Estimation of Human Emotion by Analyzing Facial Expression Transition of Image Sequences

Prarinya Siritanawan

Supervisor: Kazunori Kotani

School of Information Science
Japan Advanced Institute of Science and Technology
Overview of emotion analysis system in human-machine interaction
Problem

• Training process used only still peak emotion expressions. The rest were neglected.
• Cannot capture subtle (weak) expression
Problem

• Limited by Ekman’s basic emotion (Ekman, 1972)

• Almost every facial expression analysis in computer vision field used this category

• Discrete class

• People do not express these expressions all the time

![Basic emotion expression](image)

Basic emotion expression
(Ekman, 1972, CK dataset)
(1) disgust, (2) fear, (3) joy,
(4) surprise, (5) sadness, (6) anger
We introduce a novel feature modeled from dynamic facial expression by the extension of 2D Gabor features and independent component analysis.
Robust against:
- Face alignment error (translation, scaling)
- Other types of interferences (illumination varying, blur, noise)

Low-frequency components reduce influences from head motions and face detection/tracking errors

High-frequency components compensate the loss information
Muscle and Face appearance used in psychology (Ekman et al. 2002)

<table>
<thead>
<tr>
<th>AU Number</th>
<th>FACS Name</th>
<th>Muscular Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inner Brow Raiser</td>
<td>frontalis (pars medialis)</td>
</tr>
<tr>
<td>2</td>
<td>Outer Brow Raiser</td>
<td>frontalis (pars lateralis)</td>
</tr>
<tr>
<td>4</td>
<td>Brow Lowerer</td>
<td>depressor glabellae, depressor supercilli, corrugator supercilli</td>
</tr>
<tr>
<td>5</td>
<td>Upper Lid Raiser</td>
<td>levator palpebrae supercili, superior tarsal muscle</td>
</tr>
<tr>
<td>6</td>
<td>Cheek Raiser</td>
<td>orbicularis oculi (pars orbitalis)</td>
</tr>
<tr>
<td>7</td>
<td>Lid Tightener</td>
<td>orbicularis oculi (pars palpebralisis)</td>
</tr>
<tr>
<td>9</td>
<td>Nose Wrinkler</td>
<td>levator labii superioris alaeque nasi</td>
</tr>
<tr>
<td>10</td>
<td>Upper Lip Raiser</td>
<td>levator labii superioris, caput infraorbitalis</td>
</tr>
<tr>
<td>11</td>
<td>Nasolabial</td>
<td>zygomaticus minor</td>
</tr>
<tr>
<td>12</td>
<td>Deepener</td>
<td>zygomaticus major</td>
</tr>
<tr>
<td>13</td>
<td>Lip Corner Puller</td>
<td>levator anguli oris (also known as caninus)</td>
</tr>
<tr>
<td>14</td>
<td>Sharp Lip Puller</td>
<td>buccinator</td>
</tr>
<tr>
<td>15</td>
<td>Dimpler</td>
<td>depressor anguli oris (also known as triangularis)</td>
</tr>
<tr>
<td>16</td>
<td>Lip Corner Depressor</td>
<td>depessor labii inferioris</td>
</tr>
<tr>
<td>17</td>
<td>Lower Lip Depressor</td>
<td>depessor labii inferioris, or relaxation of mentalis or orbicularis oris</td>
</tr>
<tr>
<td>18</td>
<td>Chin Raiser</td>
<td>mentalis</td>
</tr>
<tr>
<td>19</td>
<td>Lip Pucker</td>
<td>incisivi labii superioris and incisivi labii inferioris</td>
</tr>
<tr>
<td>20</td>
<td>Lip Stretcher</td>
<td>risorius w/ platysma</td>
</tr>
<tr>
<td>21</td>
<td>Neck Tightener</td>
<td>platysma</td>
</tr>
<tr>
<td>22</td>
<td>Lip Funneler</td>
<td>orbicularis oris</td>
</tr>
<tr>
<td>23</td>
<td>Lip Tightener</td>
<td>orbicularis oris</td>
</tr>
<tr>
<td>24</td>
<td>Lip Pressor</td>
<td>orbicularis oris</td>
</tr>
<tr>
<td>25</td>
<td>Lips Part</td>
<td>depressor labii inferioris, or relaxation of mentalis or orbicularis oris</td>
</tr>
<tr>
<td>26</td>
<td>Jaw Drop</td>
<td>masseter; relaxed temporalsis and internal pterygoid</td>
</tr>
<tr>
<td>27</td>
<td>Mouth Stretch</td>
<td>pterygoids, digastric</td>
</tr>
</tbody>
</table>
Facial Action Coding System (FACS)

Explain more complex facial expression by FACS

Training procedure

Training set

\[ \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_N \end{bmatrix} \]

EMC training

ICA training

Input

CDG = \hat{x} = \hat{\mathbf{x}}

Subspace

Manifold vector

ICA training

Dictionary

Project on ICA subspace

Distance to each AU

Output

AU1 = 0/1

AU2 = 0/1

AU4 = 0/1

AU27 = 0/1

\[ z = \{ z_{AU1}, z_{AU2}, \ldots, z_{AU27} \} \]

\[ z_{AU1} = \{ z_{isAU1}, z_{isNotAU1} \} \]

\[ z_{AU2} = \{ z_{isAU2}, z_{isNotAU2} \} \]

\[ \vdots \]

Recognition procedure

\[ \text{sim}(\hat{x}, \mathbf{x}) \]

\[ \text{sim}(\hat{x}, \mathbf{x}) \]

\[ \text{sim}(\hat{x}, \mathbf{x}) \]

\[ \text{sim}(\hat{x}, \mathbf{x}) \]

\[ \vdots \]
Beyond basic emotion

Dimensional emotion model

- Continuous values
- More complex emotion
Conclusion

• Estimating emotion parameters from subtle and complex facial expressions
  • A novel robust temporal feature
  • A novel Action Units (AUs) detector
• Facial expression beyond Ekman’s basic emotions

See more at:
