VIGART Application to Assist ASD Children
HCI Focus

Based on the Paper:
Design of a Gaze-Sensitive Virtual Social Interactive System for Children With Autism

By: Uttama Lahiri, Zachary Warren, and Nilanjan Sarkar

From: IEEE Transactions on Neural Systems and Rehabilitation Engineering Vol. 19 No. 4, August 2011
Introduction to ASD

- ASD is the acronym for Autism Spectrum Disorder
- Definition:
  - A neurological developmental disability that varies in symptoms and severity, presenting around the age of 3. The main impairment is communication and social abilities.

Pierce K et al. Brain 2004;127:2703-2716
Aspergers

High Functioning

Normal

Low Functioning
ASD in People
1 in 150 children have a form of autism

The number of children with autism in the U.S. is rising steadily. Doctors are concerned there are even more cases unrecognized.

Students with disabilities
In thousands

<table>
<thead>
<tr>
<th>Year</th>
<th>Autism</th>
<th>Mental Retardation</th>
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<tbody>
<tr>
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<tr>
<td>'06</td>
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</table>

All disabilities
Age 6-17, in millions

<table>
<thead>
<tr>
<th>Year</th>
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<tbody>
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<td>'06</td>
<td>1</td>
<td>1</td>
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</table>

Sources: Centers for Disease Control and Prevention; Department of Education; AP Office of Special Education and Rehabilitative Services; state-reported data
Life for ASD Affected Individuals

- Inability to interpret emotions
- Inability to communicate emotions
- Inability to process emotions
- Inability to control behavior
- ADHD
- ADD
- Uncontrollable Tantrums
- Overwhelmed by surrounding

AUTISM

Persons with autism may possess the following characteristics in various combinations and in varying degrees of severity:

- Inappropriate laughing or giggling
- No real fear of dangers
- Apparent insensitivity to pain
- May not want cuddling
- Sustained unusual or repetitive play; Uneven physical or verbal skills
- May avoid eye contact
- May prefer to be alone
- Difficulty in expressing needs; May use gestures
- Inappropriate attachments to objects
- Insistence on sameness
- Echoes words or phrases
- Inappropriate response or no response to sound
- Spins objects or self
- Difficulty in interacting with others

1-800-3AUTISM

Autism Society of America
7910 Woodmont Avenue, Suite 650 Bethesda, MD 20814-3015

January is National Autism Awareness Month.

Adapted from original by Professor Handel-Smith, University of Queensland, Brisbane Children's Hospital, Australia
Motivation

- Intervention to better quality of life
- Provide education to improve core skills
- There are no answers, explanations or cures
Previous Work

• VR systems designed for ASD individuals are open loop
• Low levels of customization in the VR system
• Psychological - Many Theories, No Answers
• Neurological - Many Theories, No Answers
• Distance Learning/Virtual Environments for mainstream individuals
HCI

- Human Computer Interactions
- Interactions: Emotional, Physical, Psychological
- Interfaces: Tangible, Visualization, Audio, Commands

http://mehrcenter.com/blog/tips-for-judging-a-touchscreen-display/
Interdisciplinary Overlapping Fields

Objective

- Develop a system for VR that can be individualized through feedback from gaze patterns
- Explore the usability and acceptability of VIGART for use by ASD adolescents
VIGART

• Virtual Interactive system with Gaze-sensitive Adaptive Response Technology

• 3 components
  – VR System presenting the educational information
  – Real time gaze monitoring
  – Integration of the real time data to the VR system for individualization
VR System

- Avatars are modeled in similarity to the individuals
- Avatars provide the interface of communicating the information, story or situation for the individual to interact with and learn from

Fig. 1. Screenshots of avatars demonstrating neutral (top), happy (middle), and angry (bottom) facial expression.
Gaze Detection

• Eye gaze behavior is characteristic of attention

Figure 2.1: Eye gaze tracking glasses

http://www.newscientist.com/blog/invention/labels/military.html

Data Acquisition

Fig. 2. Schematic of data acquisition and the control mechanism used.
Quantification for Feedback and Evaluation

- Mean Pupil Diameter ($PD_{\text{mean}}$)
- Sum of Fixation Counts (SFC)
- Average Fixation Duration ($FD_{\text{AVG}}$)
- Regions of Interest (ROI)

http://www.33rdsquare.com/2012/01/click-on-windows-8-apps-by-looking-at.html
Extraction of Quantifiable Features

Fig. 3. Schematic of feature extraction.

