Electroencephalograph (EEG) & Brain-Computer Interface

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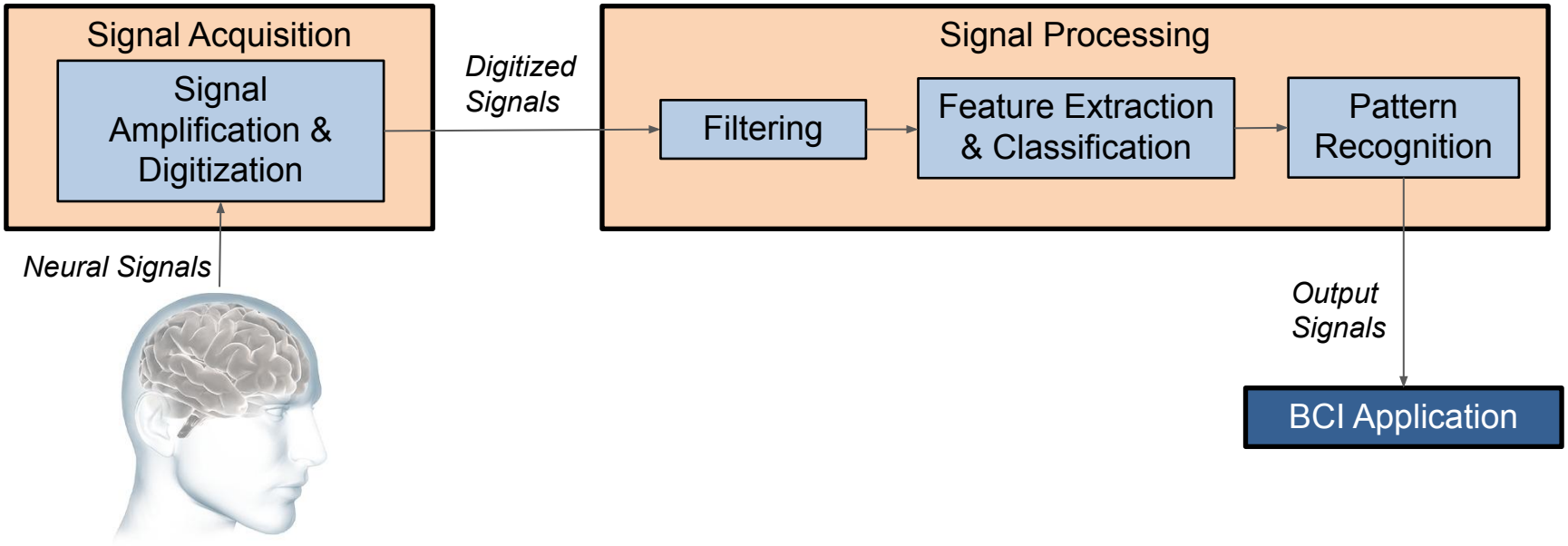
Team Members

Blaine Allen	Alex Arensmeier	Stephen Trotnic
Neuroscience & Pattern Recognition	Data Acquisition & Signal Processing	EEG Hardware & Simulation
Computer Engineer	Electrical Engineer	Electrical Engineer

