Detecting Eye Contact using Wearable Eye-Tracking Glasses

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2nd International Workshop on Pervasive Eye tracking and Mobile Eye-Based Interaction in conjunction with UbiComp 2012
Overview
Overview
Overview
Overview
Overview
Overview

Eye Tracker

Forward-looking Camera
Overview

Eye Tracker

Forward-looking Camera
Overview

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Eye Tracker
Forward-looking Camera

Eye Contact Detected
Motivation

Gaze Tracking for Children

Our Method

Experiments
Motivation

• Eye contact is the most powerful form of nonverbal communication.

• Especially, eye contact is an crucial aspect in the social development of young children.

• Atypical patterns of gaze and eye contact have been identified as potential early signs of Autism Spectrum Disorder (ASD).
Motivation

• Evidence of atypical patterns of gaze for children with ASD in comparison to Typically Developed (TD) children.

Motivation

• Looking at the eyes of others was significantly decreased in 2-year-old children with ASD.

Motivation

• Validate the findings in daily interactions between a child and an adult.

• Study older children who may be uncooperative.
Motivation

• Validate the findings in daily interactions between a child and an adult.

• Study older children who may be uncooperative.

• A system to detect eye contact in naturalistic dyadic settings.
Motivation

Gaze Tracking for Children

Our Method

Experiments
Manual Annotation of Eye Contact

- Scoring Sheets
- Video Annotation Tools
- Coding Consistency
Eye Tracker for Children

Pros:
• Lightweight mobile eye tracker
• Designed for children

Cons:
• Can be dangerous for toddlers
• Might be distracting for older children
Motivation
Gaze Tracking for Children
Our Method
Experiments
Design

Gaze point of the adult

First Person View Video
Design

Gaze point of the adult

First Person View Video

Face Analysis of the Child
Design

- Gaze point of the adult
- Random Forest Classifier
- Eye Contact Detection
- First Person View Video
- Face Analysis of the Child

3 ~ 5 minutes free playing
Technical Details

SMI Eye Tracking Glasses

Face Orientation
- Vertical Direction: $\alpha$
- Horizontal Direction: $\beta$
- Rotation: $\gamma$

Omron OKAO Vision Library

Gaze Direction
- Vertical Direction: $\theta$
- Horizontal Direction: $\phi$
Technical Details

SMI Eye Tracking Glasses

Omron OKAO Vision Library

Relative Location (Gaze - Eyes), Face orientation, Gaze Direction …

Features

Decision Tree

- Is eye confidence high?
  - true
  - false

- Is relative distance large?
  - true
  - false

Eye Contact, Not Eye Contact
**Technical Details**

SMI Eye Tracking Glasses

Relative Location (Gaze - Eyes), Face orientation, Gaze Direction …

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**Features**

Relative Location (Gaze - Eyes), Face orientation, Gaze Direction …

Decision Tree

Is eye confidence high?

Is relative distance large?

Eye Contact

Not Eye Contact

Random Forest
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Experiments
Annotation
Annotation

Ground Truth

Eye Contact
Video Demo

Project and Demo will soon be available here.
More Results

Successful Cases

Failure Cases
Quantitative Measures

- One subject currently
- >12000 frames
- Foot Pedal for Ground Truth
- Detection as binary classification
- 60% frames for training

<table>
<thead>
<tr>
<th>Ground Algorithm</th>
<th>True</th>
<th>False</th>
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</thead>
<tbody>
<tr>
<td>True</td>
<td>1322(75.3%)</td>
<td>145(1.7%)</td>
</tr>
<tr>
<td>False</td>
<td>433(24.7%)</td>
<td>8455(98.3%)</td>
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</table>

- 80% precision
- 72% recall
What are the important features?

- Relative Location (both vertical and horizontal)
- Vertical Gaze Direction of the Child

<table>
<thead>
<tr>
<th>Face Location</th>
<th>Child’s Gaze Direction</th>
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<tbody>
<tr>
<td>Vertical</td>
<td>Horizontal</td>
</tr>
<tr>
<td>1.00</td>
<td>0.78</td>
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<td>0.66</td>
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<td>0.42</td>
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<table>
<thead>
<tr>
<th>Head Orientation</th>
<th>Eye Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>Horizontal</td>
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<tr>
<td>0.40</td>
<td>0.31</td>
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<td>0.35</td>
</tr>
<tr>
<td></td>
<td>0.51</td>
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</table>
Conclusion

• We present a novel alternative approach to measure child-adult gaze behavior in dyadic naturalist interactions.

• Preliminary results based on a laboratory implementation are promising.
The Future

• A larger dataset with more subjects
• A real time streaming system
• Prediction of social engagement by eye contact and facial expression of the child
Other Efforts

Other Efforts

Alireza Fathi, Yin Li, James M. Rehg, *Learning to recognize daily actions using gaze*, the European Conference on Computer Vision (ECCV), 2012  [Project and Dataset]
Questions?
Thanks for your attention!