Wearable Assistive Technologies for Autism

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What is Autism?

• Autism spectrum disorder (ASD) is a broad term used to describe a group of neurodevelopmental disorders.

• These disorders are characterized by problems with communication and social interaction. People with ASD often demonstrate restricted, repetitive, and stereotyped interests or patterns of behavior.

• According to the Centers for Disease Control and Prevention (CDC), autism does occur more often in boys than in girls, with a 4 to 1 male-to-female ratio.

• The CDC estimated in 2014 that nearly 1 in 59 children have been identified with ASD.

• There are indications that instances of ASD are on the rise. Some attribute this increase to environmental factors.
Skills of Concern

• Communication Skills
  • Talking, Reading, Writing
  • Learning new vocabulary

• Social Skills
  • Social understanding, awareness
  • Emotion identification, recognition

• Functional Life Skills
  • Mobility, Planning, Organizing
  • Daily tasks e.g. cooking
  • Educational tasks

Assistive technology makes things possible! 🌟
Assistive Technology

• Any customized item, piece of equipment, software or product that is used to increase, maintain, or improve the functional capabilities of people with disabilities

• Wearable AT enhances and supports daily life in a practical way due to the capability to wear or carry around the equipment
# Assistive Technology Categories

<table>
<thead>
<tr>
<th>Low tech AT</th>
<th>Mid tech AT</th>
<th>High Tech AT</th>
</tr>
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<tbody>
<tr>
<td>Tools that do not need batteries or electricity and require little-to-no training to operate</td>
<td>Tools that require a bit of training, they may be battery-operated and add a level of specialization</td>
<td>Electrically-powered devices (and software) that require the most training and they are highly specialized and customizable based on individual needs</td>
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- **Mid tech AT**: Tools that require a bit of training, they may be battery-operated and add a level of specialization.
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Wearable Technologies

- Social Robot
- Solar Smart Cap
- Wearable IoT
- AR Smart Glasses

- Super Power glass
- Virtual Reality
- Proximity awareness
- Detection of Stereotypical Motor Movements
Social Robot

• Communicates with autistic children by following social behavior

• Helps them in improving their eye contact during communication

• Laser detection system for analyzing expressions

• Approaches the child and displays images and play sounds in order to change the mood of the child

• Touch screen display for interaction - Child can give input to the robot
Solar Smart Cap

- Rechargeable DC battery with 2 charging modes: normal or solar cell
- Sensors, for children vitals data collection
- GSM module, for delivering children health condition to the smartphone of the parents or caregivers
- GPS technology, for locating and sending the position of the children
- Emergency button, for alerting parents if the child feels uncomfortable
Wearable IoT

-Measuring pair-wise human interaction between individuals with a nametag-sized sensor badge and subsequent wireless upload of data to an access point

-Multi-modal sensing including:
  - ultrasound sonar
  - Face-to-face time - the amount of time two individuals face each other
  - Proximity - the physical distance between the two participants
  - accelerometer
  - Activity level - the physical movement of participants
AR Smart Glasses

- Data Gathering module: sensors send data to the next module through MQTT

- Data integration module: Smart glasses and Alexa work as subscribers and Data Gathering module works as publisher

- Therapist can model a task in a high level of abstraction through web platform

- Improves daily living activities skills
Emotion recognition by Superpowerglass

• Components:
  • Google glass
  • Android phone

• Activities:
  • Capture the smile game: the child is challenged to provoke prompted emotions in an adult.
  • Guess the emotion game: challenges the child to guess the emotion.
  • Unstructured Activity: at home glasses can be used as emotional aid during social activities (e.g. dinner)
Emotion recognition by Superpowerglass

- Feedback Choices:
  - Visual Emotion and Color Cues: three possible heads-up interfaces
  - Auditory cues: emitted via bone-conducting speaker on the glass
  - combined visual and auditory cues
- Computational heavy tasks such as frame processing, video encoding and data storage are handled on the android phone due to limited processing power on glass CPU and battery life.
Virtual Reality Social Cognition Training

- Use of VR to enhance social skills, social cognition and social functioning in young adults with ASD
- Focused on:
  - Real-time emotion: recognizing other’s feelings and tone of voice recognition
  - Theory of mind: recognizing and responding to other’s thoughts and desires
  - Conversational skills: initiating, maintaining and closing
ProCom prototype
Mobile and wearable system for proximity awareness

• system includes:
  • a wearable sensor module and mobile application connected via Bluetooth.
  • hardware includes a 3D printed box with two infrared (IR) sensors and a servomotor on its top.
  • The internal components include an Arduino Uno, a Bluetooth module, and a 9V battery.

• Function:
  • IR sensors sweep between $-30^\circ$ and $30^\circ$, collecting distance values.

• mobile interface:
  • an aerial view with the user depicted at the bottom
  • A traffic light represent distance zones
Detection of Stereotypical Motor Movements in Autism using a Smartwatch-based System

- **system:**
  - Motorola Moto 360 with a 3-axis accelerometer and a 3-axis gyroscope.
  - Android tablet with Bluetooth

- **model:**
  - Person-independent model to recognize four target behaviors: Hand flapping, Head banging, repetitive dropping, others
  - Accuracy 92.6%
  - Limitation: simulated data from adults imitating children with ASD is used to train the system.

Confusion matrix.

![Smartwatch Image]
<table>
<thead>
<tr>
<th>Type</th>
<th>Technology</th>
<th>Targeted Social Challenge</th>
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<tbody>
<tr>
<td>Smart Glasses</td>
<td>Super Power Glass [1]</td>
<td>Emotion Recognition</td>
</tr>
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<td>Smart Glasses</td>
<td>Smart Glasses [2]</td>
<td>Emotion Recognition</td>
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<tr>
<td>Smart Wear</td>
<td>Smart Cap [6]</td>
<td>Health Monitoring – Location Tracking</td>
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<tr>
<td>Smart Watch</td>
<td>Filip2 [7]</td>
<td>Location Tracking</td>
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<tr>
<td>Smart Watch</td>
<td>[8]</td>
<td>Movement Detection</td>
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<td>Smart Wear</td>
<td>ProCom [9]</td>
<td>Proximity Detection</td>
</tr>
<tr>
<td>Smart Wear</td>
<td>Accelerometers [10]</td>
<td>Stereotypical behaviors</td>
</tr>
<tr>
<td>Smart Glasses / VR</td>
<td>VR Training [12]</td>
<td>Social Training</td>
</tr>
<tr>
<td>Smart Glasses</td>
<td>AR Smart Glasses [14]</td>
<td>Task Achievement</td>
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• WATs are an important advance in improving autistic people’s opportunity to integrate in society and enhancing their understanding and awareness in different social scenarios.

• Although WAT is a hot topic, most of the technologies presented are in research and prototype phase, and therapy sessions. It is a challenge to integrate them to ASD people’s daily life. Further research is needed to further develop the area.

• WAT can be seen as a useful addition in the work with ASD children and adults.


References


