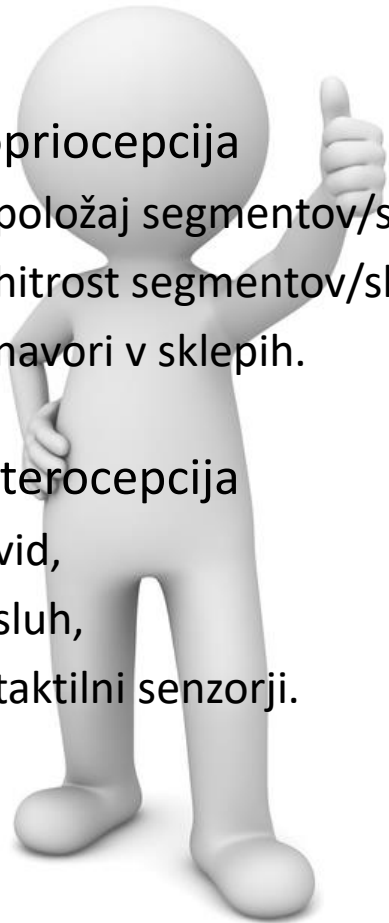
# ČLOVEKOVA ČUTILA IN ROBOTSKI SENZORJI

## ● Propriocepcija

- položaj segmentov/sklepov,
- hitrost segmentov/sklepov,
- navori v sklepih.

## ● Eksterocepcija

- vid,
- sluh,
- taktilni senzorji.

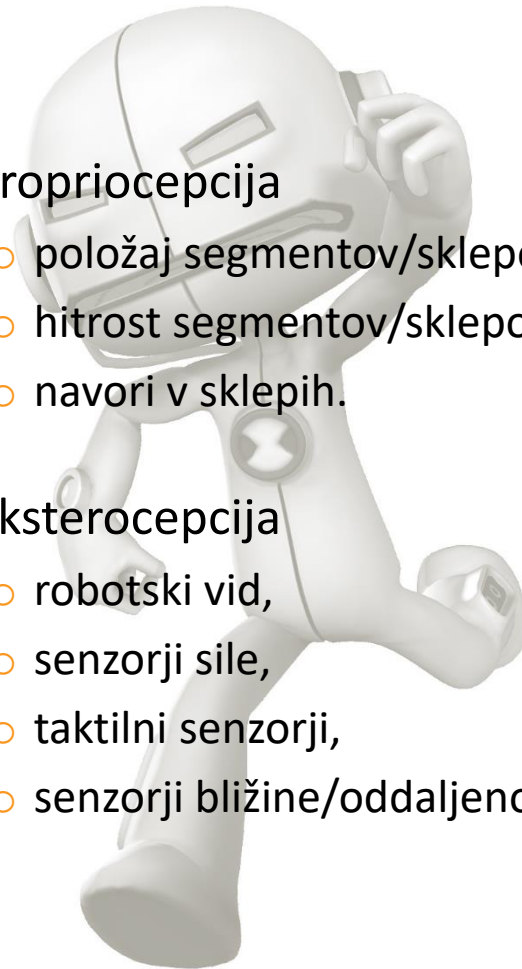


## ● Propriocepcija

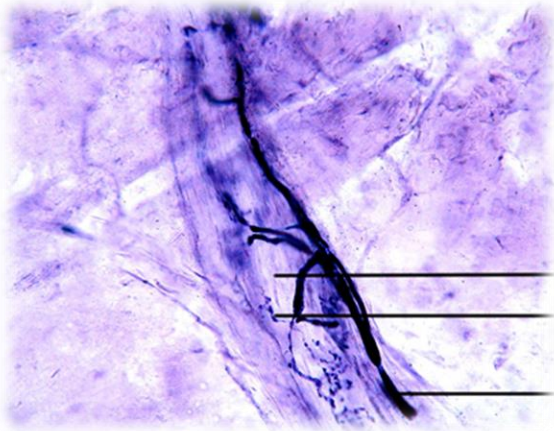
- položaj segmentov/sklepov,
- hitrost segmentov/sklepov,
- navori v sklepih.

