Neuro-Electric Machine Control

Overview of the Extension of the Human Senses Group Activities

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Extension of the Human Senses Group

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Group Projects

control with gestures

robotic interfaces
semi-autonomy

brain computer interfaces

Tool Grasps

silent speech

atmospheric inference

streaming frameworks
Applications

Neuro-electric Interfaces

Nano Device Control
Planetary Discovery
Exoskeleton Control
Silent Communication
Manipulator Control
Wearable Cockpits
Data World Immersion
Human/Machine Communication
Output sensory mapping
Virtual joystick
Output sensory mapping
Virtual Keypad
Gestures for semi-autonomy

Tool Grasps
Brain Computer Interfaces

Leonard J. Trejo, Ph.D.

mu rhythm control:

Real Movement

Imagined Movement

EEG(C3,C4): 8.7 Hz ERD
EMG: 40 Hz ERS

Subject 01
11 Real Motions

REST
MOVE
REST

REST
IMAGINE
REST
Sensor Positioning System

1. 64-electrode EEG signal from real-motion condition
2. Narrow-band filter at desired frequency
3. Select artifact-free EEG segments
4. Spatial SVD
5. First 2 Orthogonal Components
6. Approximate C1, C2 with 2 electrode pairs
7. Incorporate in sensor design for real-time system
Non-contact Sensor Development

Design Goals

Near-term
- Refine non-contact technology
- E-field sensor (normal to scalp)
- Shielded room

Mid-term
- Differential sensor (tangential to scalp)
- Mini sensors (2-3X smaller, thinner, with manufactured cover)

Long-term
- Unshielded room
- Multichannel

QUASAR: Quantum Applied Science and Research Inc.
Application of KPLS and SVM

- Classification of EEG patterns associated with single-tap typing motions in three subjects
- Developed and tested a linear PLS preprocessing system
- Combined PLS system with linear SVM classifier
- PLS-SVM system detected single-tap patterns with accuracy of 80% to 95% (an increase of 15% to 30% over previous system)
- Implemented and tested PLS-SVM system in real-time framework
Silent Speech

Charles Jorgensen, Ph.D.

Electrode Placement:

Ground
Gesture Control

movie
Signal Processing Environment for Algorithm Development
The Need for SPEAD

Earth Sciences –
• **data**: large, distributed, heterogeneous formats, lacking docs
• **time waste**:
  – formatting and manipulating files (80/20 rule)
  – implementing machine learning algorithms from literature for discovery tasks
  – lack of scientific method due to accessibility of appropriate forward models (need implementation using first principles)

Neurosciences –
• **data**: never enough, many artifacts, heterogeneous formats
• **time waste**:
  – formatting and manipulating files
  – manual artifact rejection
  – implementing machine learning algorithms for pattern recognition
  – porting from batch to “live” environments for closed-loop experiments
System Requirements

• Easy to program (graphical wiring diagrams)
• Multiple platforms (Mac OS X, Linux)
• Runs on single or multiple machines
• Very fast interactive 2-D & 3-D graphics (OpenGL)
• Support commercial domain packages (e.g. Matlab)
• Seamless transition from batch to streaming processing
• Ability to work with HDF, XML, text, Matlab, and other formats
• Scripts can be run without graphical front-end
• Inclusion of atmospheric forward modeling code for Bayesian inference
• Easy to modify for different scenarios
Conclusion

Collaborations & Partnerships

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Atmospheric Inference
Naïve Bayes Classification
Concluding Goals

• Collaborations & Partnerships:
  • pattern recognition for streaming data problems
  • providing software framework to partners
  • application of bioelectric interfaces to real-world problem domains.
  • converting from full manual to semi-autonomous control
  • atmospheric inference
  • Bayesian modeling techniques
  • Space based construction
Conclusion

control with gestures

robotic interfaces
semi-autonomy

brain computer interfaces

atmospheric inference

streaming frameworks

silent speech