

# Detecting Eye Contact using Wearable Eye-Tracking Glasses

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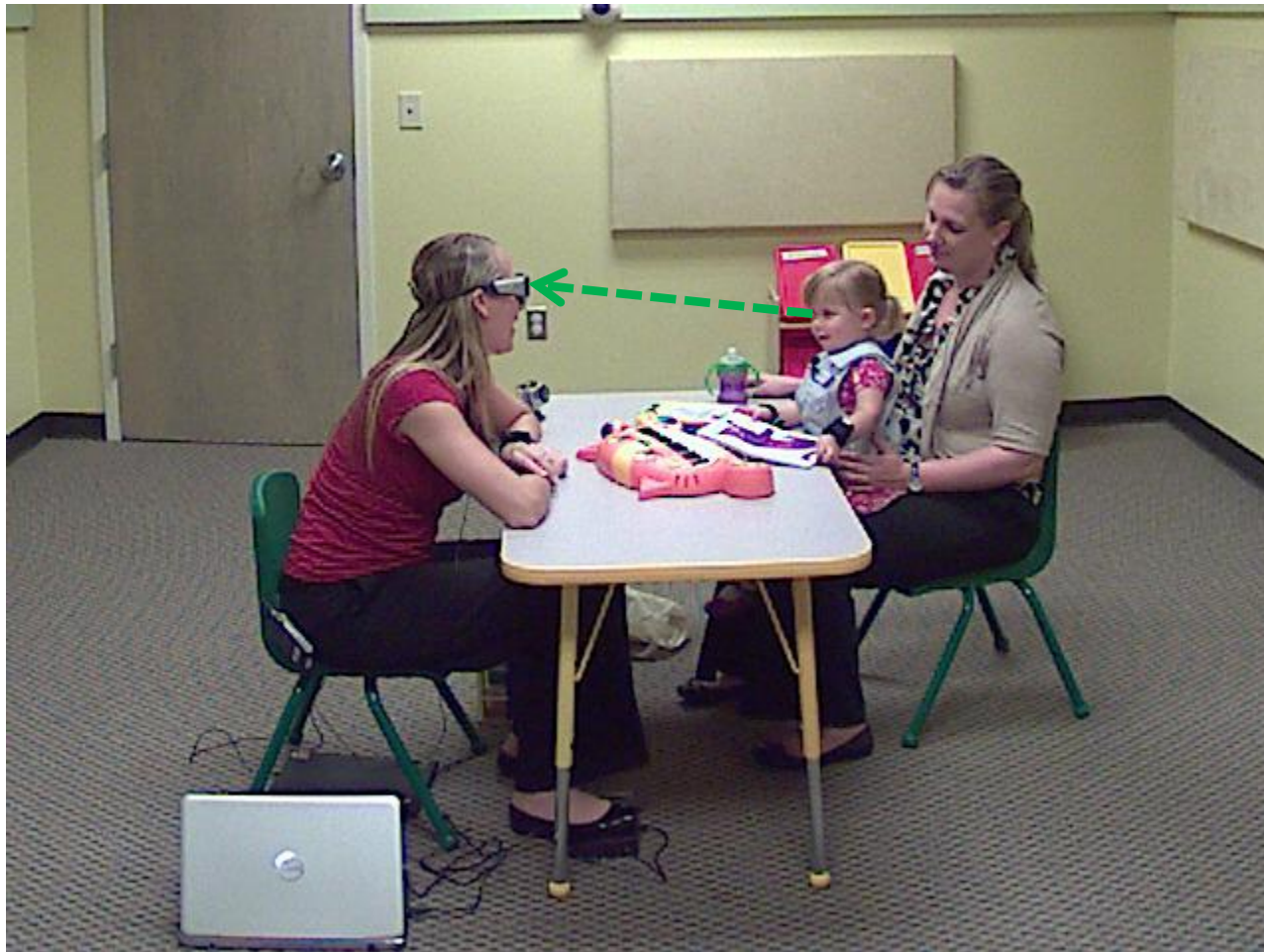
Zhefan Ye, Yin Li, Alireza Fathi, Yi Han, Agata Rozga,  
Gregory D. Abowd, James M. Rehg

Center for Behavior Imaging  
College of Computing  
Georgia Institute of Technology

