Combining fNIRS and EEG to improve motor cortex activity classification during an imagined movement-based task

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HCI International 2011

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Biomedical Engineering Research Group

THE ADELAIDE & MEATH HOSPITAL, DUBLIN
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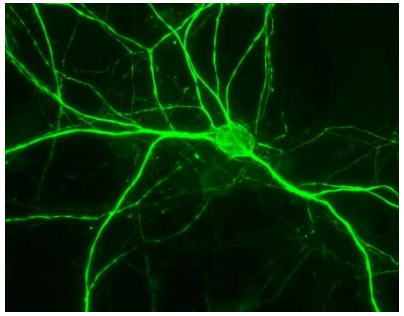
Introduction

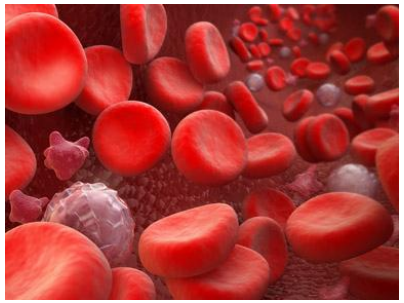
- Brain-Computer Interfacing
- Different recording modalities in use
- Our specific BCI goals
- Aims of this work

Measurement Modalities

- Electroencephalograhy (EEG)
  - Records electrical activity
  - Due to firing neurons
  - Good temporal resolution
  - Poor spatial resolution



- Functional Near-Infrared Spectroscopy (fNIRS)
  - Records haemodynamic activity
  - Due to oxygenated haemoglobin (HbO) and deoxygenated haemoglobin (Hb)
  - Poor temporal resolution
  - Good spatial resolution



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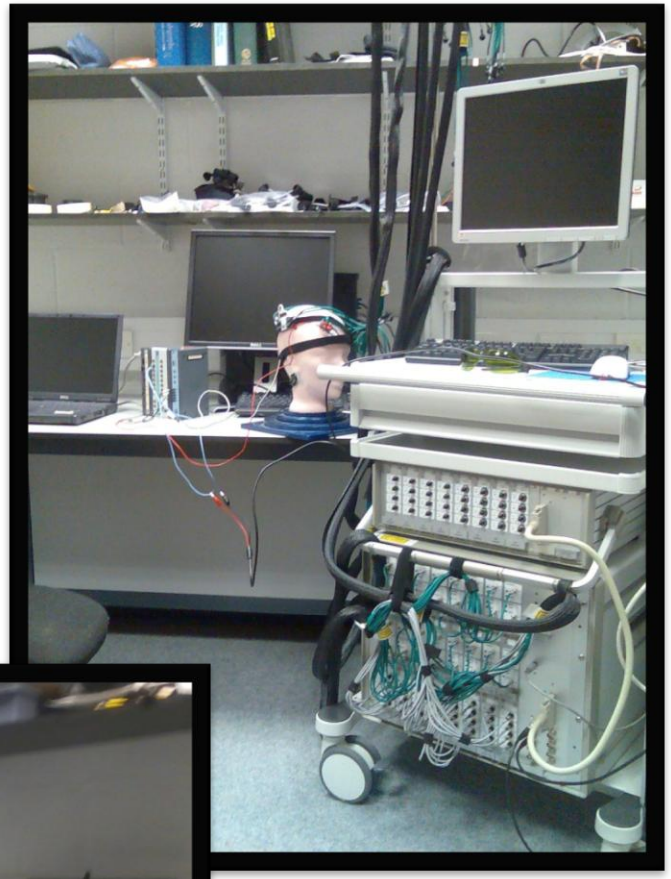
Measurement Modalities

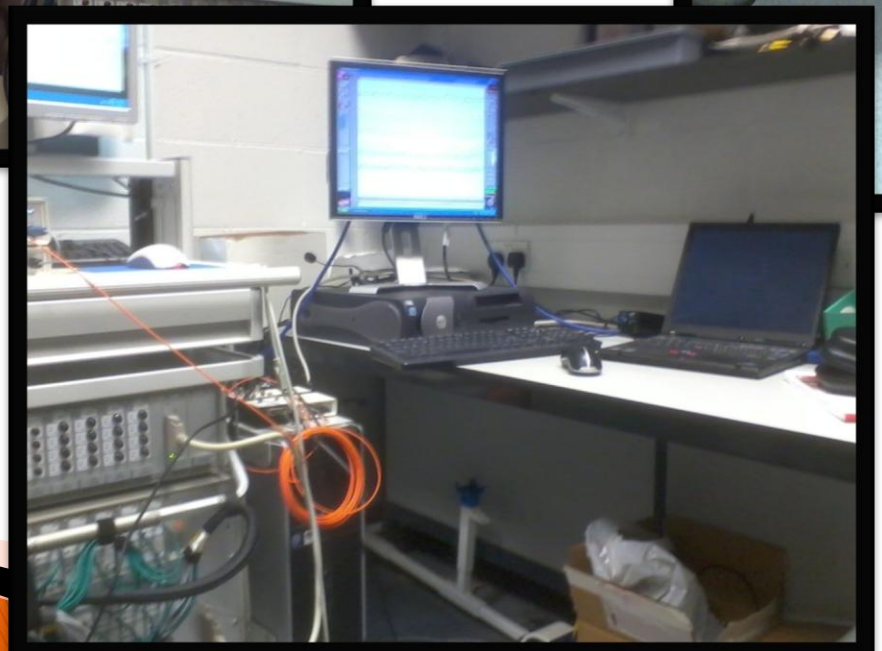
- Neurovascular coupling
  - The relationship between electrical and hemodynamic activity in the brain