## ● Eksterocepcija

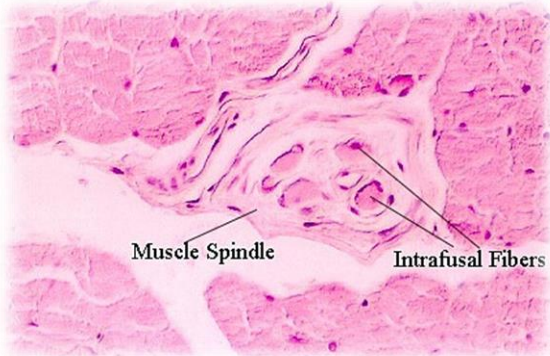
- robotski vid,
- senzorji sile,
- taktilni senzorji,
- senzorji bližine/oddaljenosti.





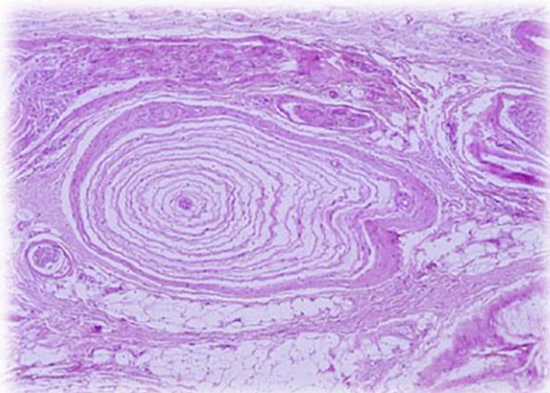


Golgijev tetivni organ

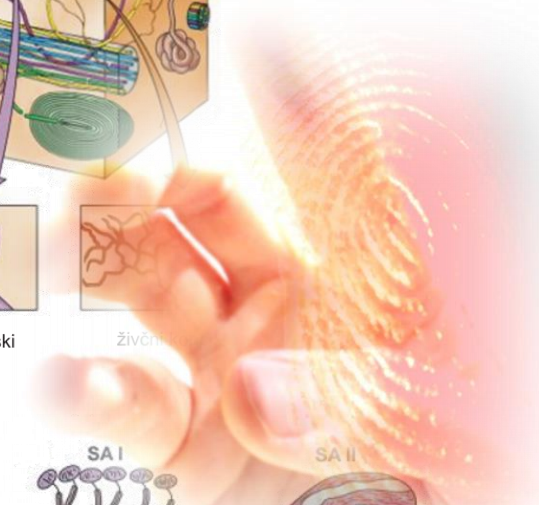
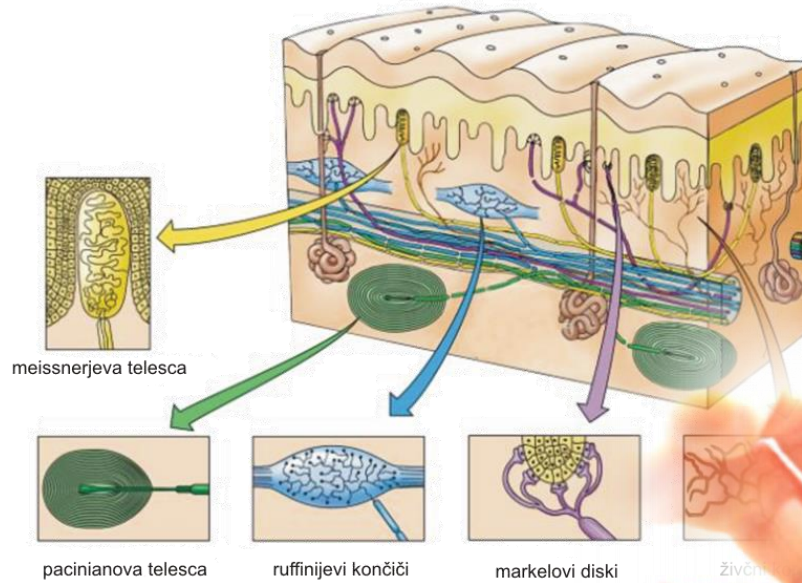


