Brain-Computer Interface

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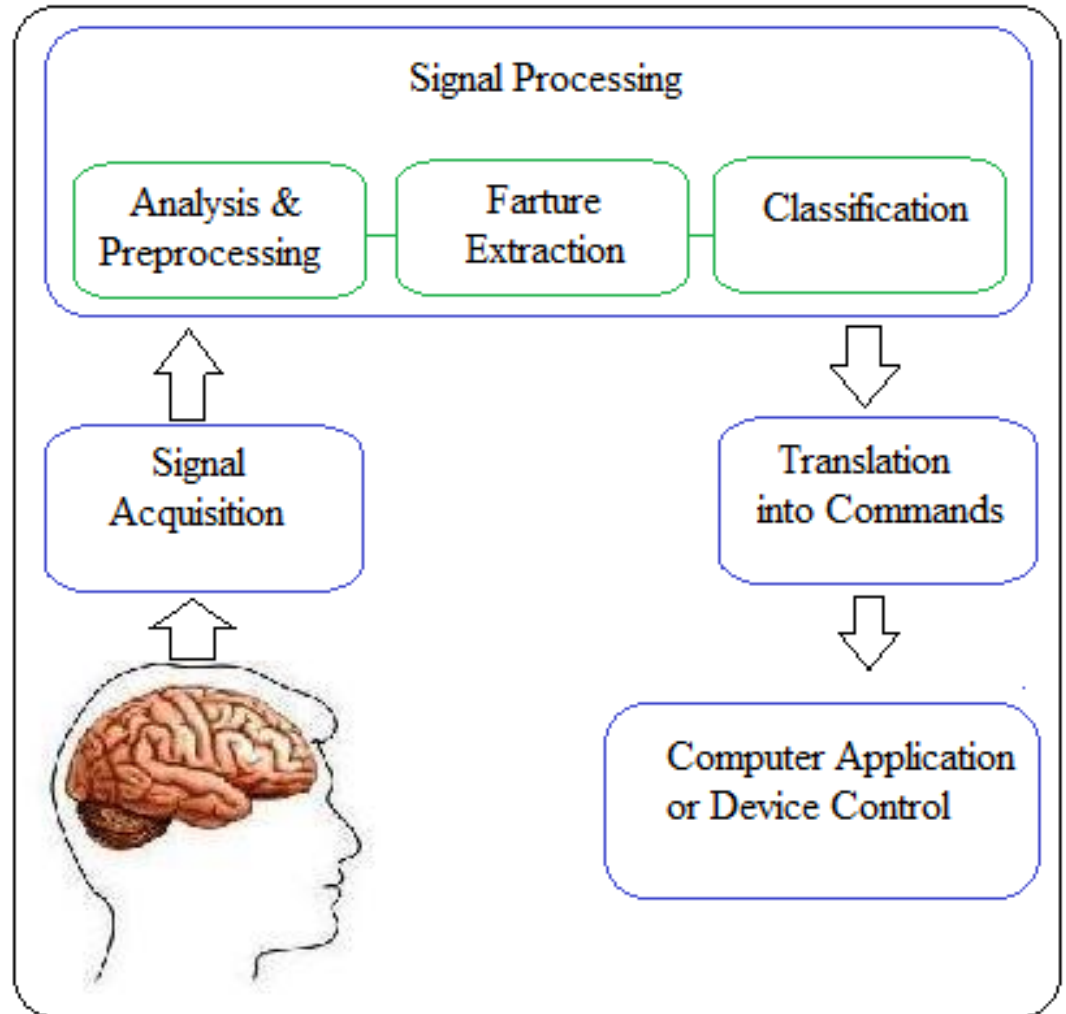
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- Introduction to BCI
- Brain
- EEG
- Robotics Applications
- Tools
- Current status

Introduction to BCI

- It is a technology that enables humans to control computer through their brain waves .

- Brain waves are Electroencephalogram (EEG Signals).

Introduction to BCI

A system for **controlling a device** like computer, wheelchair or a **neuroprothesis** by human **intention** which does not depend on the brain's normal output pathways of **peripheral nerves and muscles.**

Names given to this concept:

HCI – Human Computer Interface

DBI – Direct Brain Interface

TTD – Thought Translation Device

# <u>Neuro-prosthetics</u>

- In medicine, a prosthesis or prosthetic implant is an artificial device that replaces a missing body part, which may be lost through trauma, disease, or a condition present at birth.