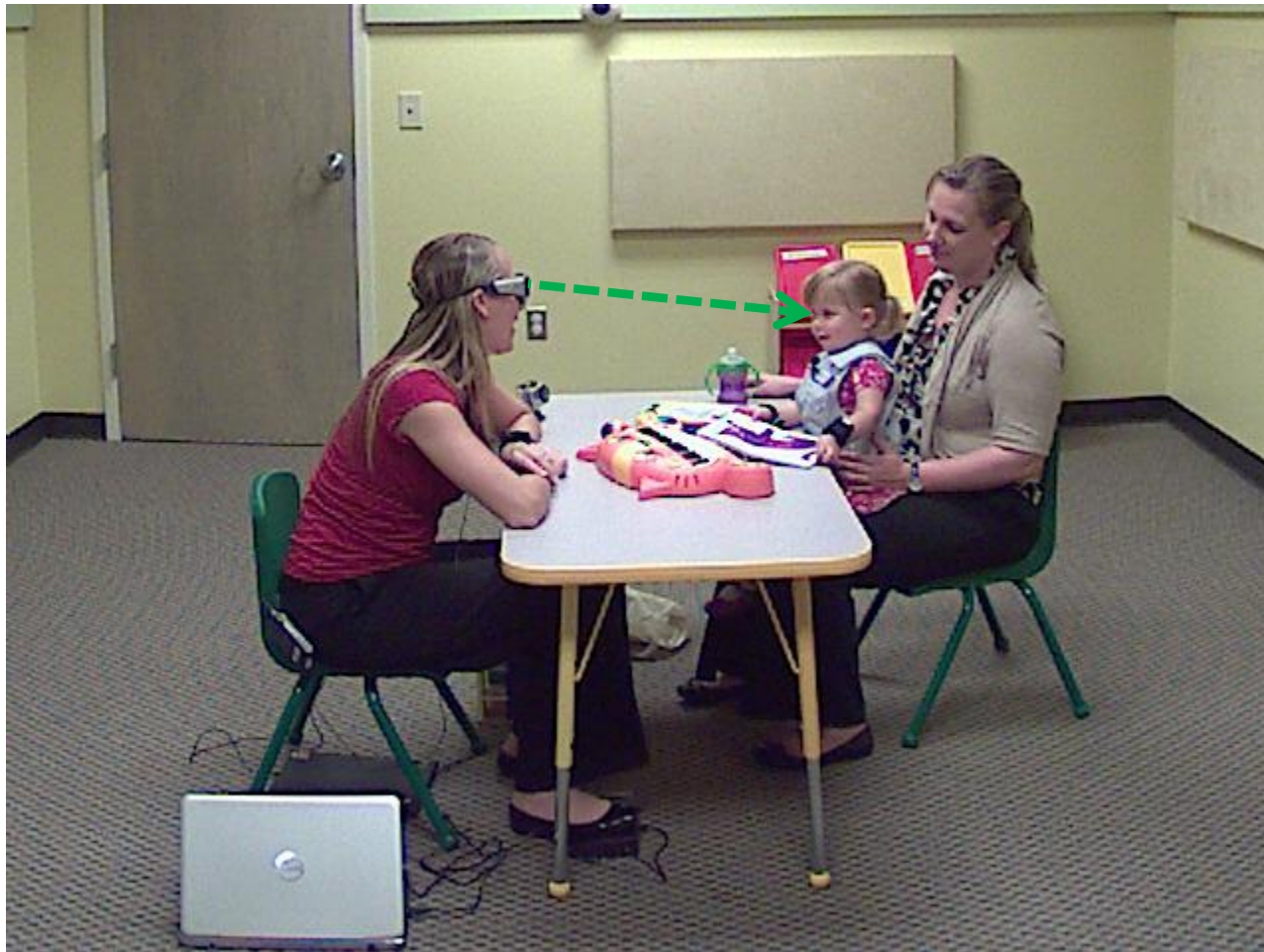
# Overview



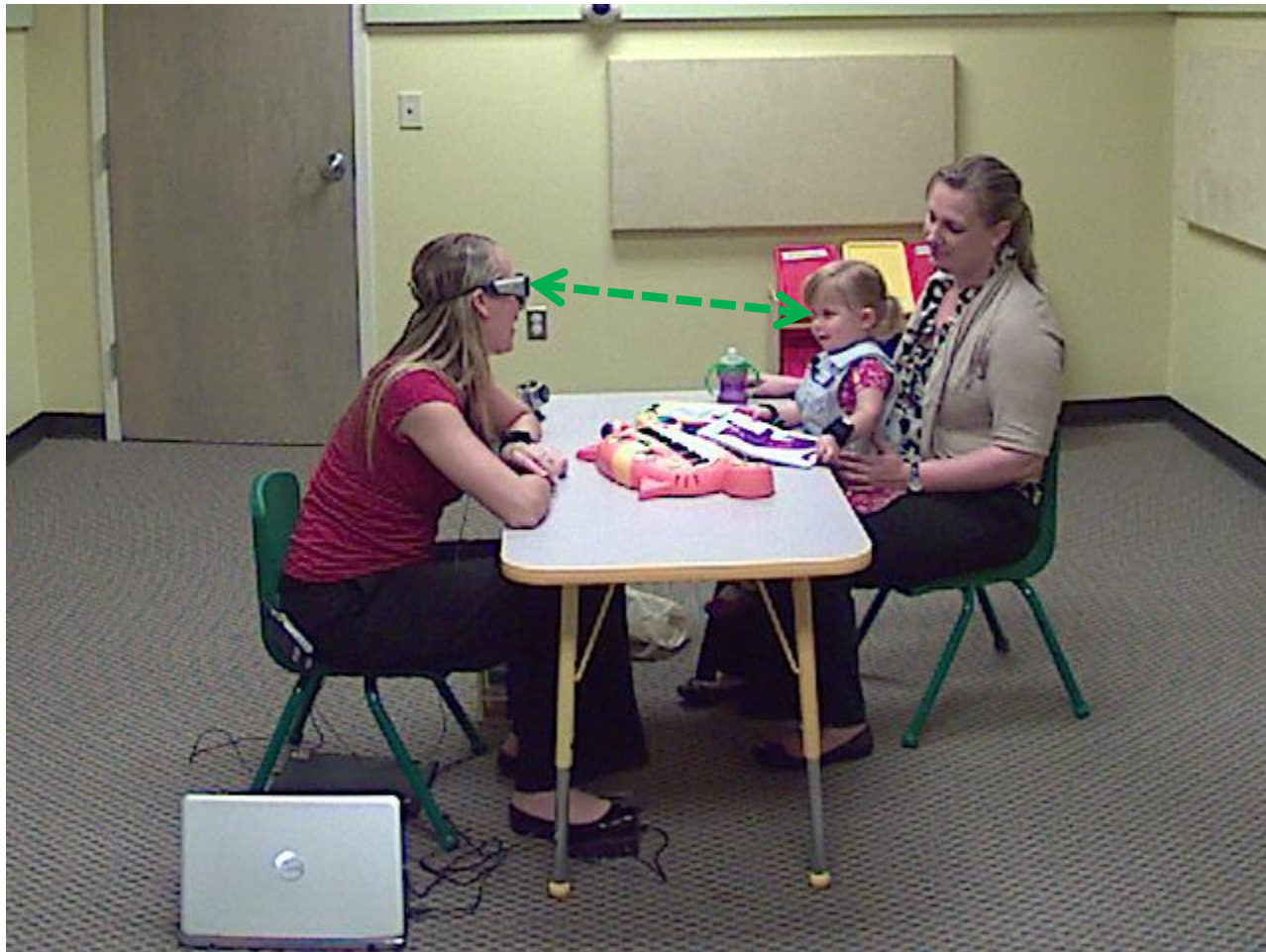
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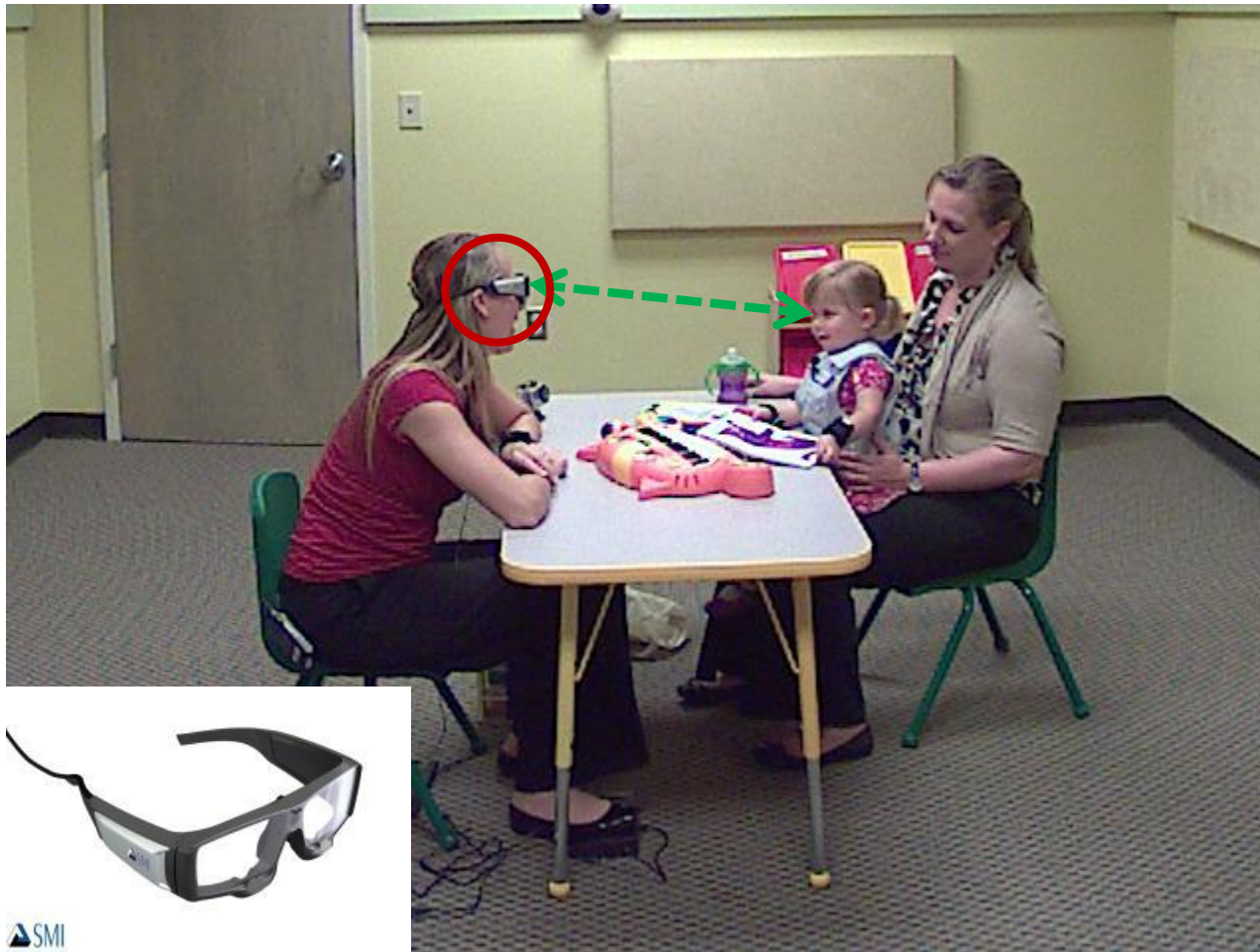
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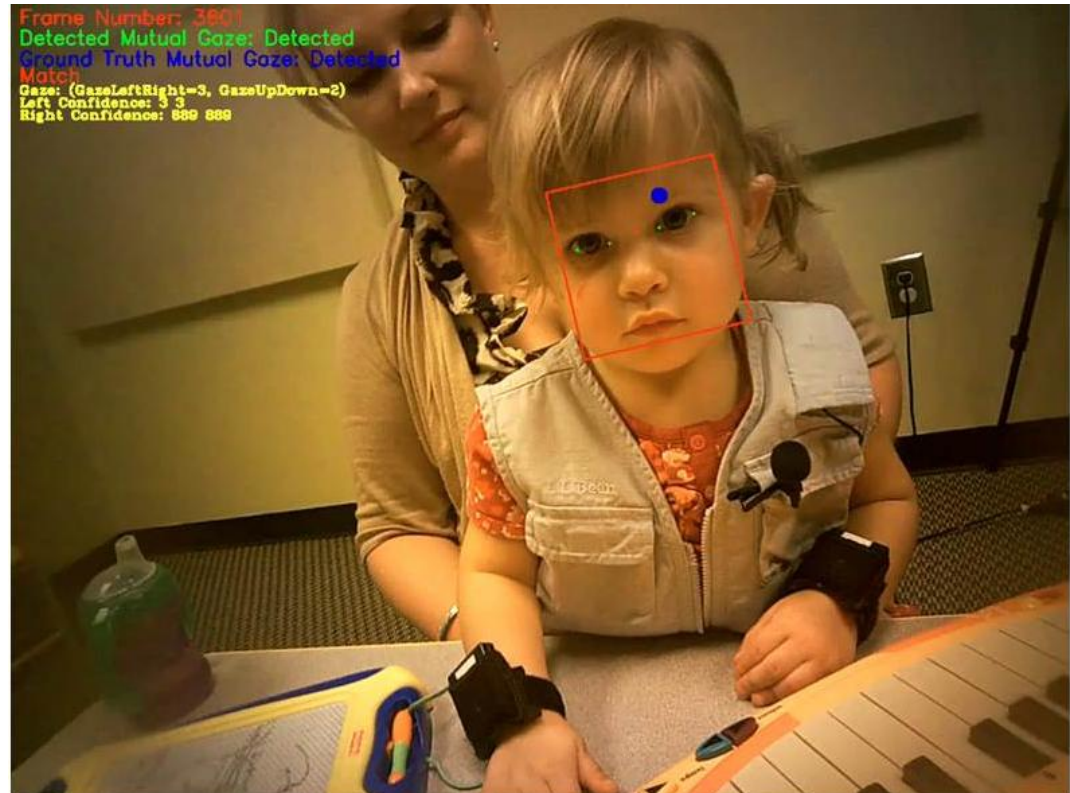
# Overview