Muscle Spindle  
Intrafusal Fibers

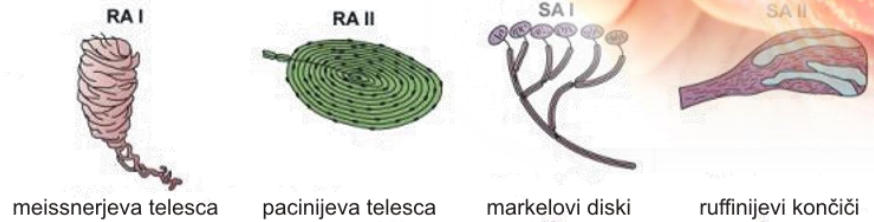
Mišično vreteno



Pacianiano telesce

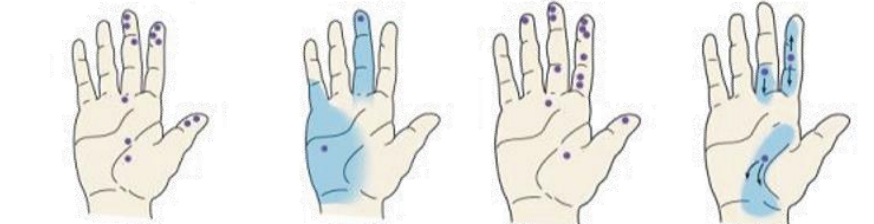


receptorji



meissnerjeva telesca    pacinijeva telesca    markelovi diski    ruffinijevi končiči

področje zaznav



majhna, ostri robovi    velika, neizržit rob    majhna, ostri robovi    velika, neizržit rob

dražljaj



odziv

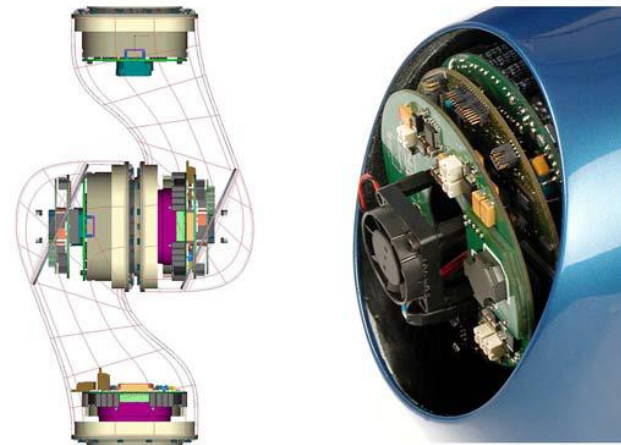
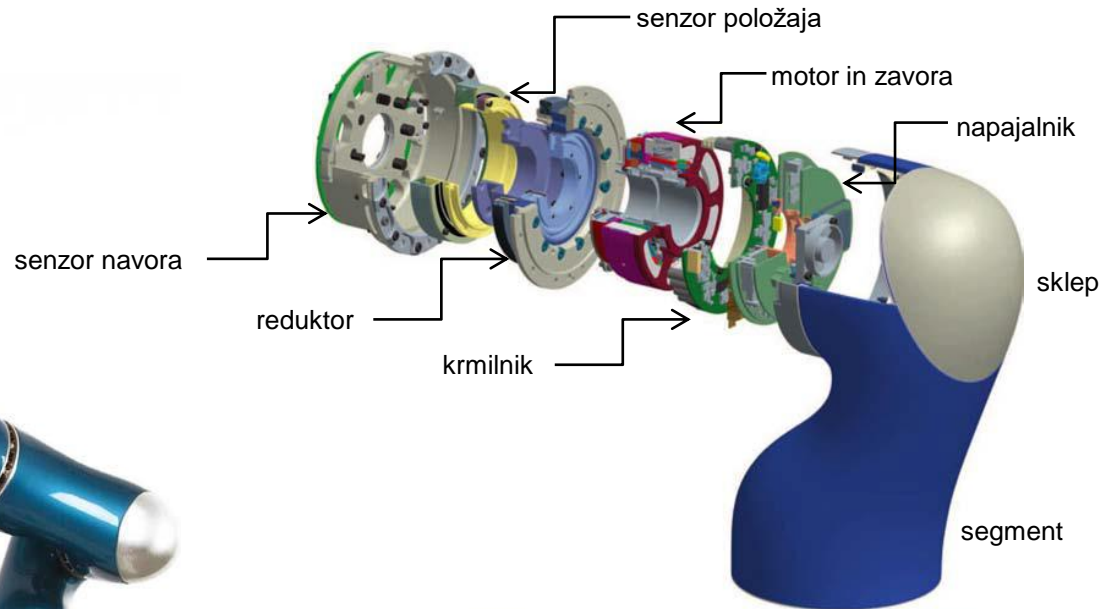