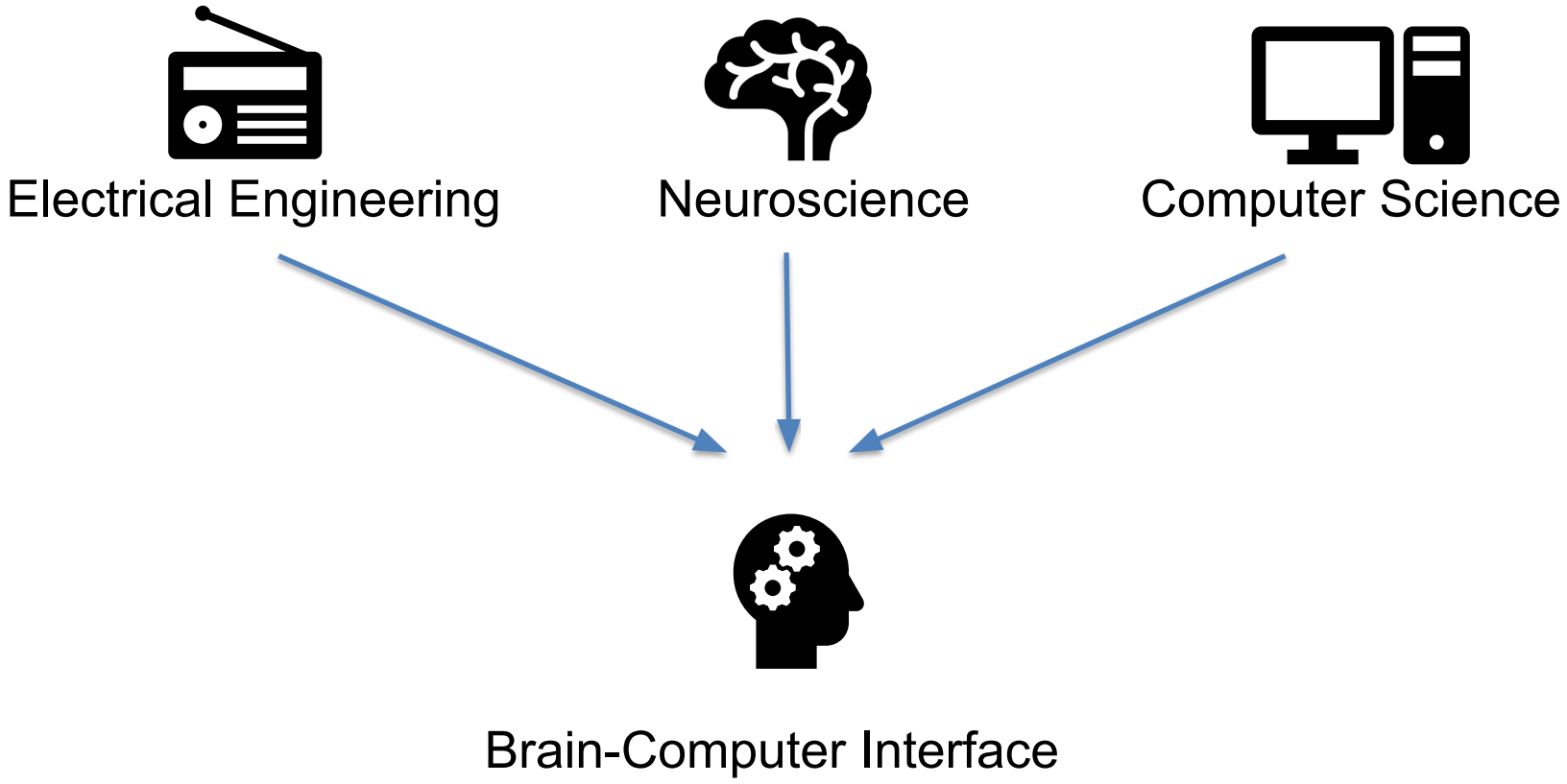
Brain-Computer Interface (BCI)

What is a Brain-Computer Interface?

Interaction between a human neural system and one or more computers

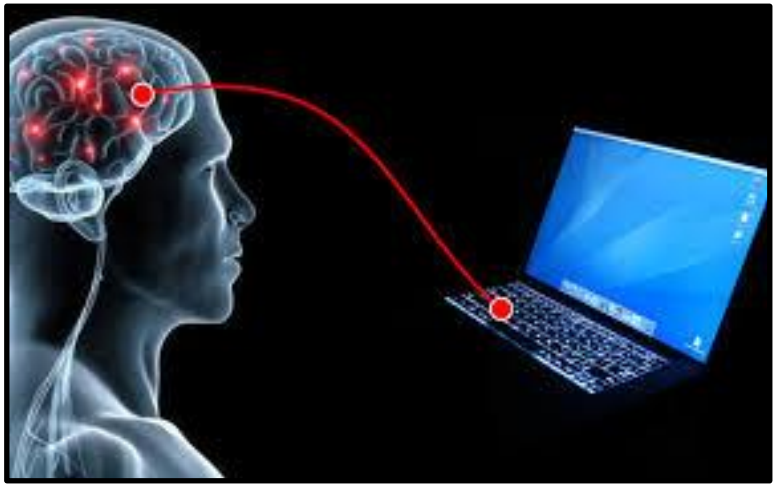


Multidisciplinary Research



Overview

Primary:
Design & Construction of Electroencephalogram (EEG)



Ancillary:

Signal Processing &
Neural Pattern Recognition
Brain-Computer Interface

EEG Design

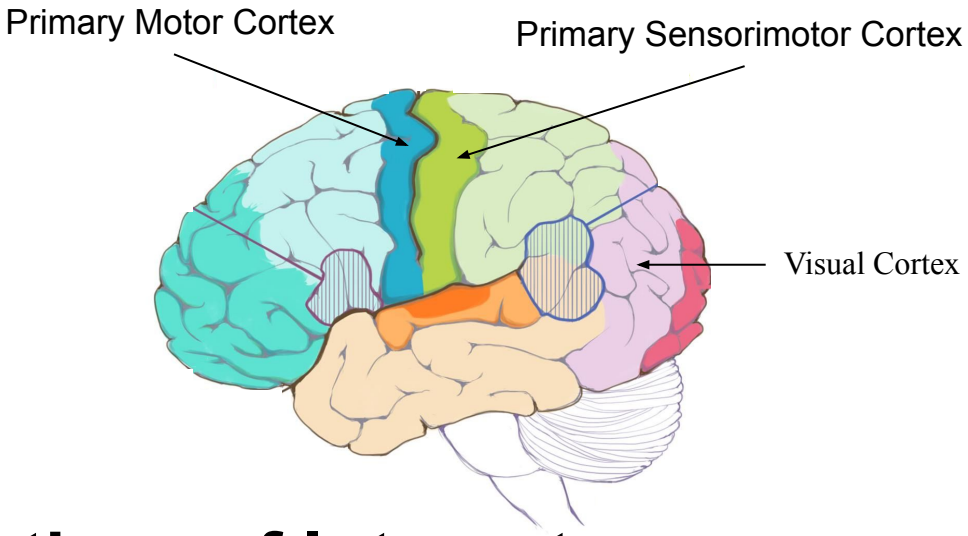
What is an Electroencephalograph?

EEG Design

- Repeatable placement of electrodes
- Amplification of the 10-100 μV brain waves
- Required understanding of brain function for electrode placement

Neuroscience of Electrode Placement

We aim to discern neuro-electrical signals pertaining to vision, movement, and planned action.



Neural Cortices of Interest:

Visual Cortex

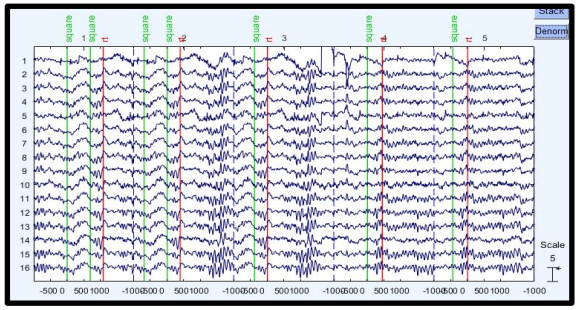
Primary Motor Cortex

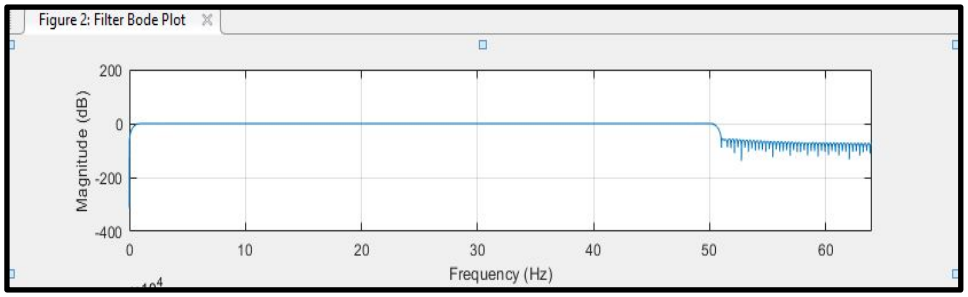
Primary Sensorimotor Cortex

Software & Signal Processing

Signal processing utilizing MATLAB

- Data acquired with an Arduino Mega at greater than 500 samples / second
- Initial data filtering and artifact detection done through the EEGLab & BCILab Toolboxes





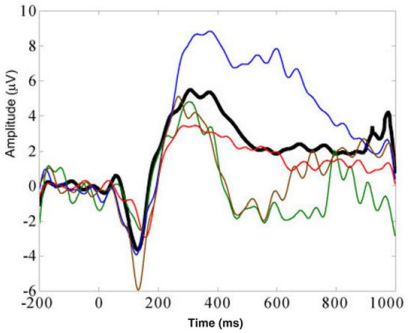
$$f(t) = \int_{-\infty}^{\infty} f(\omega) \cdot \mathrm{e}^{-i\omega t} \mathrm{d}\omega$$

Fourier Transform

Neural Signal Pattern Recognition

Event Related Potentials:

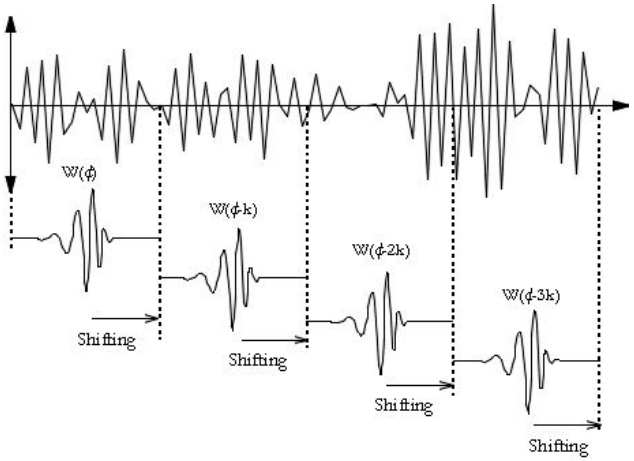
- Repetitive averaging of test samples



Event Related Potential

Wavelet Analysis

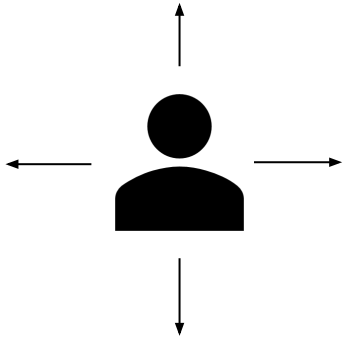
- Discrete component of wave
- Recognized wavelet generates electrical output control signals



Wavelet Analysis

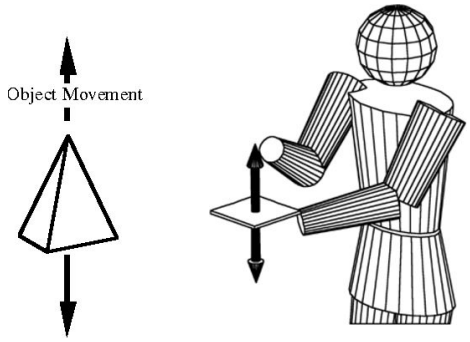
In-progress BCI Application

Thought-controlled interaction with a virtual-reality environment



2-Axis Movement

Pattern Recognition triggers output controls for movement and object manipulation



Object Manipulation

Potential Thought-Controlled Future Applications

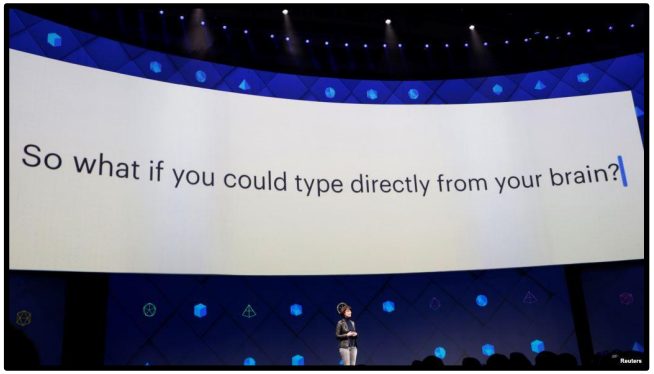
Medical

- Wheelchairs
- Thought-to-Text Communication
- Advanced Prosthetics & Bionics

Credit: John's Hopkins University Acquired: 4/1/2018

Commercial

- Realistic Full-Immersion Virtual Reality Gaming
- Realistic Military, Police, Surgeon Training Simulation



Credit: Building 8 Research Lab. Acquired: 4/1/2018

Acknowledgements

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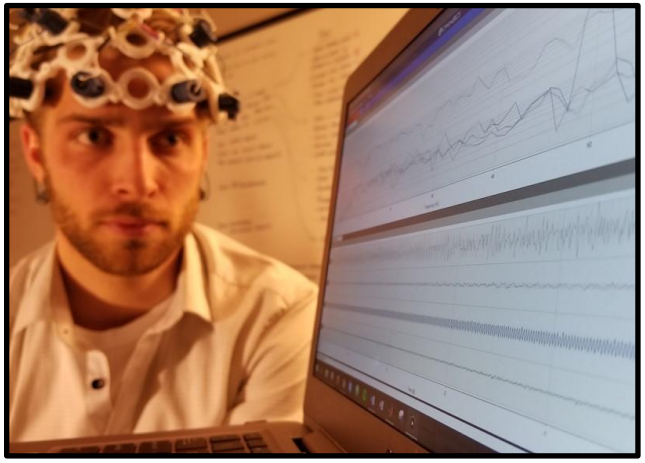
Dr. Donald Wunsch - Pattern Recognition Advisor

Missouri University of Science & Technology



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