Real Time Emotion Detection using EEG

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Emotions

- Emotion is a mental and a physiological state

- Emotion is very subjective

- There are more than 90 definitions of “emotion”
Models of Emotion Representation

• Two models for emotion representation
  – Darwin’s Model
  – Multi-dimensional View
Models of Emotion Representation

• The multi-dimensional view is often used
  – Simplicity
  – Universality
Motivation

• Lots of applications
  – Quantifying customers’ experience for product evaluation
  – Assistive Technology
  – Software Adaptation
  – Monitoring safety critical systems
Emotion Detection Channels

• Machine vision

• Voice detection
Physiological Channels

• They cannot be faked
• Produced from involuntary secretion glands
• Peripheral nervous system
  – Skin conductance
  – Skin temperature variations
  – Blood pressure
  – Heart Beat
Why EEG?

- Based on the cognitive theory of emotion, the brain is the center of every human action.

- Physiological signals, facial expressions, voice are all generated as a result of brain signals.
EEG Primer

• Whenever a neuron is active, its voltage changes
• Million of neurons fire together
• Each mental state produces a distinct pattern of electrical activity
Brain Regions

• **Frontal Lobe**
  – Primary motor cortex, Frontal Eye,
  – information processing,

• **Parietal**
  – Sensory information, taste, pressure, sound, temp..

• **Occipital**
  – Visual processing center

• **Temporal**
  – Auditory processing
<table>
<thead>
<tr>
<th>Rhythm</th>
<th>Frequency Range</th>
<th>Location</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta</td>
<td>(0-4) Hz</td>
<td>Frontal lobe</td>
<td>Deep sleep</td>
</tr>
<tr>
<td>Theta</td>
<td>(4-7) Hz</td>
<td>Midline, temporal</td>
<td>Drowsiness and meditation</td>
</tr>
<tr>
<td>Alpha</td>
<td>(8-13) Hz</td>
<td>Frontal, Occipital</td>
<td>Relaxing, closed eyes</td>
</tr>
<tr>
<td>Mu</td>
<td>(8-12) Hz</td>
<td>Central</td>
<td>Contralateral Motor acts</td>
</tr>
<tr>
<td>Beta</td>
<td>(13-30) Hz</td>
<td>Frontal, central</td>
<td>Concentration and thinking</td>
</tr>
<tr>
<td>Gamma</td>
<td>(30-100+) Hz</td>
<td></td>
<td>Cognitive functions</td>
</tr>
</tbody>
</table>
EEG and Emotions

- Emotions are most obvious in the alpha band
- The right hemisphere is responsible for negative emotions (disgust, fear, stress)
- The left hemisphere is responsible for positive emotions (Happiness, joy)
- EEG power decreases during sadness and increases during happiness (frontal lobe)
EEG and Emotion
General Approach

Signal Acquisition → Signal Preprocessing → Feature Extraction → Classification
Questions?

• Can we detect four different emotions, happiness, fear, disgust and neutral with reasonable accuracy?
• What is the minimum number of electrodes that can be used to detect the four emotions with a reasonable accuracy?
• What are the best features to extract?
Experiments

- Black Image (10 sec)
- Questions and rest (20 sec)
- Image (stimulus) (10 sec)
EEG Montage

- 10-20 international system
Signal Preprocessing

- Notch filter (to remove line noise)
- Independent Component Analysis
Feature Extraction
Classification

- Support Vector Machines (SVMs)
- Artificial Neural Networks
- Bayesian Networks
Tools

- G.Mobilab
  - 8 channels
  - Active electrodes
- BCI2000
- EEGLAB
- IAPS
Plan

• Classify the signals into positive, negative and neutral states and classify between these signals
• Try to divide the negative states into disgust and fear
• Explore emotion detection accuracy Vs. number of channels