- Neuroprosthetics is a discipline related to neuroscience and biomedical engineering concerned with developing neural prosthesis.
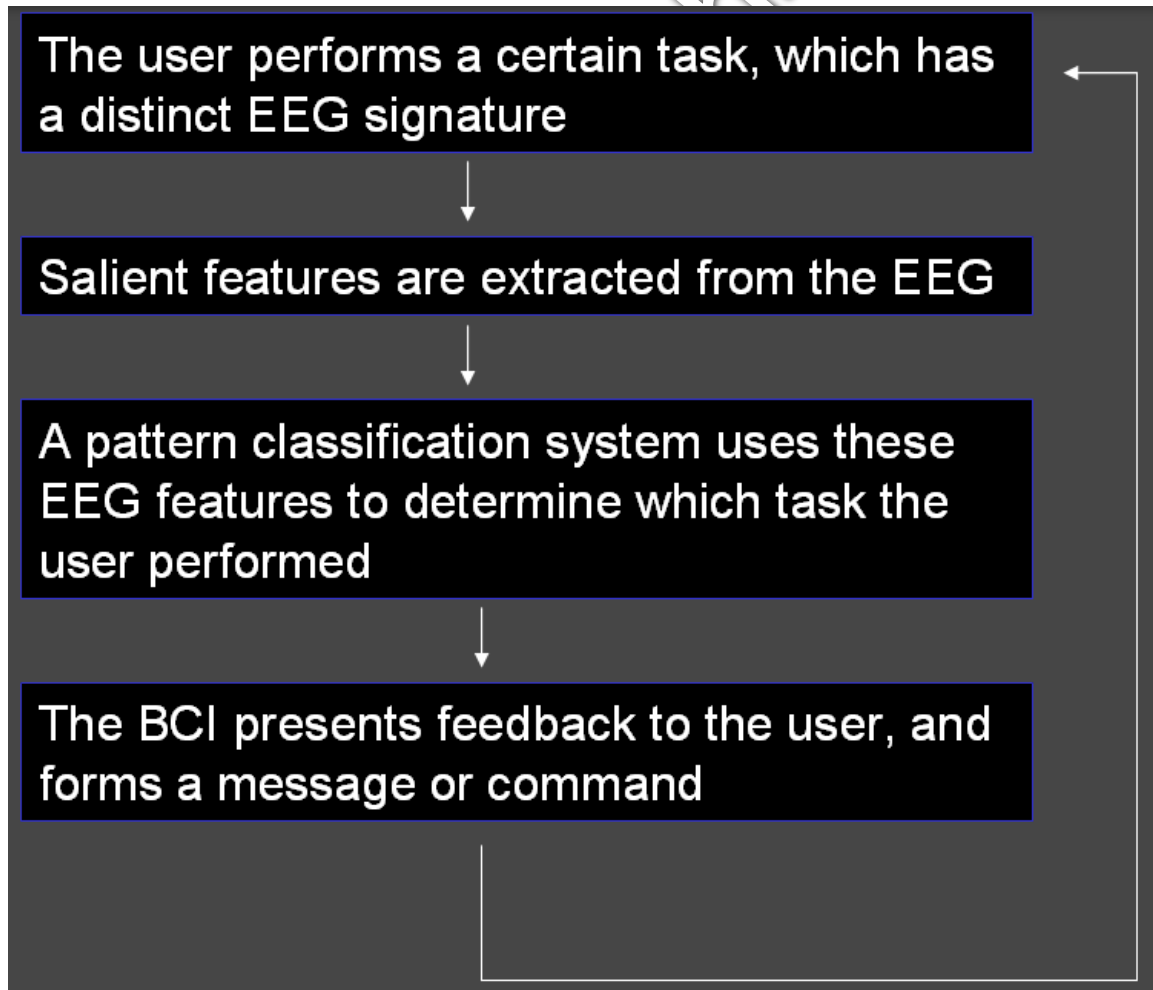