Why EEG and fNIRS?

- Inexpensive
- Portable
- Wearable
- Robust

Our “rig”



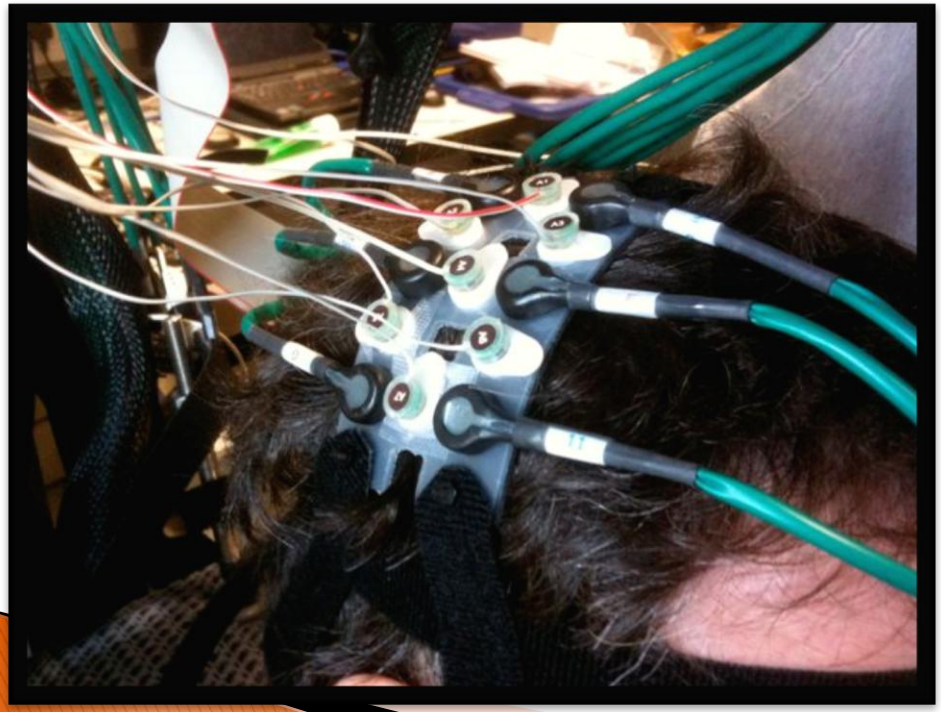


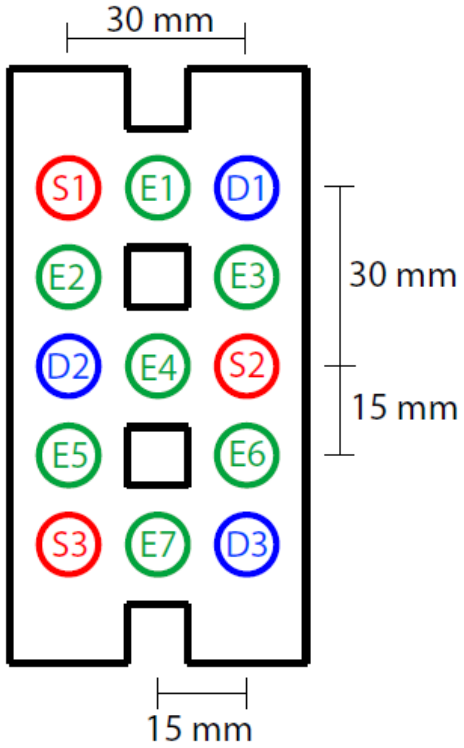
EEG:
BioSemi Active Two

NIRS:
TechEn CW6

Recording setup

- 7 EEG channels
- 7 fNIRS channels
- Centred on C3 or C4





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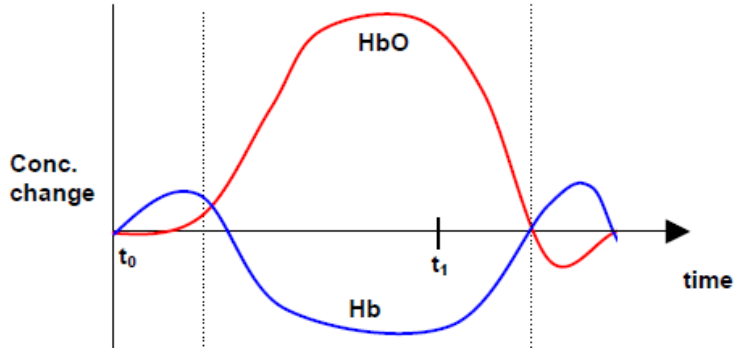
Experimental Procedure

- Two subjects
- Imagined Movement task
- Two alternating on-screen instructions
- 10 second epochs – 40 epochs per subject

Signal Processing

- EEG
  - Event Related (de)Synchronisation (ERD/ERS)
