Human-Robot Interaction in ASD

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Outline

- Autism Spectrum Disorder (ASD)
- Robot Models
- Robot Designing requirements
- Zeno Robot
- DTW Algorithm

What is ASD ?

- ASD stands for **Autism Spectrum Disorder** and can sometimes be referred to as **Autistic Spectrum Disorder**. ASDs are any developmental disabilities that have been caused by a brain abnormality. A person with an ASD typically has difficulty with social and communication skills.

- Autism (or ASD) is a wide-spectrum disorder.

- Autism spectrum disorders are among the most common pediatric diagnoses in the United States with a prevalence of 1 in 88 children and 1 in 54 males.

Autism Spectrum Disorder

Social Interaction	Communication	Behavior
• Eye Contact • Facial Expression • Emotional Signals • Interest in shared enjoyment • Understanding of others feeling	• Delay/Lack of talk • Remaining Engaged • Stereotyped • Humor • Concrete - Focus on self needs	• Focus on parts • Preoccupations • Flapping • Twiddling • Lack of awareness

AUTISM

Persons with autism may possess tho 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

Robot Models

- There are three forms of using robots as an assistive tool for children with ASD:

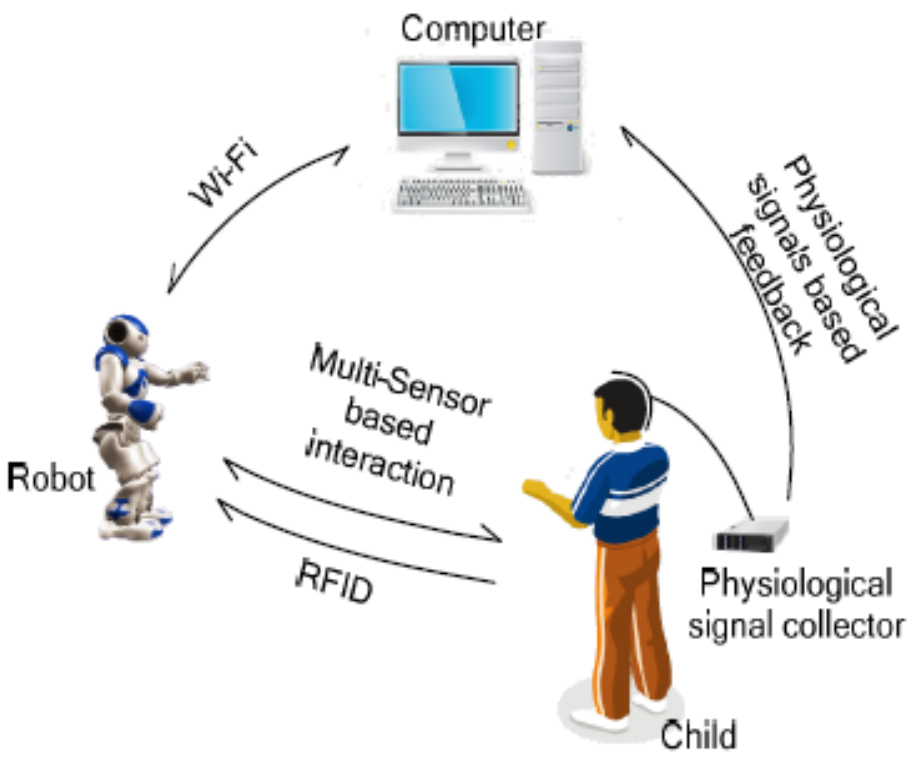
1. **A robot serves as an agent. An adult could simply interact with a child through that puppet.**

2. **A robot works as a social companion. A child could interact with an autonomous robot in a simple and predictable way.**

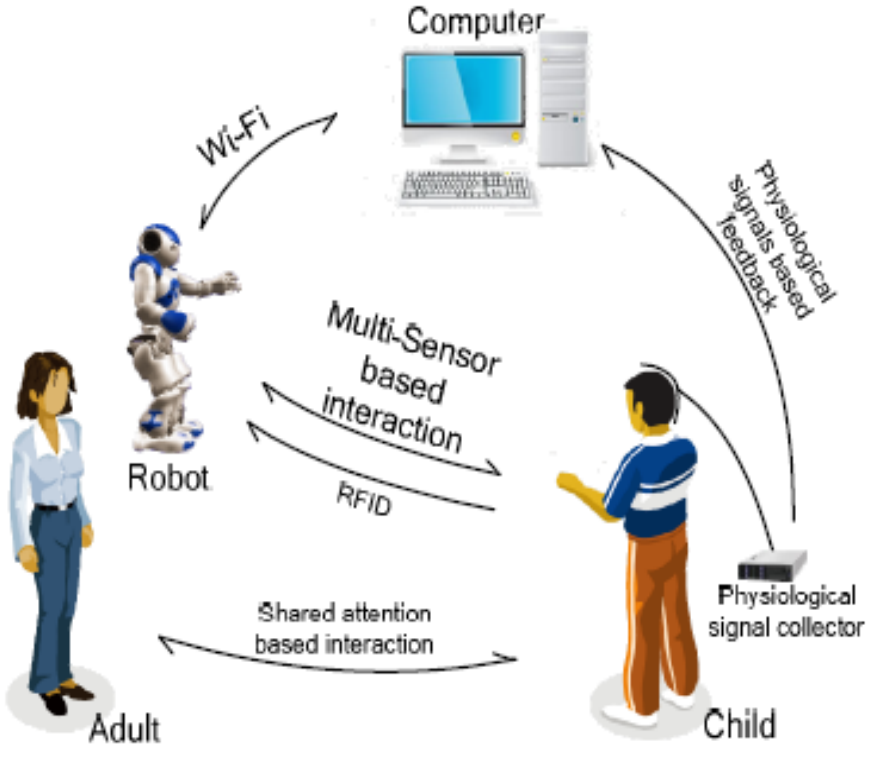
3. **A robot works as a social participator which could be a shared attention between a child and an adult such as a therapist.**

Robot Models Cont.

The robot can recognize the individual by radio frequency identification devices **(RFID)** and respond an individualized behavior to him or her autonomously. During the interaction, the physiological signals of the child such as electroencephalography (EEG) are collected by the physiological signal collector and processed by the computer. The computer can adjust the behaviors of the robot through Wi-Fi connection according to the physiological signals based feedback.



Model 1



Model 2

Designing Requirements

- There are three aspects of designing a humanoid robot for autistic children:

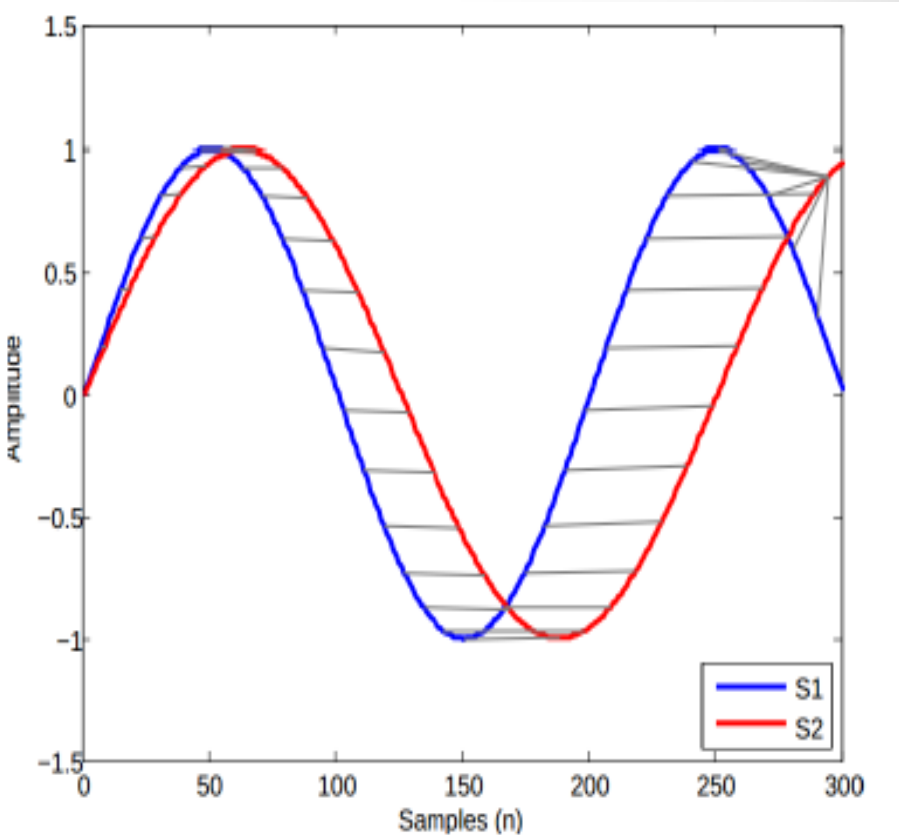
1. **Functionality and appearance.**
2. **Safety requirements.**
3. **Autonomy.**

Zeno Robot

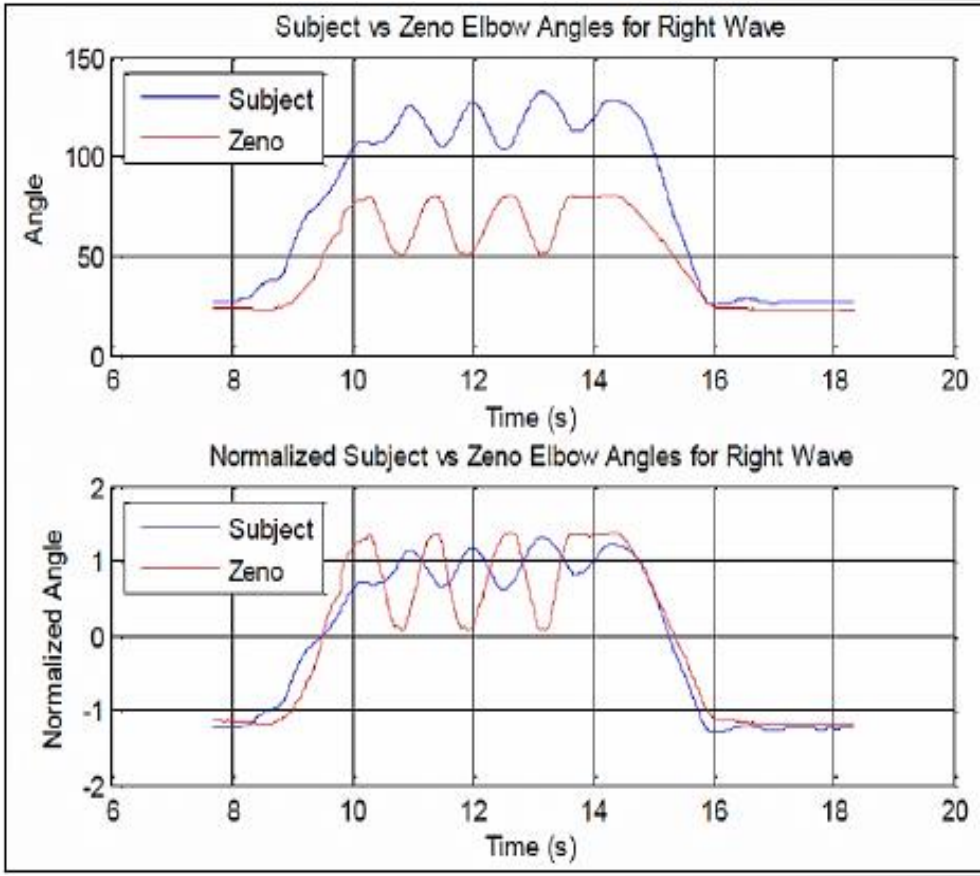
- He looks like a 4-7 year old child.
- His head is about ¼ the size of an adult human head.
- The head of Zeno is powered by 9 servo motors.
- 3 degrees of freedom (DOF) at the neck joint, and it is capable of tilting the head back and forth as well as left to right.
- It also has 2 degrees of freedom in each eye (pan and tilt), and 4 of the servos are used for generating facial expressions (eye blink, jaw motion for smile, eyebrow motion for frown, etc.).

Dynamic Time Warping (DTW) Algorithm

- DTW compares the similarity between signals by ignoring time-delays and uneven time sampling.
- The DTW takes each point from the angle trajectory of the ASD subject and compares it to each point on Zeno's angle trajectory.
- It calculates the Euclidean distance or the magnitude between each point.
- A matrix is produced with these distances. From this matrix the best path for each point compared is determined and the sum of these distances is the value of DTW.



Raw and normalized elbow angles for Zeno and child waving motion.



Video

http://www.youtube.com/watch?v=Fp8kndY5E84

The Use Of Robots In Therapy Is Received Positively By Children With ASD

Conclusion

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- Robot Models
- Robot Designing requirements
- Zeno Robot
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References

Literature:

1. **A Humanoid Robot Used as an Assistive Intervention Tool for Children with Autism Spectrum Disorder, 2013.**

2. **Human-robot interaction as a tool to evaluate and quantify motor imitation behavior in children with Autism Spectrum Disorders,2011.**

3. **Robotic assistants in therapy and education of children with autism: can a small humanoid robot help encourage social interaction skills? Robins, B., Dautenhahn, K., Boekhorst, R., Billard, 2005.**


Thank You
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