India's first blade-runner Major Devinder Pal Singh

Some examples of BCI applications

BCI
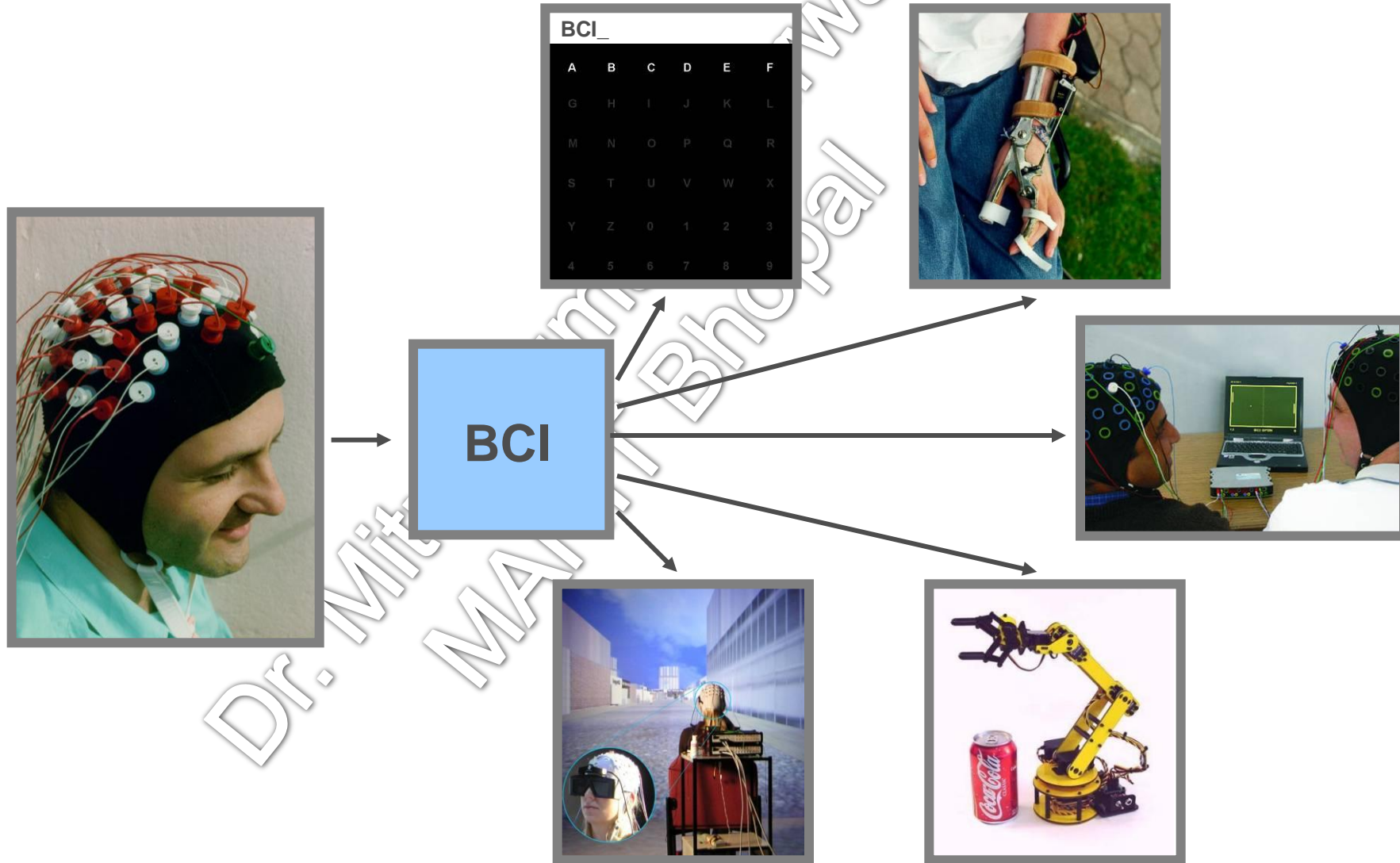
Brain Computer Interfaces

Principles of operation

Brain Computer Interfaces

Types

- Endogenous BCI

- Exogenous BCI

Endogenous BCI

- Endogenous BCI systems depend on the user's ability to control their electrophysiological activity.
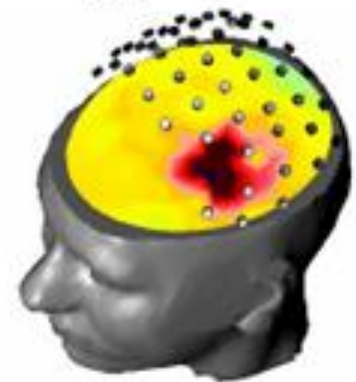
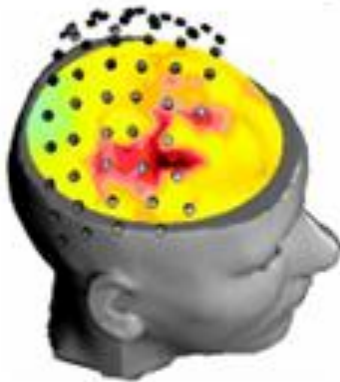- Motor imaginary (sensorimotor rhythms).

Exogenous BCI

- Exogenous BCI systems depend on the stimulation provided to users and influence their electrophysiological activity.

- P300 BCI, Steady State Visual Evoked Potentials (SSVEP).

