



# Brain-Computer Interfaces: A Timely Opportunity for Project-based Learning

**COGNITIVE  
SYSTEMS  
LABORATORY**

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## Brain Computer Interfaces

- Interest in BCI research intensified in the last decade, although fundamental advances had been persistently made over decades.
- Currently two main research camps exist:
  - Invasive brain interfaces – microelectrode arrays
  - Noninvasive brain interfaces – electroencephalography
- EEG has been a successful brain activity sensing modality for the noninvasive design approach.
- BCI application design involves and requires collaborative participation of researchers with complementary expertise areas and strengths.

## Proposed Activity: BCI Application Design

- Groups of senior undergraduate students design BCI applications targeting multiple subject populations:
  - Assistive tools for communication and control
  - Cognition aware/enhancing computer interaction tools
- Multi-faceted interdisciplinary project requires:
  - Joint hardware/software design considerations
  - Rudimentary understanding of how brain works
  - Incorporation of human factors in design criteria
  - Tackling of challenges associated with real-time closed-loop control using high uncertainty signals and decisions
  - Ethics of data-collection involving human subjects
  - Experiencing and understanding impact on lives of users

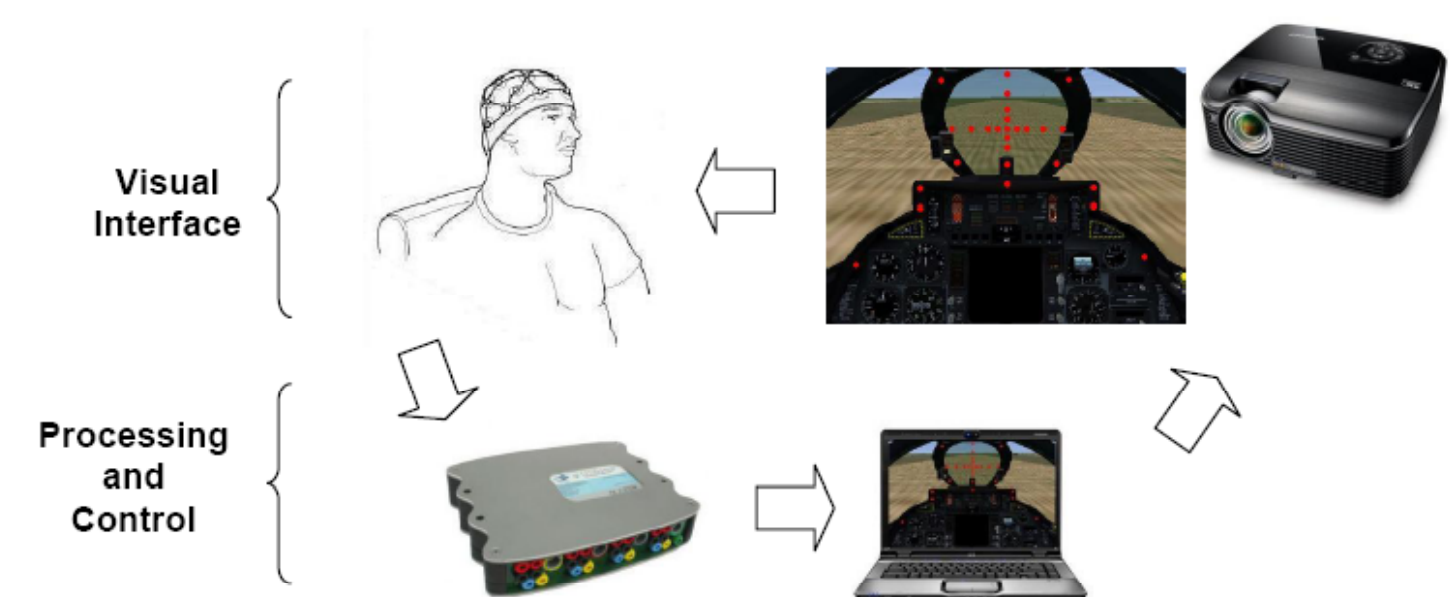
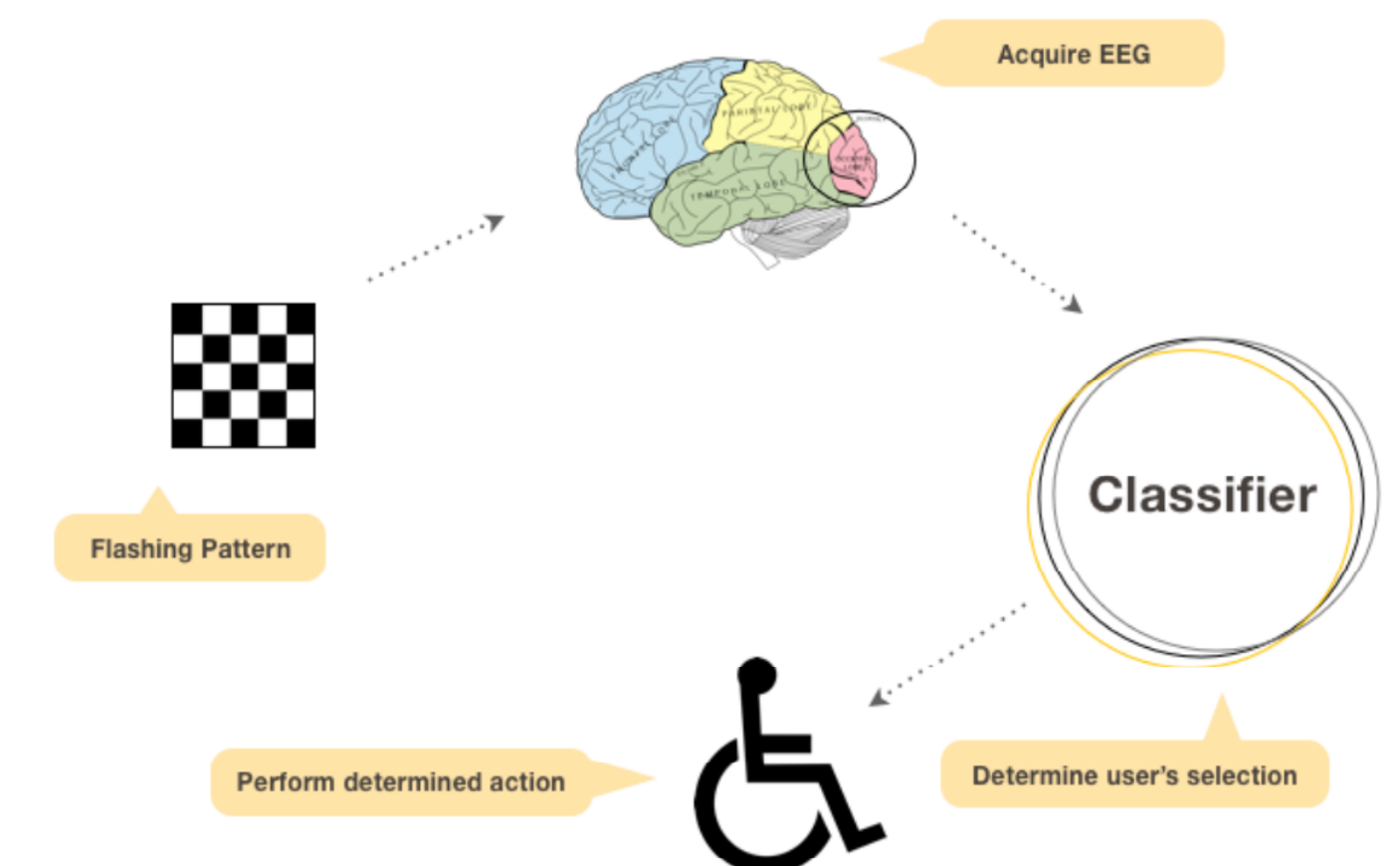
## Expected Education Outcomes