Eye Tracker

Forward-looking Camera

# Overview

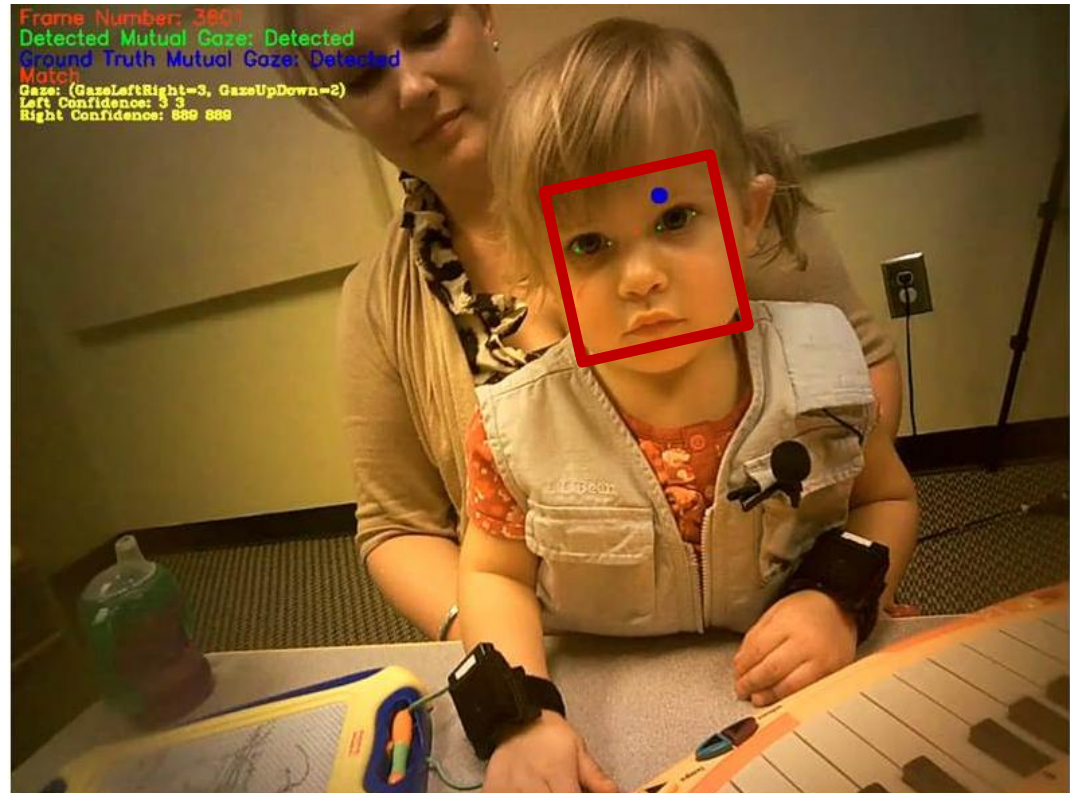


Eye Tracker

Forward-looking Camera



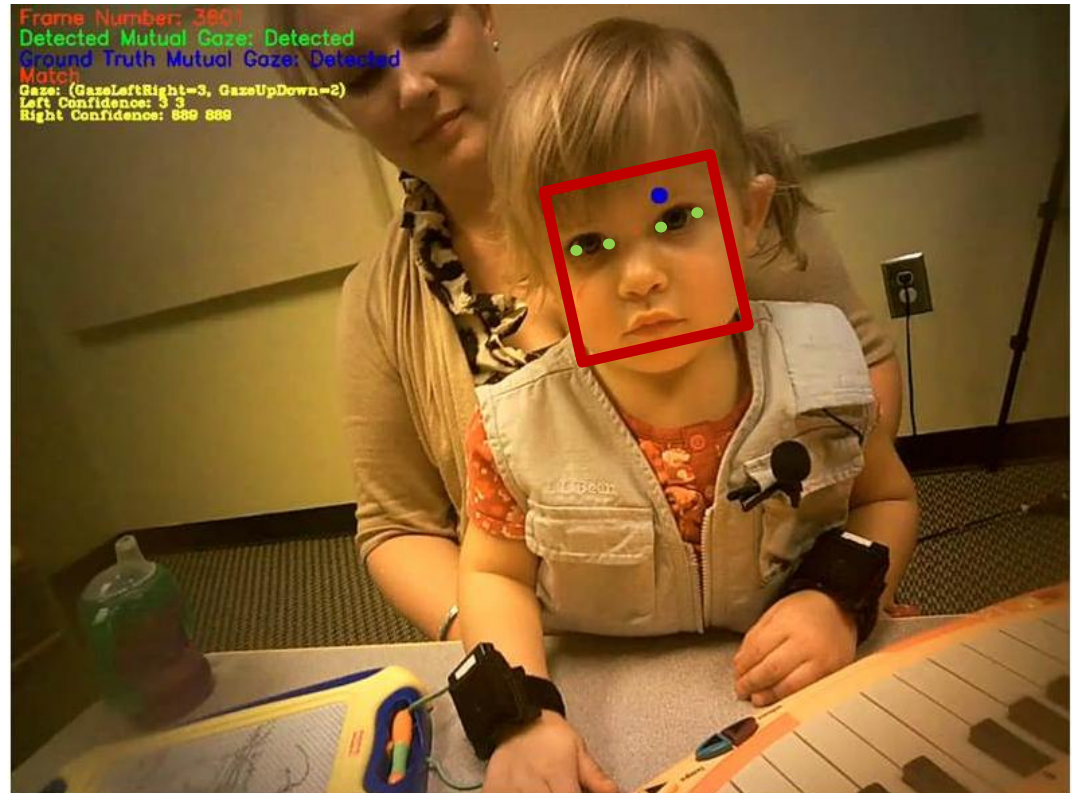
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Eye Tracker