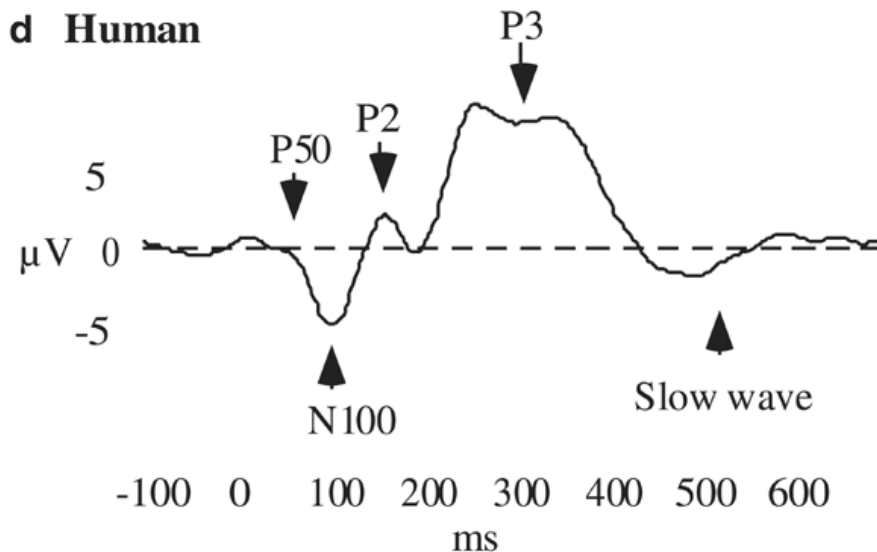# Motor Imaginary BCI
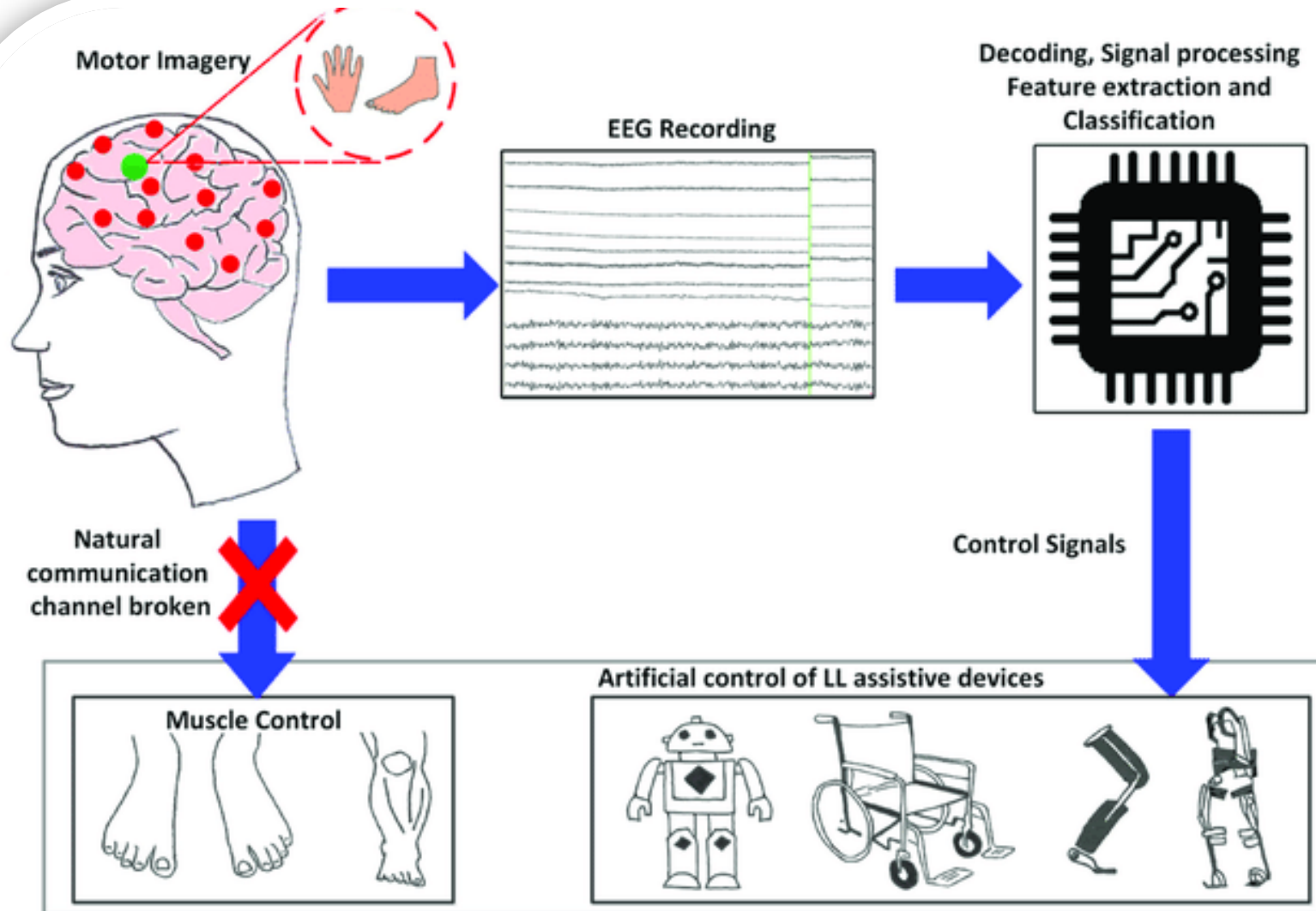
Motor Imaginary BCI