  - Isolate reference and response EEG data
  - Find frequency range of Mu and Beta activity
  - Measure spectral power change
- fNIRS
  - Raw intensity to Optical Density
  - Optical Density to HbO and Hb
  - Measure amplitude change



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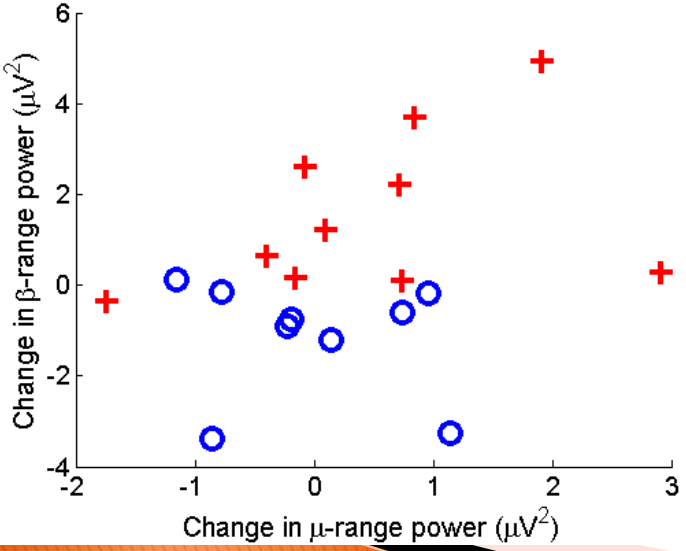
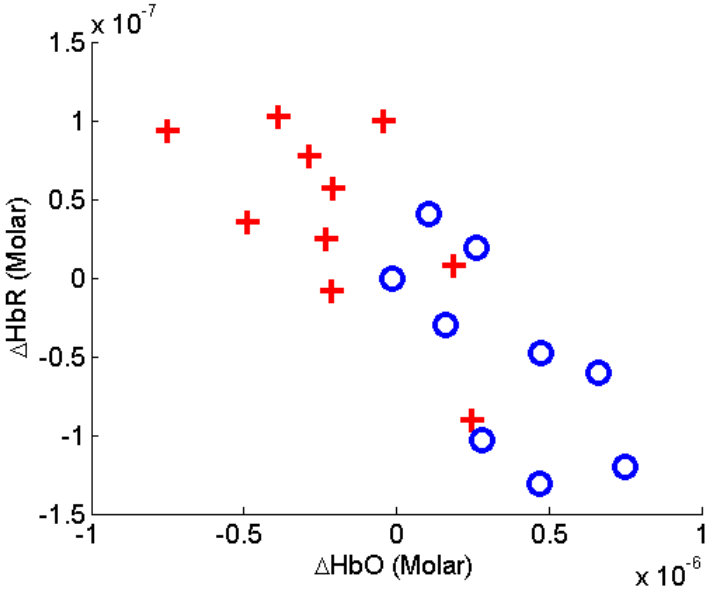
Classification

- EEG and fNIRS feature extraction
- 2 dimensional feature space
- Classification
  - Linear Discriminate Analysis (LDA)
  - Leave-one-out Cross Validation (LOOCV)