Forward-looking Camera

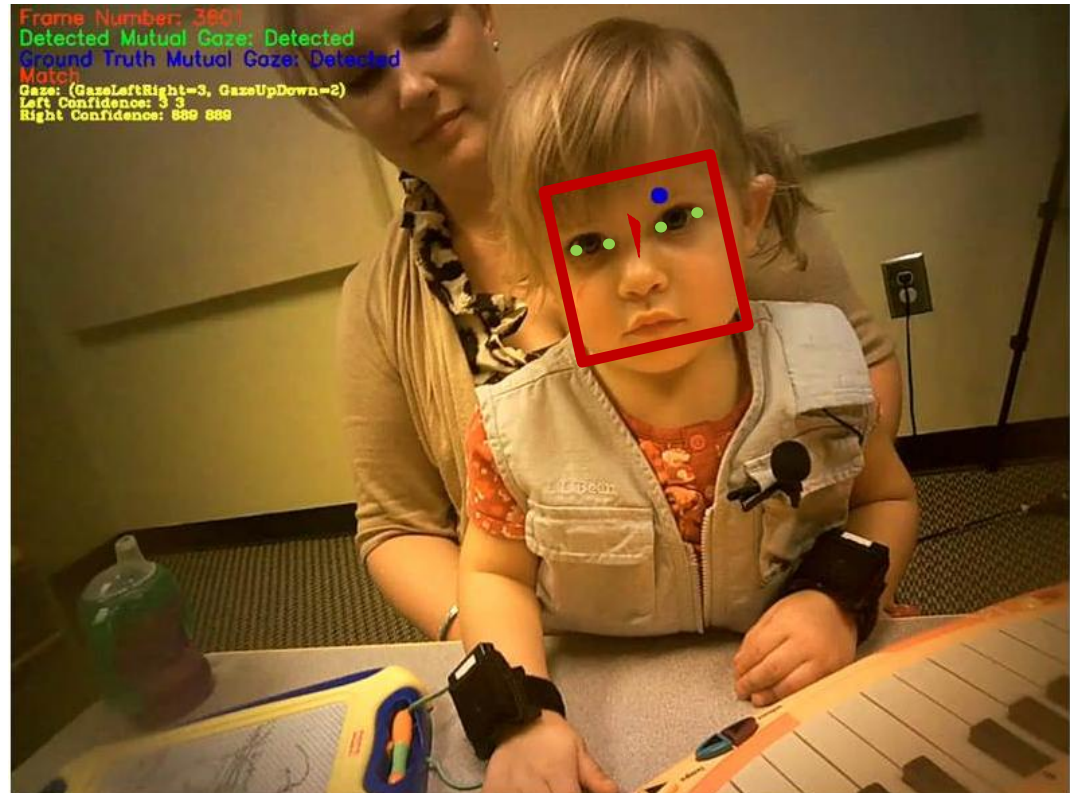
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Eye Tracker

Forward-looking Camera

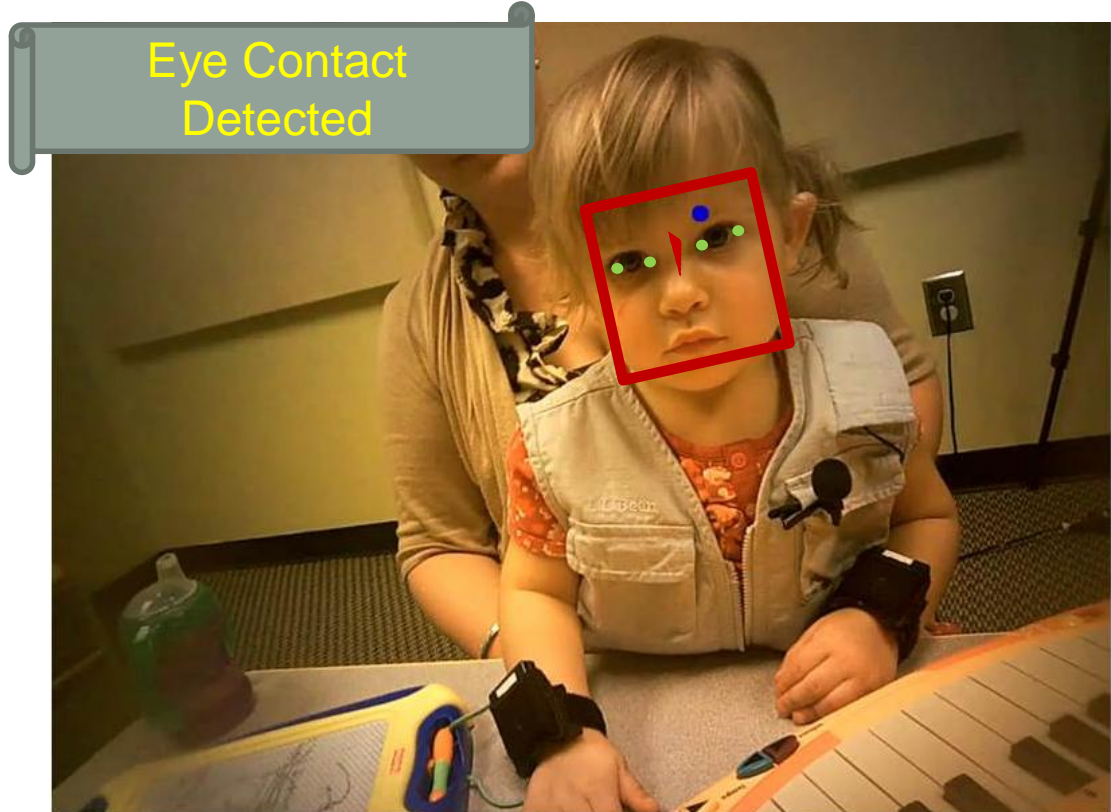
# Overview



Eye Tracker

Forward-looking Camera

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Eye Tracker

Forward-looking Camera

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.



## On-Screen Eye Tracking



ASD

TD

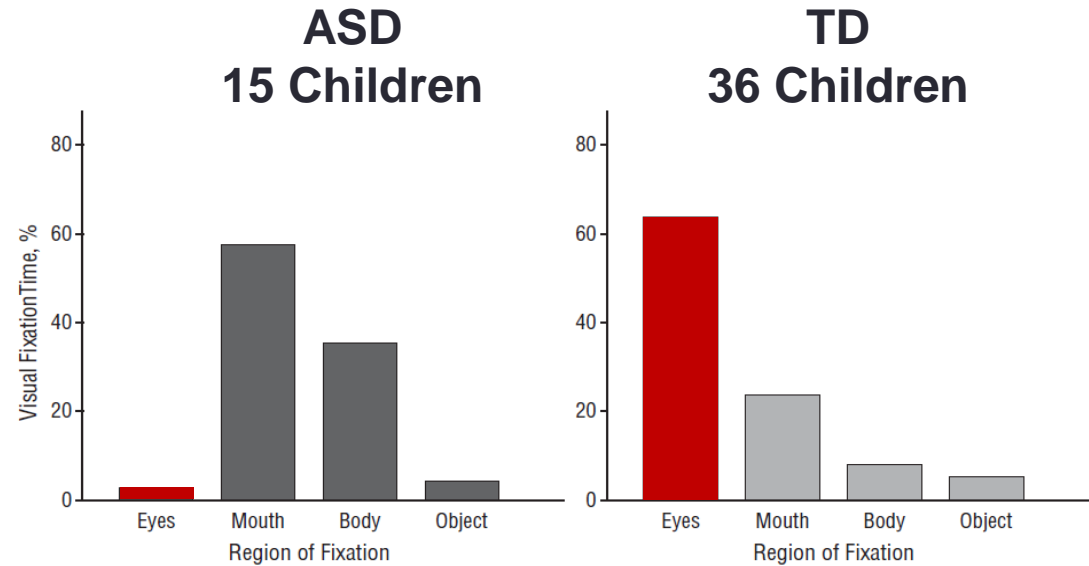
Jones W, Carr K, Klin A. **Absence of preferential looking to the eyes of approaching adults predicts level of social disability in 2-year-old toddlers with autism spectrum disorder.** Arch Gen Psychiatry. 2008 Aug;