P300

- P300 wave: posivite component in the event related potential, 300ms after a stimulus

- Selection of a symbol/character: count/ identify the flashes sequence in columns and rows corresponding to P300 wave

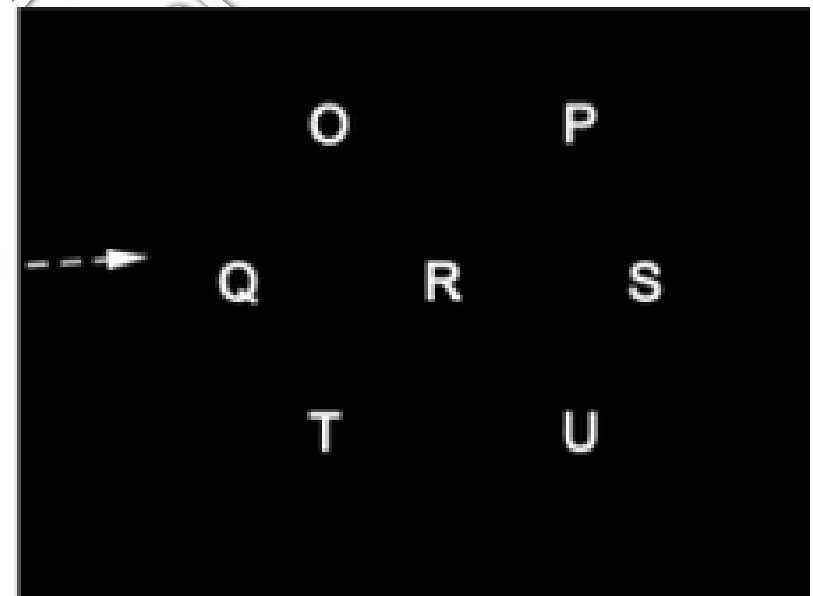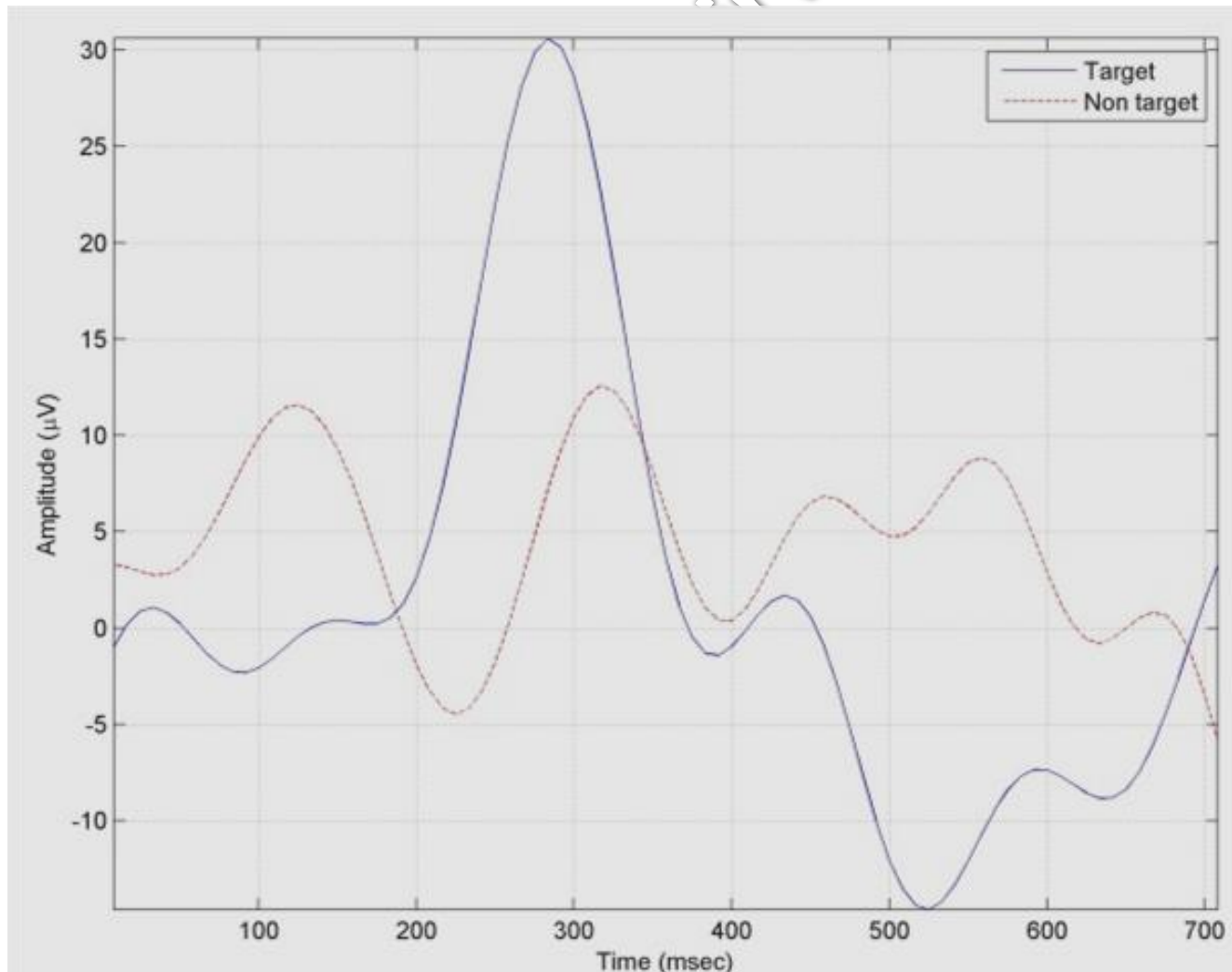# Experimental set-up for P300 BCI

