Goal  A robot that develops multimodal emotional intelligence as < 1 yr olds

1. Background
In 2010, we developed robots that could play music with humans.

While useful for practice, these and other empathetic companion robots are not accepted because they do not express true feelings: “nobody likes fake emotion.”

2. Research questions
How can we create an emotionally authentic robot?

Authentication: “Made or done the same way as an original” (Merriam Webster)

Can we make a robot develop and learn emotions like a human?

3. Development of emotional intelligence

Expression

<table>
<thead>
<tr>
<th>Primary Emotions</th>
<th>First appearance</th>
<th>Emotion</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>Joy</td>
<td>Sadness</td>
</tr>
<tr>
<td>2 to 6 months</td>
<td>Sadness Displeased</td>
<td></td>
</tr>
<tr>
<td>First 6 months</td>
<td>Surprise</td>
<td></td>
</tr>
<tr>
<td>6 to 12 months</td>
<td>Fear/peaks at 18 months</td>
<td></td>
</tr>
</tbody>
</table>

Self-Consicous Emotions

| 11/2 to 2 years | Empathy Judgment Embarrassment |

[Sigelman & Rider, 2012]

4. Scope of my research

- An emotion model developed through interaction with a human, similar to < 1 year olds
- Expression and recognition of emotion in multiple modalities
- Primary emotions: happiness, sadness, anger, fear

5. Proposed Approach

Motherese: “Concurrent with the exaggerated speech of motherese, there are probably exaggerated facial displays. Child-centered displays may serve as opportunities for learning about affective events.” (Soken and Pick, 1992)

6. SIRE Emotion Model

It’s long been suggested that music emotions have its origins in the voice (Juslin & Laukkia, 2001). In 2011, we developed a cross-modality model to describe happiness, sadness, anger and fear through 4 common perceptual parameters: speed, intensity, regularity and extent (SIRE) [Lim et al, 2012]

7. Training by voice, Testing of motion

We train 2-mix Gaussian Mixture models with normalized SIRE samples from voice, one for each of our 4 emotions.

- Recognition of emotion by taking the model with max probability.
- Expression of emotion by sampling the desired GMM and perceptually mapping the SIRE to music [Lim et al, 2012] or motion [Lim et al, 2011].

8. Experiments

Recognizing emotion in motion (gait)

- Happy and sad walks recognized well over chance
- Hot anger mis-recognized as elation
- Anxious fear confused as sadness [Lim and Okuno, 2012]

Expressing emotion in voice & motion (see video)

- Happiness and sadness again well recognized.
- Terror fear expressed approaching the object was mistaken as happiness
- Cold anger expressed approaching the object lacked dominance component [Lim and Okuno, in prep.]

9. Future Work

- Offline → Online training
- Happy/sad as basis, scaffolding for anger and fear
- Grounding learned SIRE samples in positive and negative somatosensory states, e.g. battery levels [Ask to learn more!]

Using Motherese to Develop Multimodal Emotional Intelligence for Robots
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