hitra adaptacija    hitra adaptacija    počasna adaptacija    počasna adaptacija

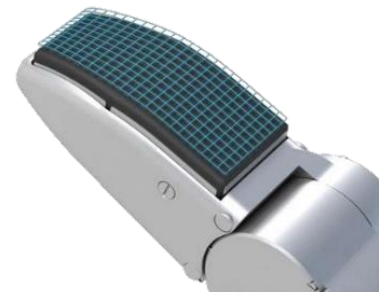
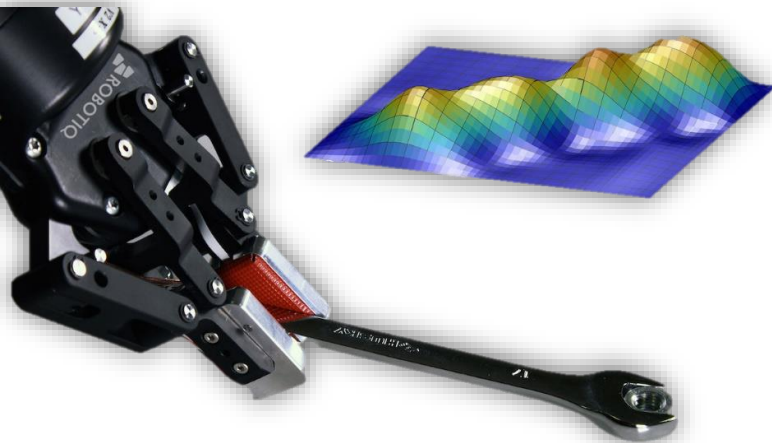
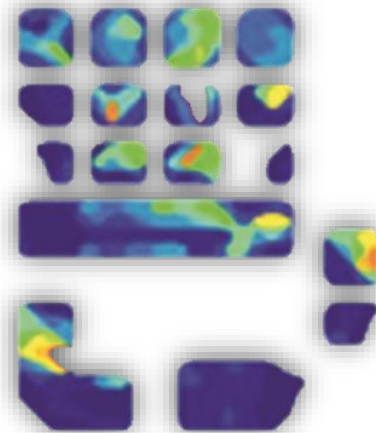




# ROBOT – PROPRIOCEPCIJA



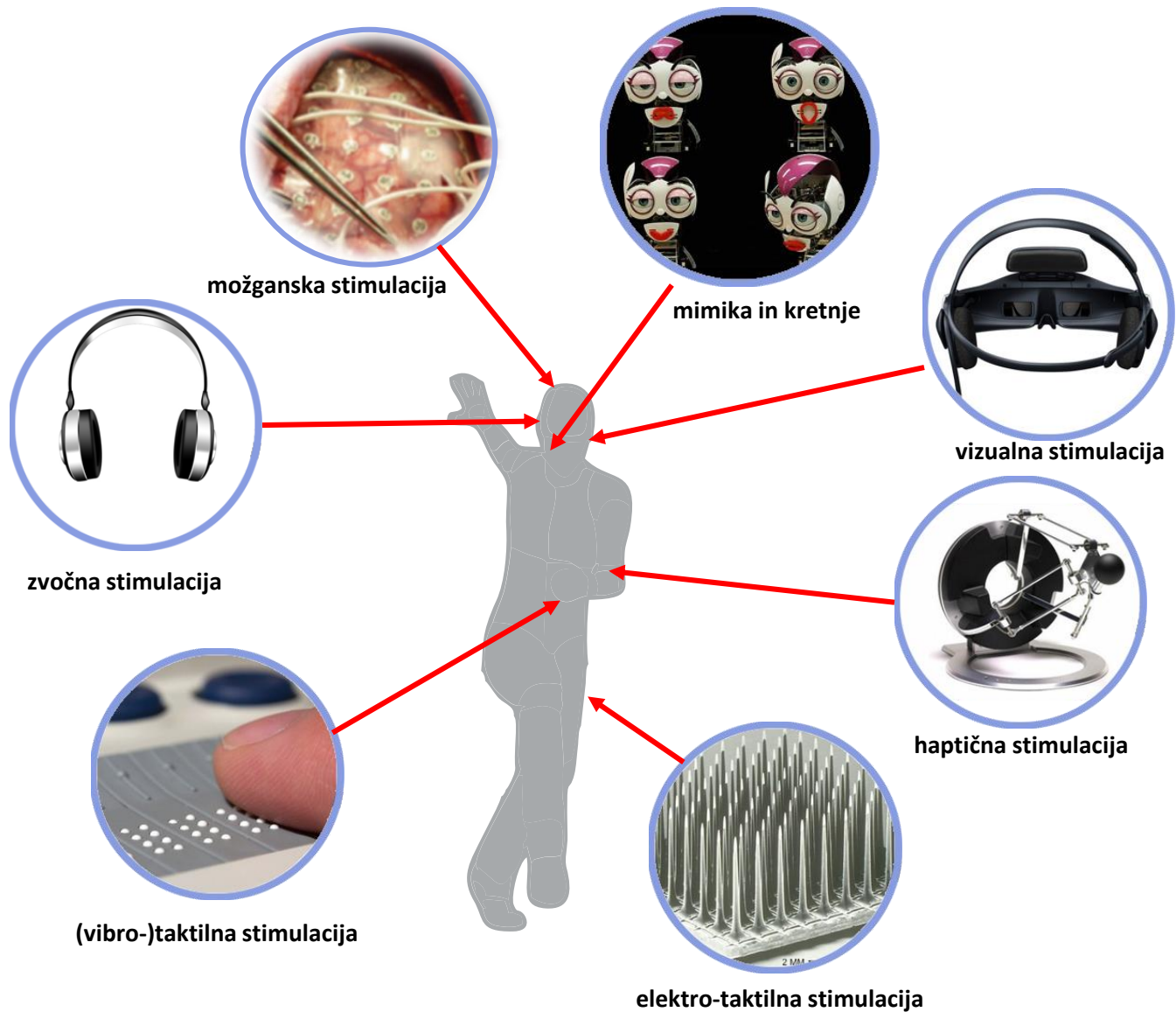
# ROBOT – EKSTEROCEPCIJA



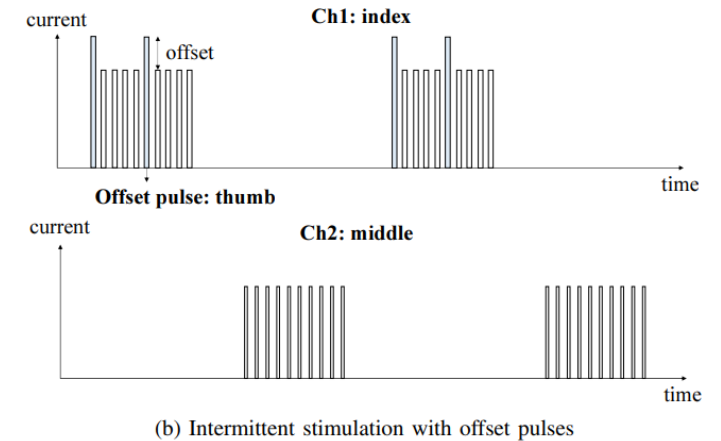