# Motivation

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



## On-Screen Eye Tracking



Jones W, Carr K, Klin A. **Absence of preferential looking to the eyes of approaching adults predicts level of social disability in 2-year-old toddlers with autism spectrum disorder.** Arch Gen Psychiatry. 2008 Aug;

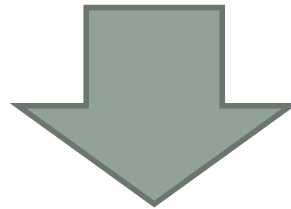


# Motivation

- Validate the findings in daily interactions between a child and an adult.
- Study older children who may be uncooperative.

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- **A system to detect eye contact in naturalistic dyadic settings.**

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# Manual Annotation of Eye Contact

**RAPID - ABC / screener™**

Step 1. Score a PLUS if behavior is present and a MINUS if behavior is not present. Step 2. RATE BASED ON ENGAGEMENT

When you are ready to start, smile and say in a playful tone "Hi (insert child's name)!" Pause for 2 seconds, say "Are you ready to play with some new toys?" Lean in and keep smiling for 2 seconds.

SMILING & SAYING "HELLO"

Hold the ball to the right about 12 inches from your head at your eye level. Say, "Look at my ball." Watch to see if child looks at the ball then back to your eyes.

Say, "Let's play ball. Ready, set, GO!" See if the child will roll or throw the ball back to you, then repeat at least 2 times, but not more than 4.

On the 3<sup>rd</sup> roll say, "Ready, set" PAUSE for 5 seconds... "GO!"

BALL PLAY

Hold the book up to your right, at your eye level, about 12 inches from your head. Say, "Look at my book"

Present the book, within 6 inches in front of child, as you read the 1<sup>st</sup> page. Model turning the page, read the 2<sup>nd</sup> page, then say, "Let's see what's next" (Wait for child to turn page). If the child does not turn the page, turn the page for them. Say "Where is the (insert animal's name)?" then say "Can you turn the page?" (repeat asking child to turn the page up to 3 times.)

After child turns the page on the 3<sup>rd</sup> turn, say "Let's turn the page..." PAUSE for 5 seconds while holding the page with your thumb preventing the child from turning the page.

BOOK

Gasp while smiling. Say, "Where's the book?" Wait for seconds, then say, "It's on my head, it's a hat!"

PUTTING ON A HAT

Hold your hands up in front of you, wiggling your fingers, and say, "I'm gonna tickle you." Wait 2 seconds, then say, "I'm gonna get you, I'm gonna get you, I'm gonna get you," while slowly leaning in toward the child. Tickle the child on the belly or arms, saying "tickle tickle tickle." (repeat 3 times)

On the 3<sup>rd</sup> press say, "I'm gonna get you" then PAUSE for 5 seconds before tickling.

SMILING & TICKLING

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TOTAL IN RED BOXES =

Elan - NGT\_AH\_fab5.eaf

File Edit Search View Options Help

CAM 3

Grid Text Subtitles Controls

Translation Dutch  
Hij keek voorzichtig rond, niemand te zien.

Translation English  
He looked around carefully, nobody there.

Gloss RH  
NIETS

Mouth  
bilabial

00:00:13.640 Selection: 00:00:13.640 - 00:00:15.650 2010

Translation Dutch  
nand te zien.

Translation English  
nobody there. He ran into the shop, took the bone and took off as fast as he could. He ran far away up to the bridge.

Gloss RH English  
NOTHING (p-) running dog | CATCH | (p-) running d | (p-) dog disappears | BRIDGE | (p-) run

Gloss LH English  
NOTHING (p-) running dog | (p-) running d | BRIDGE

Gloss RH  
NIETS (p-) rennen hond | GRUPEN | (p-) rennen ho | (p-) hondje verdwijnen in d | BRUG | (p-) ren

- 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

## Positive Science



Motivation

Gaze Tracking for  
Children

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Experiments

# Design



Gaze point  
of the adult

First Person  
View Video



# Design

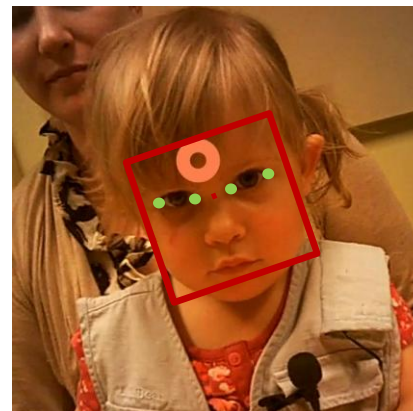
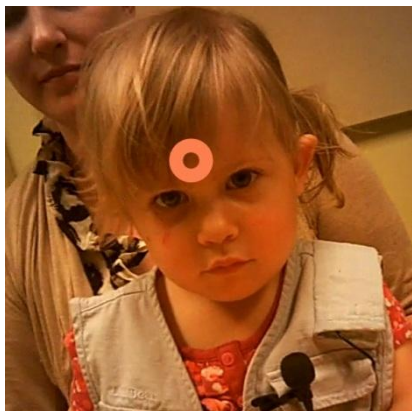