Devanagari script-based P300 speller

Region-Based P300 Speller

Target and Non-target Wave in P300 experiment

TTD Feedback and Communication System

EEG control unit   EEG amplifier

subject

feedback-screen

PC with TTD software
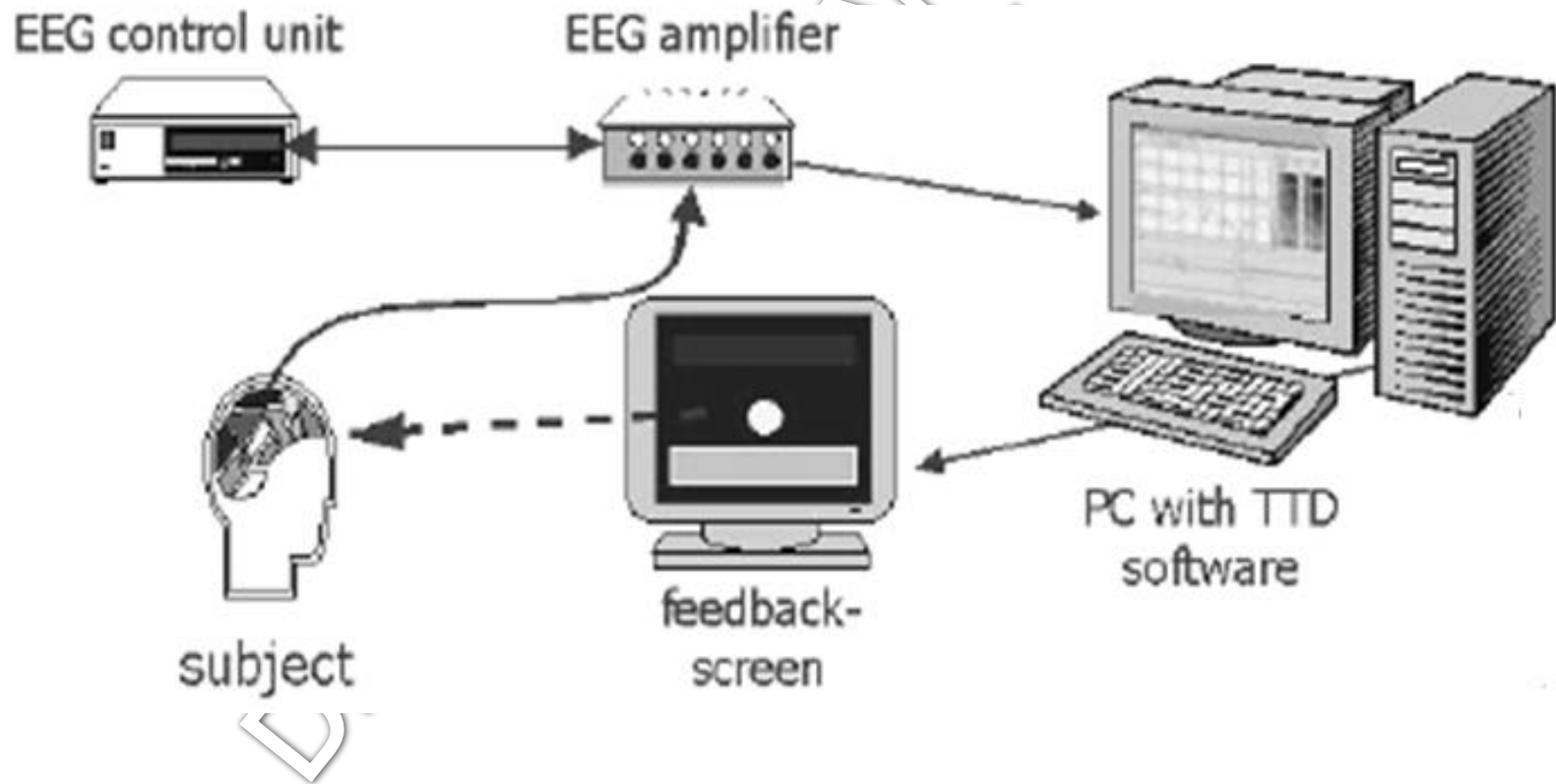
BCI Software - BCI2000
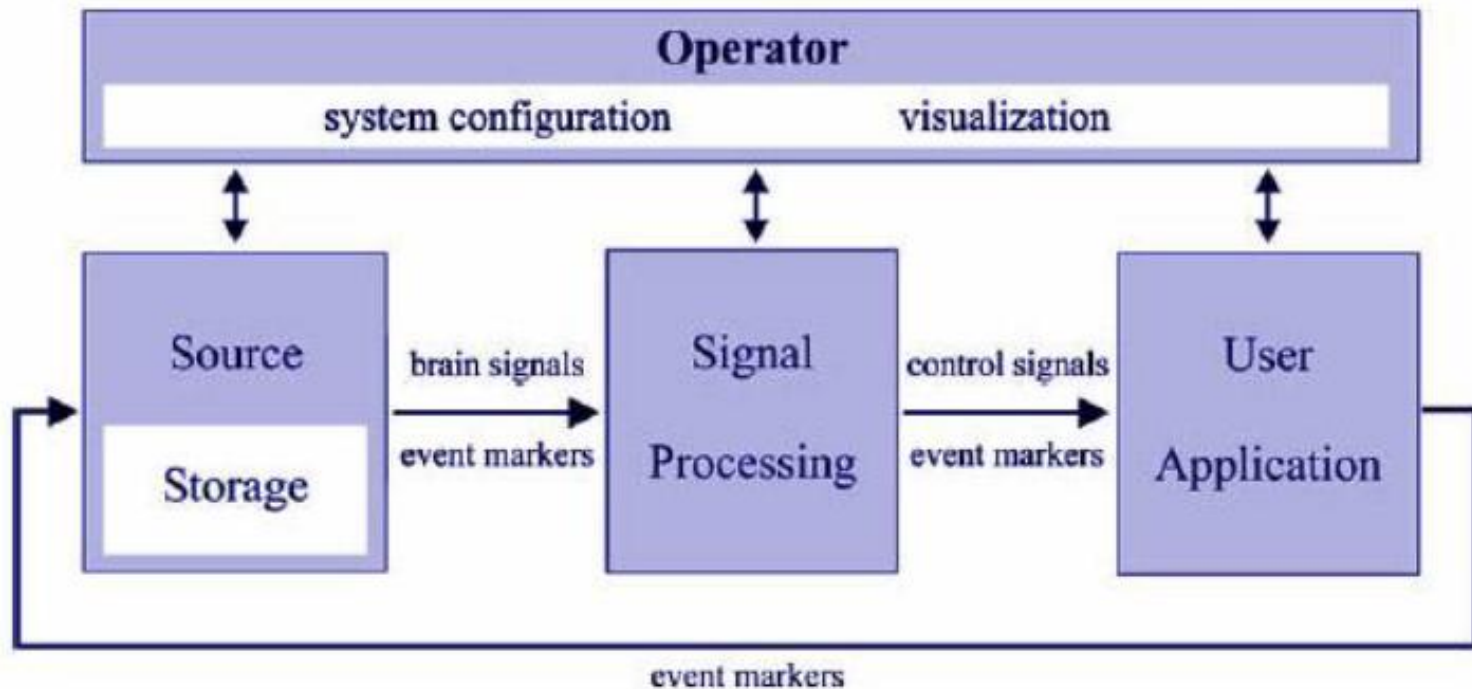
●Research Platform for BCI Systems

●Modular structure: Signal Aquisition, Signal Processing and User Application

BCI2000: Components

- Filters
  - Spatial, temporal, and spectral
- Online artifact detection and correction
- Classification
  - Linear Discriminant Analysis (LDA)
  - Simple Threshold Classification
  - Support Vector Machine (SVM)
- MATLAB interfaces.

