Facial Emotion Recognition

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What are emotions?

• Defining emotions is an everlasting debate
  – Categorical [1]?
  – Dimensional [2]?
  – Appraisal [3]?

• Facial Emotion Recognition concentrates mainly on categorical approach

Facial Expressions

• A face does not only express emotions, but also other social signals [1], such as:
  
  - Personality
  - Dominance
  - Regulation
  - Status
  - Persuasion
  - Rapport

• Further, humans are in control of showing and hiding emotions

Facial Emotion Recognition Systems

1. Analyse streaming video and track the facial feature points over time

2. Calculate feature vectors

3. Detect emotions according to trained models

4. Recognition models are trained using annotated database
Architecture

Face Extraction

Face Position & Rotation

Facial Feature Extraction

Geometric-based  Appearance-based

Affect Recognition

Spatial  Spatio-temporal
Facial Feature Tracking

• Geometric features [1] (Our approach)
  – The shapes of the facial components (eyes, mouth, etc.)

• Appearance features [2]
  – The texture of the facial skin (wrinkles, bulges, and furrows)


Our tracking

1. Fitting the skeleton Active Shape Models
2. Refining lips by lips color segmentation
3. Refining tracking by template matching
Emotion Classification

- Using Spatial Information (Our approach)
  - Based on static facial expressions [1]
- Using Spatial-Temporal Information
  - Based on transformation of facial expressions over time [2]
  - Makes it possible to distinguish spontaneous emotional expressions from fake ones [3]
  - Difficulty in implementation results in lower accuracy

Databases

• The most well-known databases:
  – Cohn-Kanade AU-Coded Facial Expression Database [1]
  – FABO database [2]
  – MMI Facial Expression Database [3]
  – Belfast Naturalistic Emotional Database [4]

• Controlled Environment

## Results

<table>
<thead>
<tr>
<th>Nr</th>
<th>Type</th>
<th>Classes</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>Spatial</td>
<td>6</td>
<td>73%</td>
</tr>
<tr>
<td>[2]</td>
<td>Spatial</td>
<td>8</td>
<td>80%-100%</td>
</tr>
<tr>
<td>[3]</td>
<td>Spatial</td>
<td>4</td>
<td>93%-95%</td>
</tr>
<tr>
<td>[4]</td>
<td>Spatial-Temporal</td>
<td>6</td>
<td>77%</td>
</tr>
<tr>
<td>[5]</td>
<td>Spatial-Temporal</td>
<td>2</td>
<td>94%</td>
</tr>
</tbody>
</table>


MultiModal Affect Fusion

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Fusion of Multi-Modalities

• Decision Level Based

Fusion of Multi-Modalities

• Feature Level Based

Static Fusion

• Feature Level Based [1]
  • Features from different modalities are classified by one classifier
  • Dimensionality reduction is applied
• Decision Level Based [2]
  • Classified emotional values are fused according to the confidence
  • Trained on ground truth values

Next to confidence levels, historical information is also taken into consideration to determine the next emotion.

- Feature Level Based [1]
  - Changes in the features over time
- Decision Level Based [2] (our approach)
  - Duration of previous detected emotion
  - Variability of previous detected emotion


Results

<table>
<thead>
<tr>
<th>Nr</th>
<th>Face</th>
<th>Speech</th>
<th>Bio</th>
<th>Level</th>
<th>Type</th>
<th>Acc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Decision</td>
<td>Static</td>
<td>95%-98%</td>
</tr>
<tr>
<td>[2]</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Feature</td>
<td>Static</td>
<td>84%-87%</td>
</tr>
<tr>
<td>[3]</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Decision</td>
<td>Temporal</td>
<td>89%</td>
</tr>
<tr>
<td>[4]</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Feature</td>
<td>Temporal</td>
<td>84%</td>
</tr>
<tr>
<td>[5]</td>
<td>X</td>
<td></td>
<td>X</td>
<td>Decision</td>
<td>Static</td>
<td>54%</td>
</tr>
<tr>
<td>[5]</td>
<td></td>
<td>X</td>
<td>X</td>
<td>Feature</td>
<td>Static</td>
<td>51%</td>
</tr>
</tbody>
</table>


Other Research
About Emotions
MIRALab

• A pluridisciplinary lab working on virtual human simulation and virtual worlds

- Facial animation
- Motion capture
- Virtual heritage
- Social robots
- Medical simulation
- Hair simulation
- Graphics standardization
- Collaborative virtual environments
- Web 3D
- Body animation
- Mixed realities
- Virtual clothing
- Personality and emotion simulation
- Web 3D
- Multidevices platform (PDAs & cellphones)
Personality/Emotion Simulation

Egges et al. 2004

Kshirsagar et al. 2002


Emotion Engine

- OCEAN personality*
  - Openness, Conscientiousness, Extroversion, Agreeableness, Neuroticism

- OCC emotions**
  - Positive: Joy, hope, relief, pride, gratitude, love
  - Negative: Distress, fear, disappointment, remorse, anger, hate

- Mehrabian Mood***
  - 3 dimensional: pleasure, arousal, dominance
  - Positive: Exuberant, dependant, relaxed, docile,
  - Negative: Bored, disdainful, anxious, hostile

- Relationship****
  - Friendliness and dominance

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Facial Animation

Ongoing Research
Virtual Humans & Robotics
• Thank you for your attention