Combining EEG and fNIRS

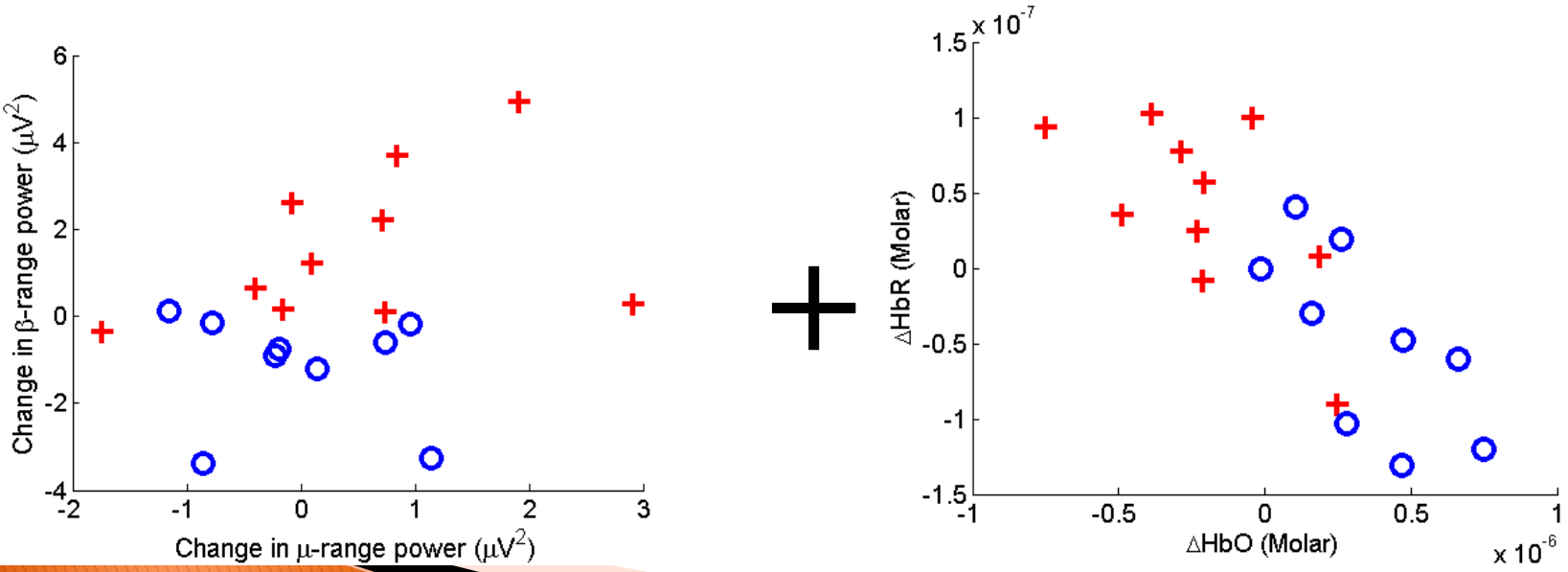
2 dimensional EEG features

+

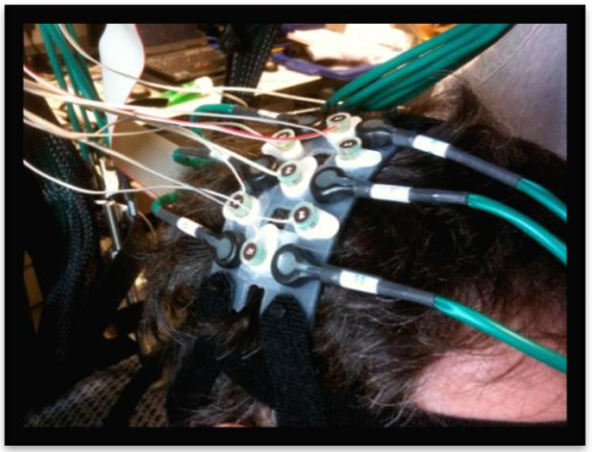
2 dimensional fNIRS features

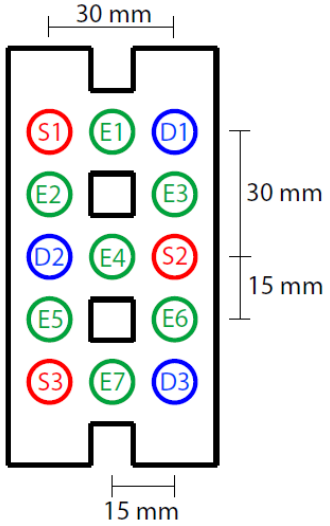
=

4 dimensional EEG/fNIRS features



Results





Classification Accuracy

	Subject A			Subject B		
Channel	fNIRS	EEG	Dual	fNIRS	EEG	Dual
1	59%	51%	64%	64%	46%	62%
2	56%	59%	67%	51%	54%	59%
3	56%	54%	64%	61%	41%	56%
4	69%	67%	72%	64%	59%	67%
5	61%	51%	72%	41%	36%	46%
6	56%	77%	64%	74%	59%	69%
7	56%	59%	62%	15%	43%	49%
Average	59%	60%	66%	53%	48%	58%

Conclusions

- Indications of improved classification accuracy
- Improved BCI performance
- Worthy of further multi-modal research
- Future work

Thank you for listening

Any questions?

With thanks to Science Foundation Ireland: Research Frontiers Program

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