Gaze point  
of the adult

First Person  
View Video

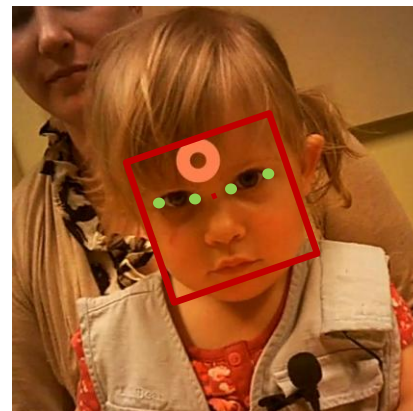
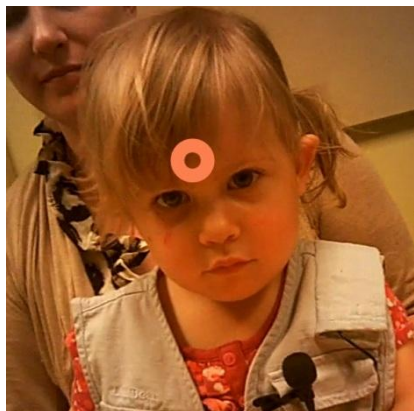
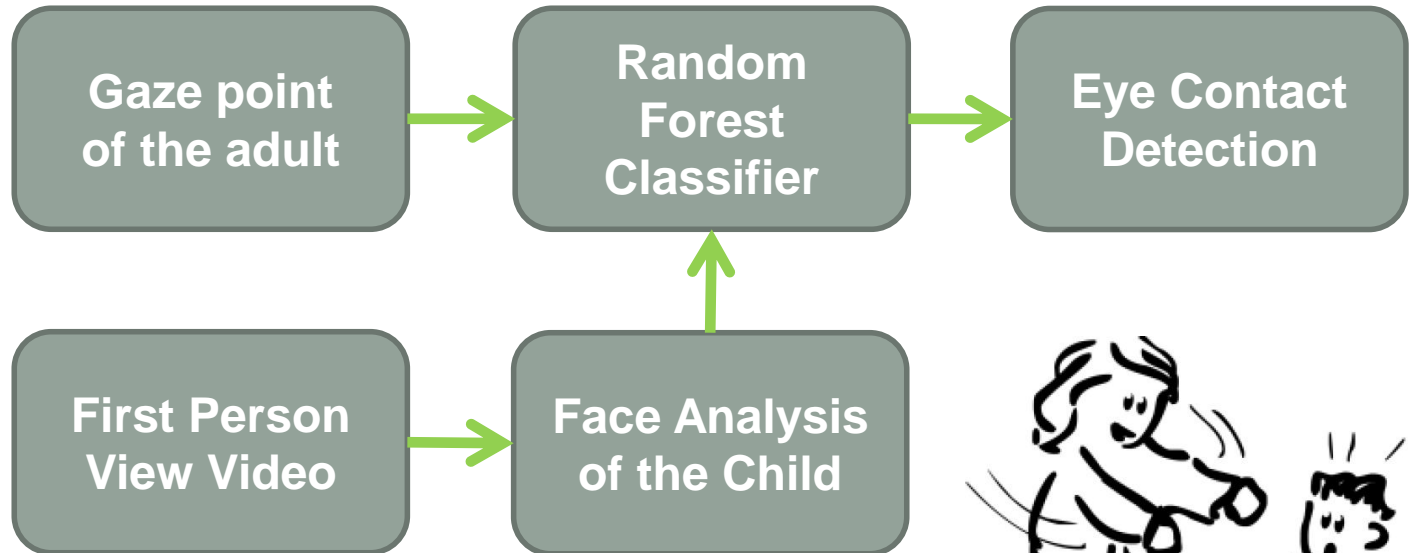


Face Analysis  
of the Child





# Design

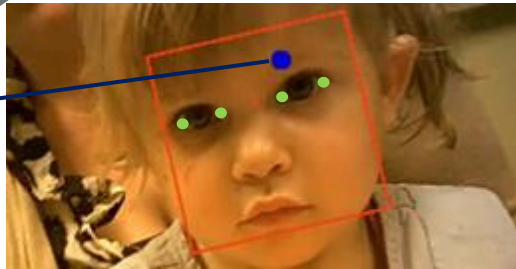
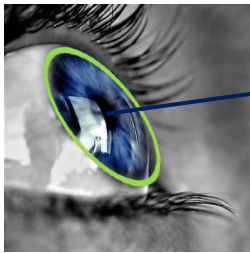


**3 ~ 5 minutes  
free playing**

# Technical Details



**SMI Eye Tracking Glasses**



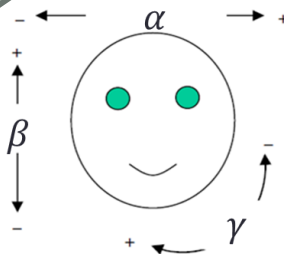
**Omron  
OKAO  
Vision  
Library**

## Face Orientation

Vertical Direction:  $\alpha$

Horizontal Direction:  $\beta$

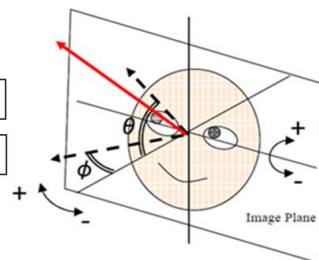
Rotation:  $\gamma$



## Gaze Direction

Vertical Direction:  $\theta$

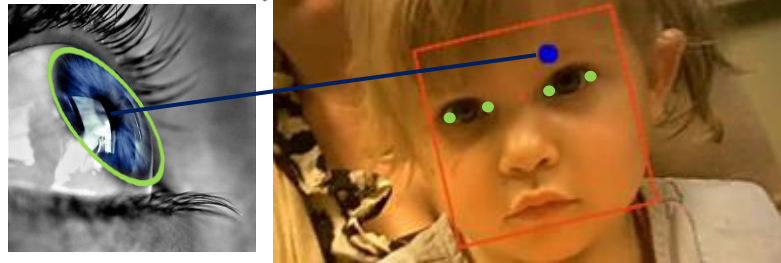
Horizontal Direction:  $\phi$



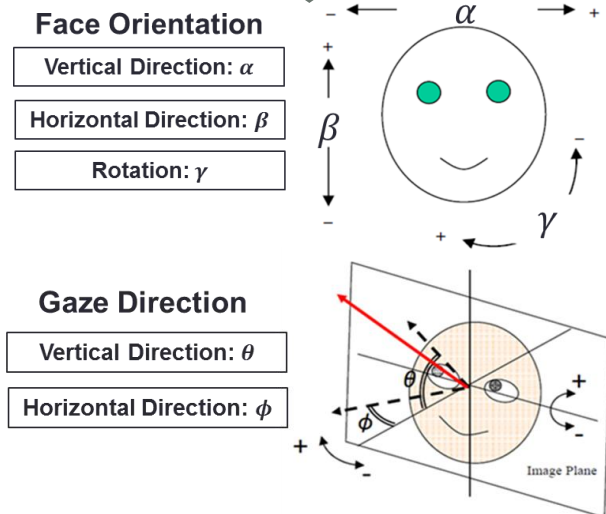
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**SMI Eye Tracking Glasses**

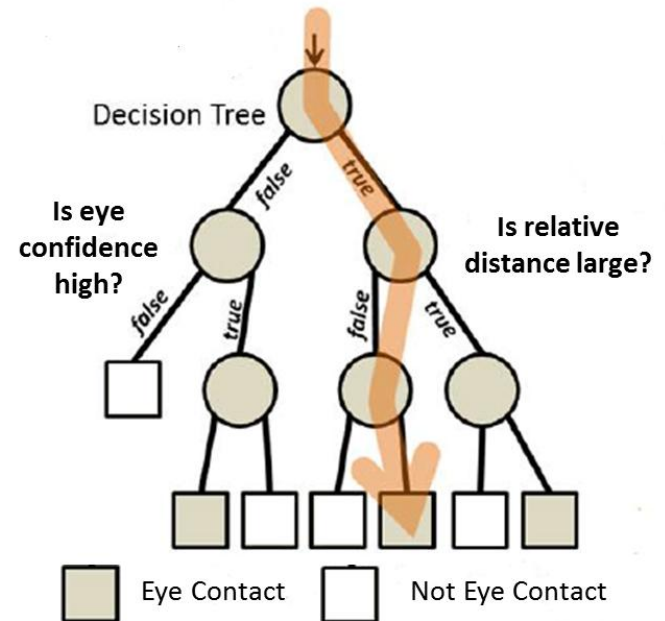


**Omron OKAO Vision Library**



## Features

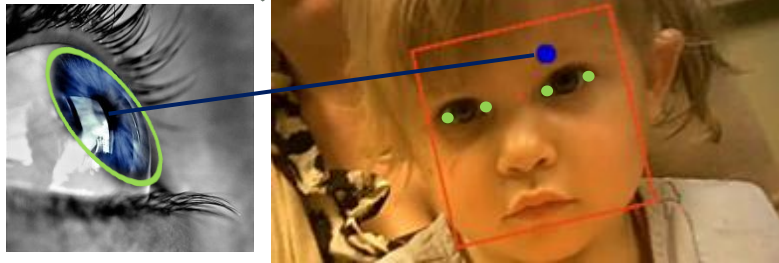
*Relative Location (Gaze - Eyes), Face orientation, Gaze Direction ...*