Design of a Gaze Sensitive Virtual Social Interactive System for Children with Autism,
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Fig. 4. Allocation of ROIs (Face_ROI, Object_ROI, and Others_ROI).
Feedback System

- Attention level needs to control the speed of the communication
- Can be a rule based system or dynamic
Questions from the user complement the data from the gaze monitoring.

Fig. 5. Individualized RGFA.
Real Time Gaze-Based Feedback Algorithm (RGFA)

- Algorithm controls sampling of the gaze coordinates, 33ms
- The ROI is determined through coordinate analysis
Usability Testing

• 6 adolescents with ASD (5 male, 1 female)
• Ages 13-17
• Half participants in mild to moderate ASD range, half in the severe range
• Language skills were required to be above 80 from the PPVT
• 5 social interactions were tested, each with a story approximately 3 minutes long
Study Results

• Exit interviews with the subjects provided the following feedback:
  − Liked interacting with VIGART
  − Wanted to use it more

• From the feedback of the caregivers, VIGART had influence on the behavior with an increase engagement
### Table III
Comparative Analysis of Variation in the Behavioral Viewing Indexes With Reported Engagement Level of Participants

<table>
<thead>
<tr>
<th>Reported Engagement Rating (Trial No.)</th>
<th>SFC for $\text{Face}_{\text{ROI}}$ as % of total SFC (%)</th>
<th>SFC for $\text{NonFace}_{\text{ROI}}$ as % of total SFC (%)</th>
<th>$\text{FD}<em>{\text{AVG}}$ for $\text{Face}</em>{\text{ROI}}$ (ms)</th>
<th>$\text{FD}<em>{\text{AVG}}$ for $\text{NonFace}</em>{\text{ROI}}$ (ms)</th>
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<tbody>
<tr>
<td><strong>LE</strong></td>
<td><strong>HE</strong></td>
<td><strong>LE</strong></td>
<td><strong>HE</strong></td>
<td><strong>LE</strong></td>
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<tr>
<td>ASD1</td>
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<td>5 (4)</td>
<td>56</td>
<td>80.5</td>
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<tr>
<td>ASD2</td>
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<td>6 (4)</td>
<td>79.3</td>
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<td>ASD6</td>
<td>4 (1)</td>
<td>7 (4)</td>
<td>69.7</td>
<td>84.7</td>
</tr>
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</table>

LE: Lowest Rating on Engagement; HE: Highest Rating on Engagement
SFC: Sum of Fixation Counts; $\text{FD}_{\text{AVG}}$: Average Fixation Duration

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### TABLE IV

**Average Fixation Duration (\(FD_{AVG}\)) as Measure of Emotion Recognition**

<table>
<thead>
<tr>
<th></th>
<th>(FD_{AVG}) (ms)</th>
<th>(% \Delta ) Neutral-To-Happy</th>
<th>(FD_{AVG}) (ms)</th>
<th>(% \Delta ) Neutral-To-Angry</th>
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</tbody>
</table>

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Results from Usability Testing

- Has Potential for Acceptance by the Target Audience
- Indexes of quantification allow VIGART to be an intelligent system
Moving VIGART Forward

- Switch to desktop mounted eye tracker
- Larger investigation to take the proof of technology concept forward to determine actual improvement statistics
HCI Conclusions

• HCI for ASD Interventions have positive results when feedback is gained from gaze tracking

• HCI utilization of Avatars allow simulation of social interactions
Future Work

- Large Scale Testing for statistics on improvement
- Advancing VR based on Feedback
- Expansion of Feedback Interactions
- Expansion of interactions for individuals with ASD