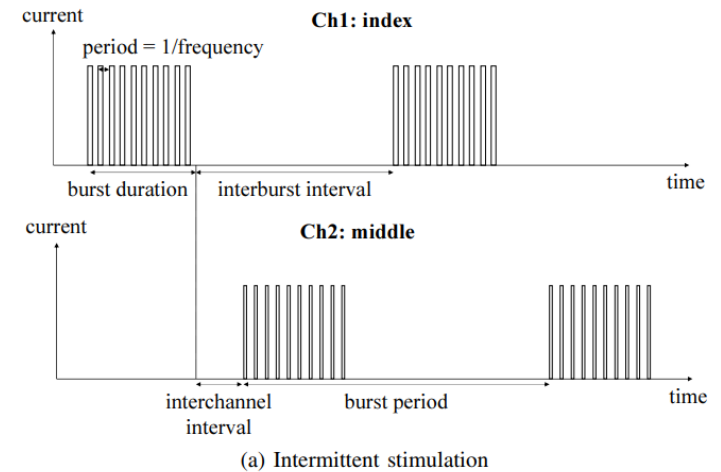
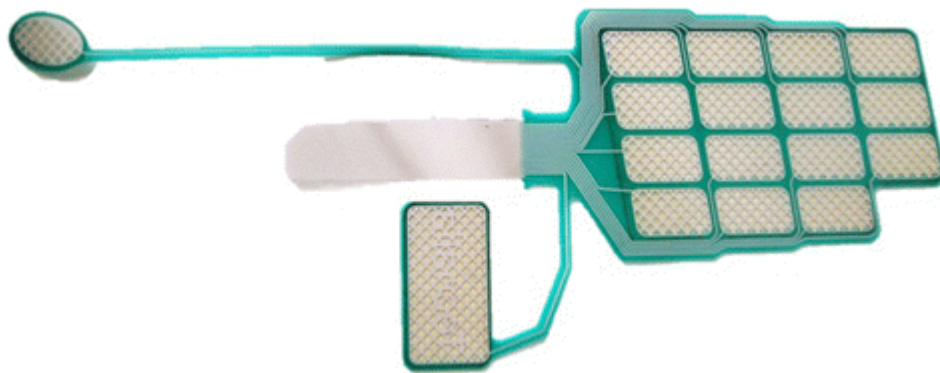
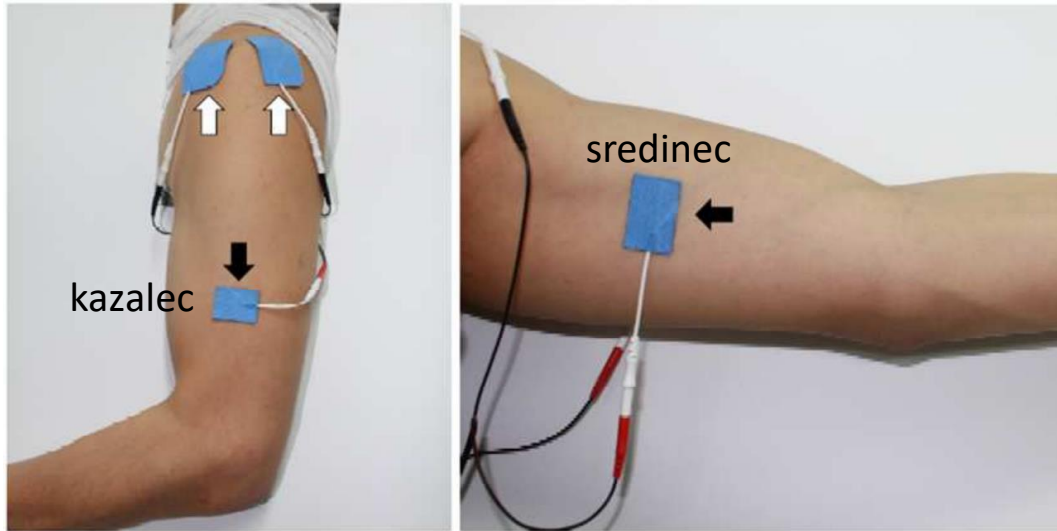