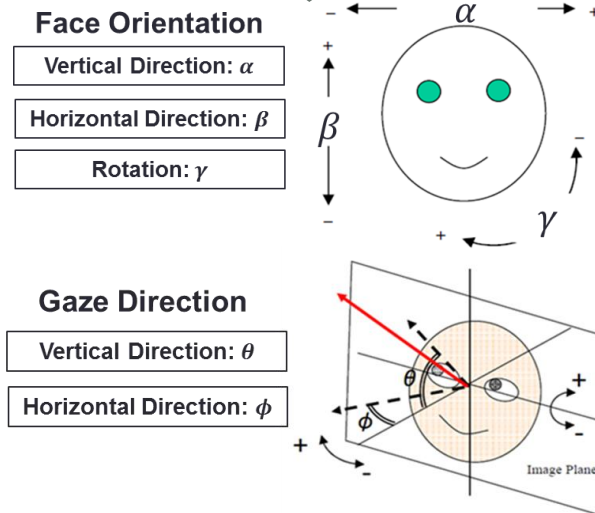
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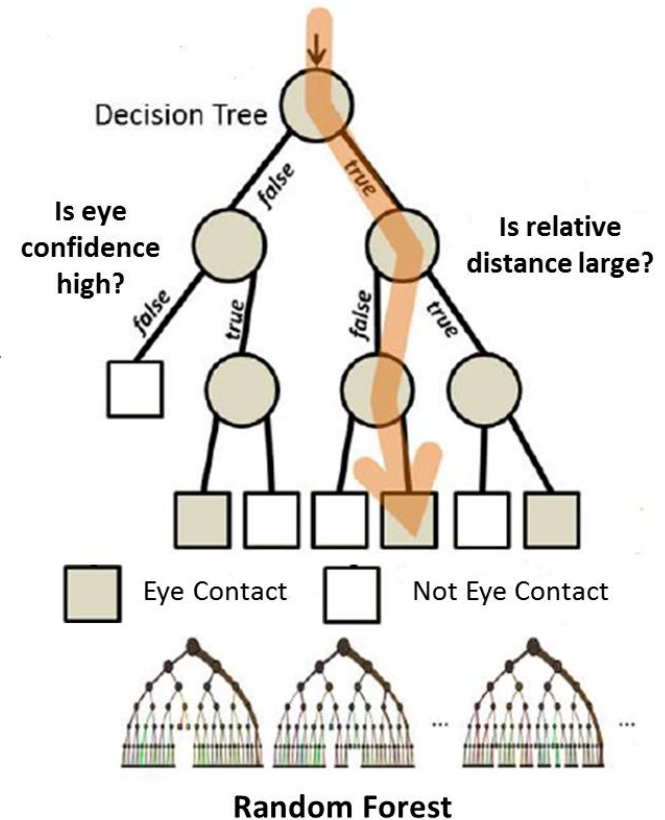