- Students will develop skills that allow them to work efficiently and effectively as a team.
- Team project with well-defined success metric will require goal-driven individual and collaborative activity, leading to self-directed & peer-to-peer learning.
- Applied project will require fusion of theory, intuition, and experimental verification.
- Cutting-edge interdisciplinary research aspects will require the use and appreciation of the scientific method.

## Preliminary Results

- Advised a group of 4 seniors for Capstone Project – won 1<sup>st</sup> place in 2010 competition.
- Project: SSVEP-BCI to control iRobot Create®
- Demo video available on YouTube:  
<http://www.youtube.com/watch?v=cuCORTf1taw>
- Students Designed (Sep'09 to Apr'10):
  - Driver for data acquisition from g.USBamp in C language
  - OpenGL code to display perfectly timed flickering checkerboards
  - Code to process and classify EEG activity (using spectrum estimation and support vector machines)
  - Code to remotely send commands and control the robot using API
- Publications and publicity:
  - Abstract and presentation at NCUR 2010, University of Montana
  - Full conference paper at AsilomarSSC 2010, Asilomar CA
  - Popular technology outlets including venues like Discovery Channel News, The Futurist, Boston Globe publicized this activity

## Current Projects



## Current and Future Activities

- Advising 3 Capstone Project groups
- Advising 3 juniors on BCI-helicopter control
- Brain interface design course
- Open source educational materials