# IMPLICITNA KOMUNIKACIJA – OD ROBOTA K ČLOVEKU



# ELEKTRO-TAKTILNA STIMULACIJA

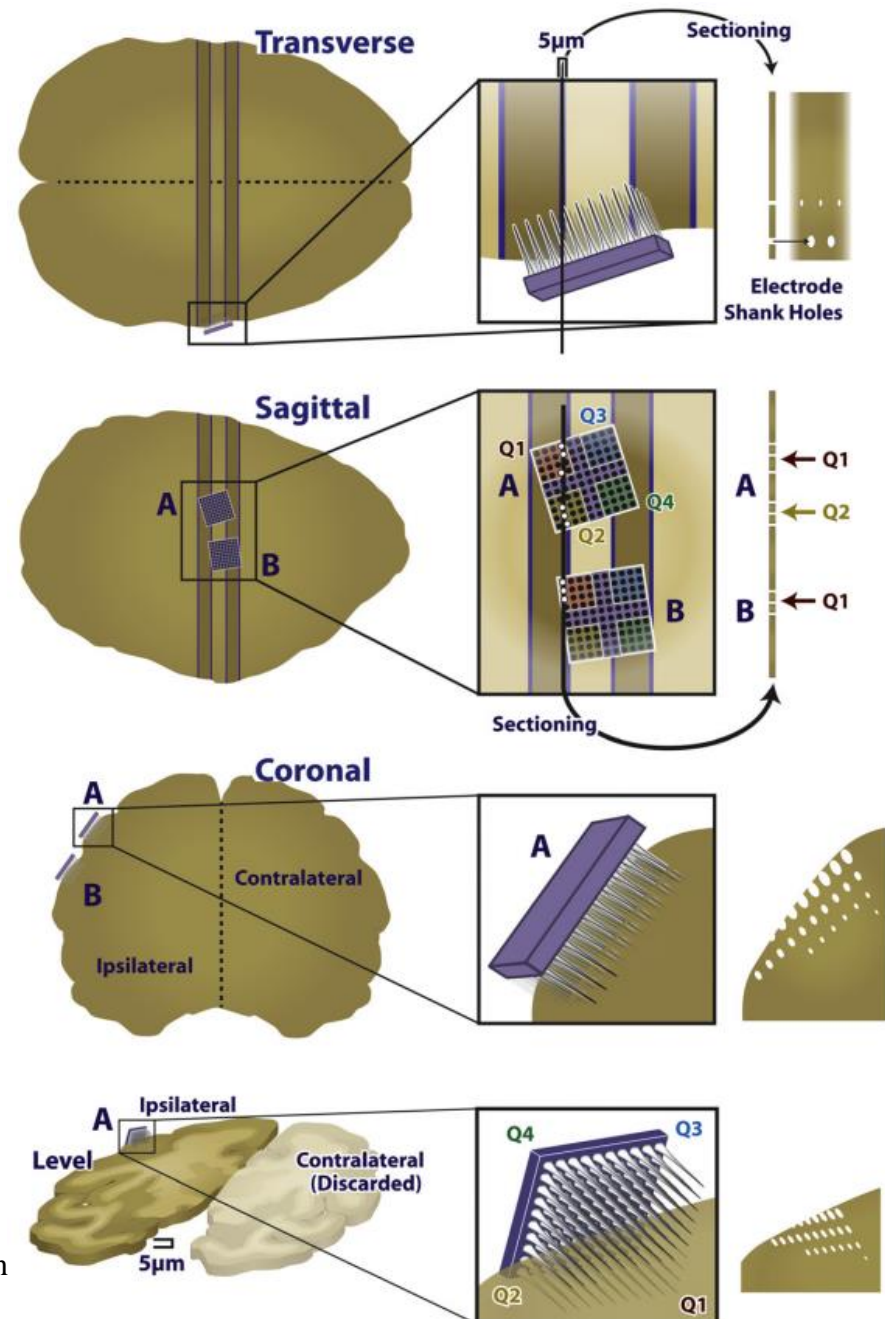
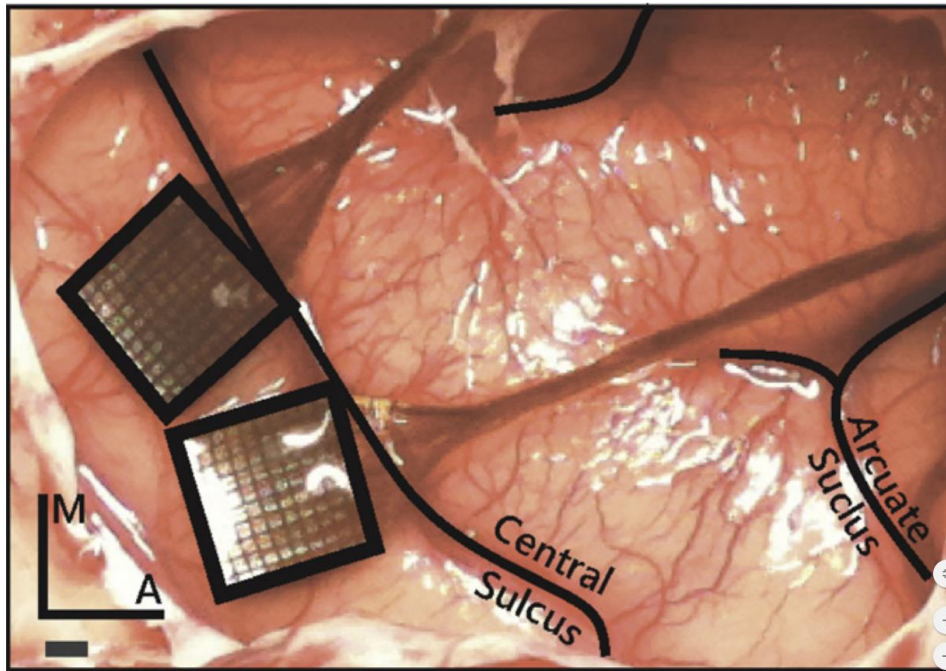








# MOŽGANSKA STIMULACIJA



A. T. Rajan, J. L. Boback, J. F. Dammann, F. V. Tenore, B. A. Wester, K. J. Otto, R. A. Gaunt, S. J., „Bensmaia, Intracortical microstimulation of human somatosensory cortex“, *Journal of Neural Engineering*, 2015.

# ODZIV V ODVISNOSTI OD AMPLITUDE STIMULACIJE