BCI experiments with Monkey
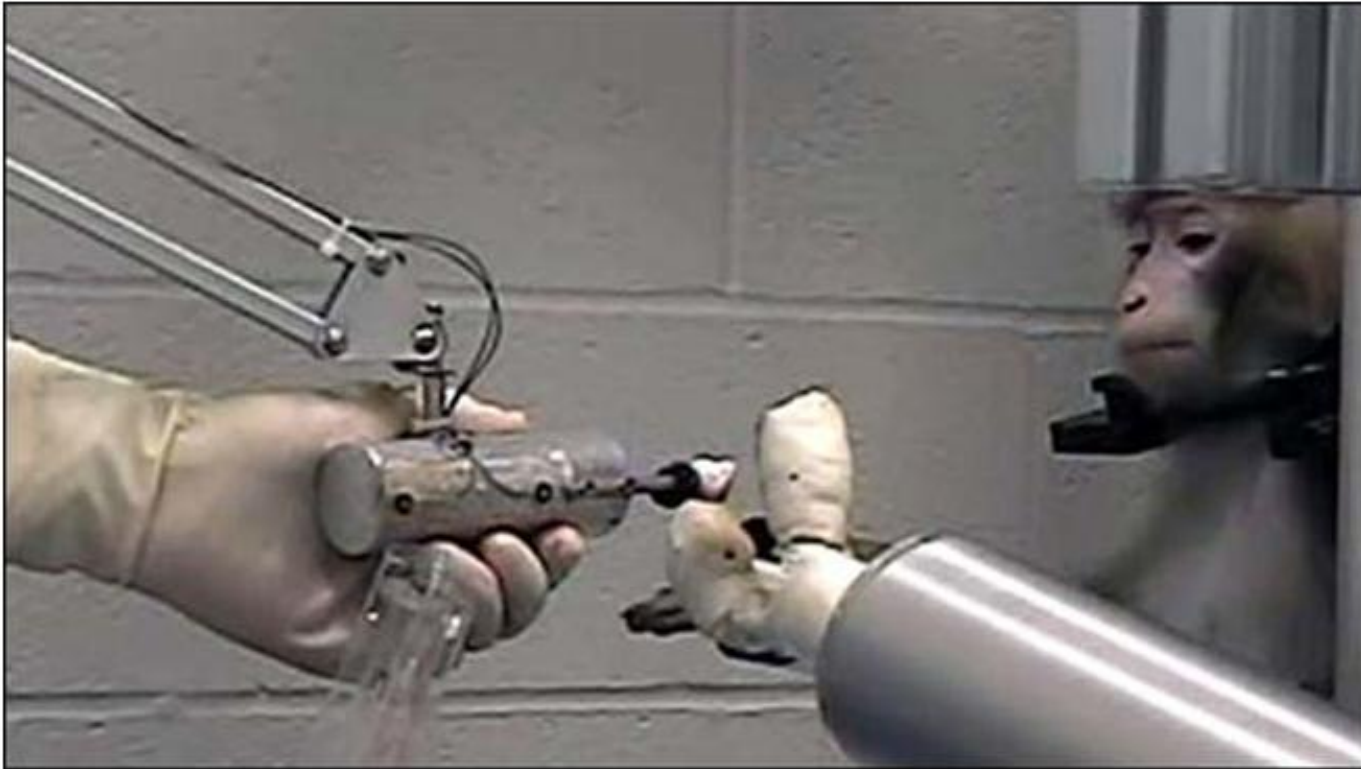
Velliste, M. *et al.* Nature advance online publication, doi:10.1038 / nature06996 (2008).

Paralyzed woman moves robot arm by BCI

People with paralysis control robotic arms using brain-computer interface, May 16, 2012 (https://news.brown.edu/articles/2012/05/braingate2)

Exoskeleton Controlled by BCI

Russian military developing mind-controlled exoskeleton.
(https://www.tweaktown.com/news/44889/russian-military-developing-mind-controlled-exoskeleton/index.html)

Movies in which applications of BCI are shown

IRON MAN

SPIDER MAN

AVENGERS

Refernces

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- Jonathan R Wolpaw, et. al., Brain–computer interfaces for communication and control, Clinical Neurophysiology, Volume 113, Issue 6, 2002, Pages 767-791.

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- R. Fazel-Rezai and K. Abhari, "A region-based P300 speller for brain-computer interface," in Canadian Journal of Electrical and Computer Engineering, vol. 34, no. 3, pp. 81-85, Summer 2009, doi: 10.1109/CJECE.2009.5443854.

- Jeon H, Shin DA. Experimental Set Up of P300 Based Brain Computer Interface Using a Bioamplifier and BCI2000 System for Patients with Spinal Cord Injury. Korean Journal of Spine. 2015 Sep;12(3):119-123. DOI: 10.14245/kjs.2015.12.3.119.

- Fazel-Rezai, Reza, et al. "A Review of P300, SSVEP, and Hybrid P300/SSVEP Brain-Computer Interface Systems." (2013).

Thanks