**Omron  
OKAO  
Vision  
Library**



## Features

*Relative Location  
(Gaze - Eyes),  
Face orientation,  
Gaze Direction ...*



Motivation

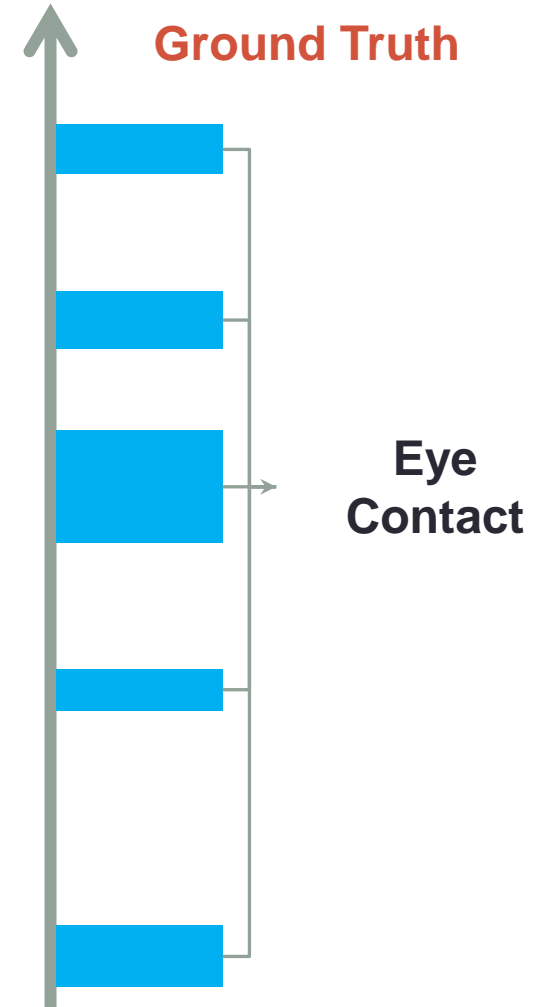
Gaze Tracking for  
Children

Our Method

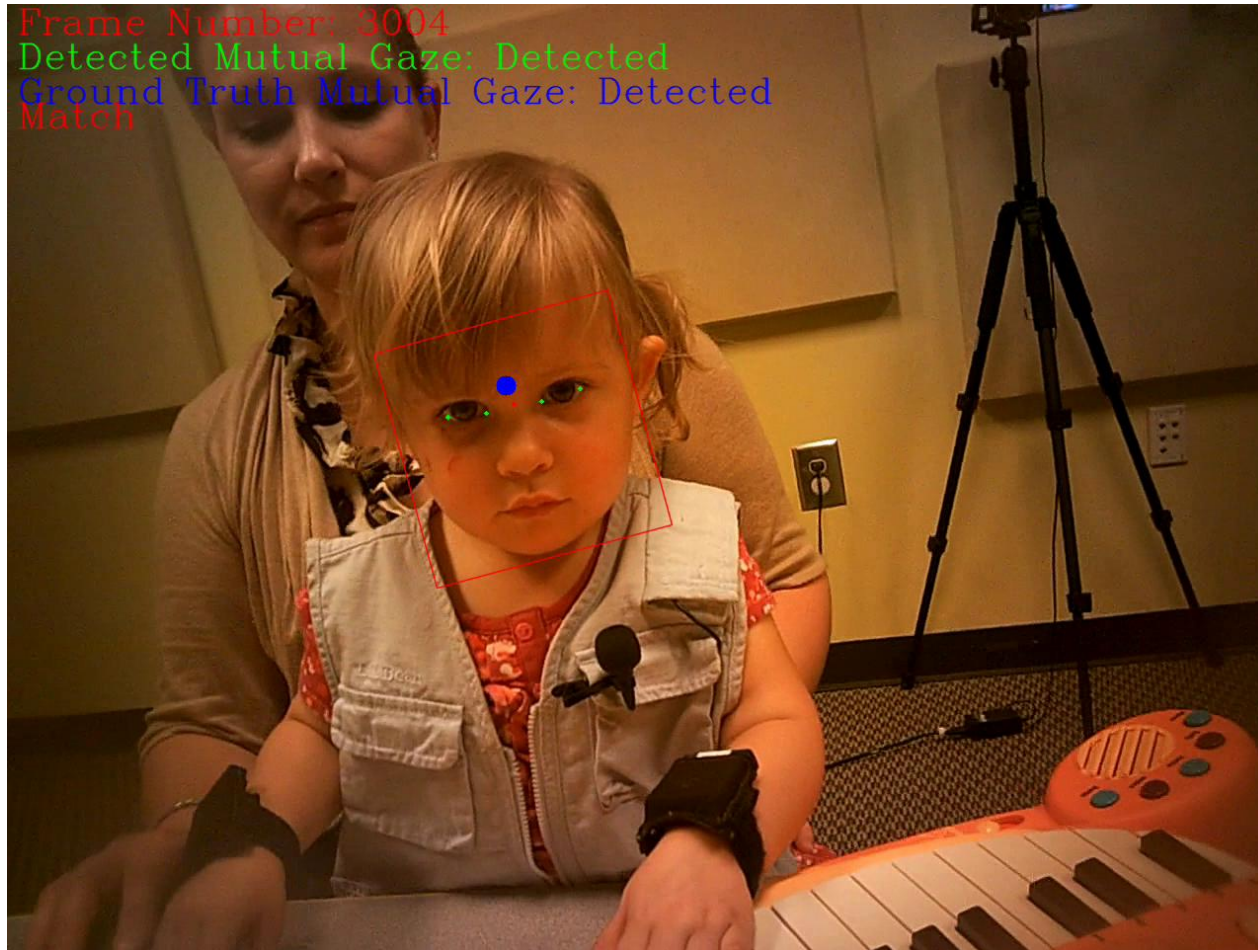
Experiments



# Annotation



# Video Demo

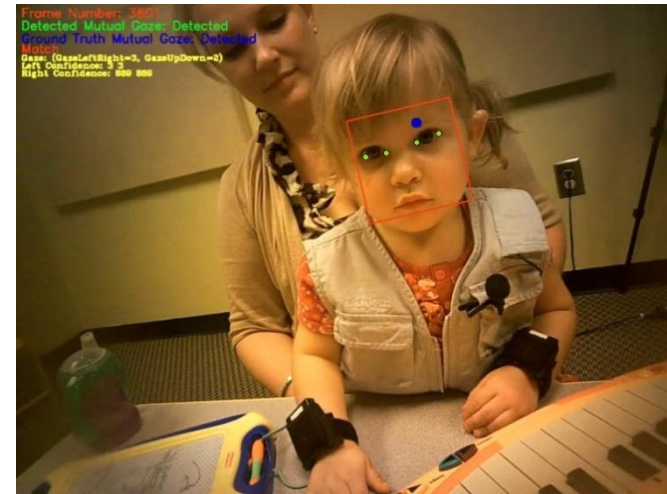
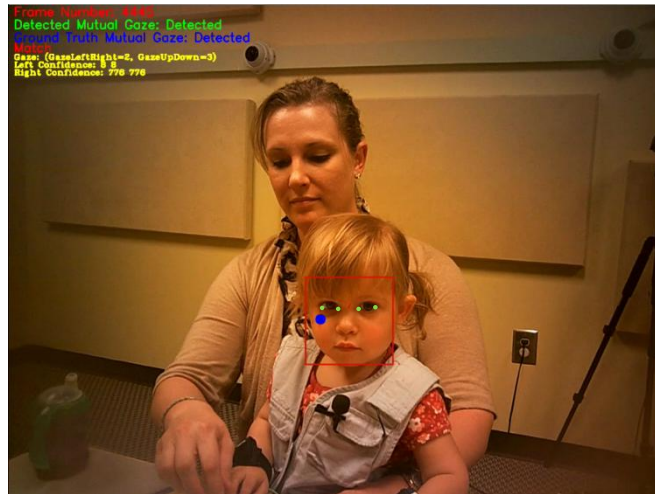


Project and Demo will soon be available [here](#).

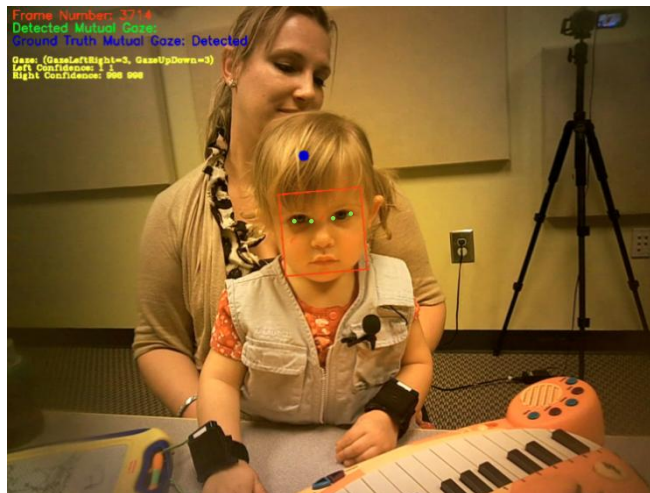


# More Results

## Successful Cases

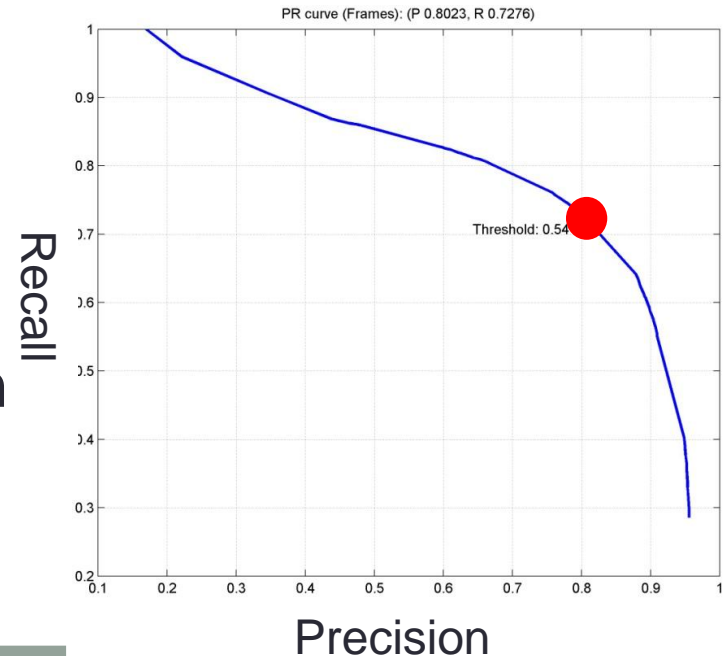


## Failure Cases



# Quantitative Measures

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

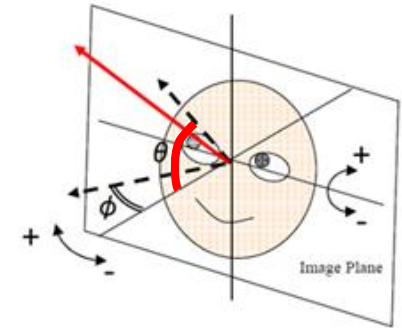
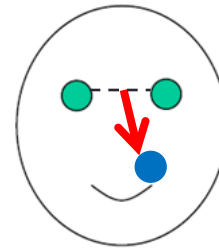


Truth \ Algorithm	True	False
True	1322(75.3%)	145(1.7%)
False	<b>433(24.7%)</b>	8455(98.3%)

- **80%** precision
- **72%** recall

# What are the important features?

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



Face Location		Child's Gaze Direction	
<b>Vertical</b>	<b>Horizontal</b>	<b>Vertical</b>	Horizontal
<b>1.00</b>	<b>0.78</b>	<b>0.66</b>	0.42
Head Orientation			Eye Confidence
Vertical	Horizontal	Rotation	Confidence
0.40	0.31	0.35	0.51



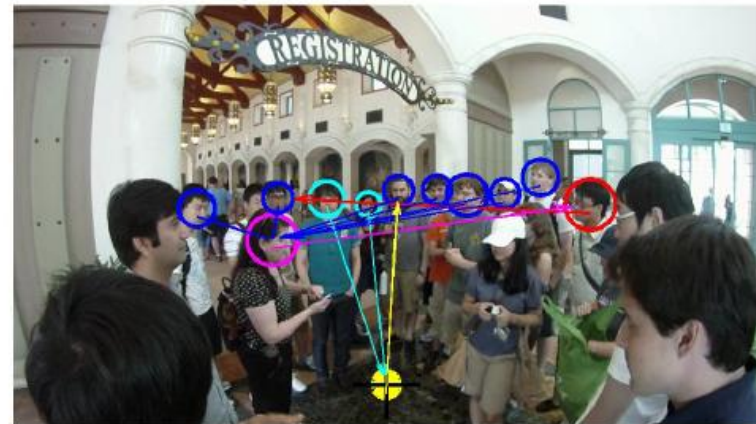
# Conclusion

- 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



Alireza Fathi, Jessica K. Hodgins, James M. Rehg, **Social Interactions: A First-Person Perspective**, *IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR)*, 2012

# 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** !*