Humanoid Robot and Avatar Assisted Sign Language Tutoring for Children

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Past work experience

• Founder of Cognitive and Social Robotics Lab @ITU -(2011-…)
• Instructor in the Computer engineering Department of Istanbul Technical University - (2010-…)
• Research Fellow in the Computer Science Department of the University of Hertfordshire, UK (2006-2010)
• R.A and T.A in the Computer Engineering Department (CMPE) of Bogazici University - (1997-2006)
Based in Istanbul Technical University, Istanbul, TURKEY

Our motivation is to design and implement imitation based interaction games for children using humanoid robots
- Sign language games
- Non-verbal imitation games for ASD
- Drumming games

5 nationally funded research projects
http://humanoid.itu.edu.tr
Drum-mate

- Imitation based autonomous drumming game
- Implemented with over 120 participants in UK.
- Currently being implemented on Nao with new e-drumsticks.
- We have an e-guitar set for Nao, too!
Drum-mate

- Robot is programmed to analyse human drumming (analyse it into drum beats, time, strength, etc...)
- Robot plays its own drum once understanding human’s drumming to imitate human.
- This game continues in turns for 2-3 mins.
- The game is evaluated both according to robot’s performance (understanding and imitating human), and humans’ opinion (questionnaires, human’s performance against robot)
Activities

• EU enterface’11 workshop
• Live demo at Robocup 2011 Aldebaran company stand
• Public demo for children at shopping centers for Robocup 2011
• Live robotic demo and test with 106 preschool children at ITU Sedat Urundul Nursery
• Web based sign language study with more than 100 participants in class based studies, web based studies and facebook studies
Introduction
Problems of People Who Use Sign Language
Humanoid Sign Language Tutor project
A Survey About Signing Avatars
Turkish Sign Language Avatar project
Conclusion
Introduction

«Turkey Disability Survey”
Turkish Statistical Institute

Graphics:
Emrah Cengiz
%72 Percent of disabled people can not take proper education.
The deaf people can not be educated by the traditional education tools and technics due to nature of their disability.

Reading and writing of spoken languages differ from sign languages, process learning how to read and write for deaf people requires special education.

For the deaf people, sign language is the main language. But it is signed by too few people. Even most parents and teachers can not speak sign language.
There are not enough tools for hearing disabled children

2-D tools can be inadequate

Computer aided solutions should be developed
To contribute the education of deaf people there are some tools and methods are implemented. These tools mostly try to eliminate the need for an actual person to be available for communication.
Motivation & Objectives

• Sign Language (SL): a visual language composed by different sets of hand and upper-torso movements combined with facial gestures
• Language acquisition: An important process in the social and cognitive development of children
• Robots used for therapeutic purposes may be very helpful in the developmental process of a child
• Game playing:
  → to handle different objects,
  → to improve social and cognitive skills,
  → to adopt an appropriate behavior,
  → important for development and creativity
Robot Sign language Tutor

• Main focus:
  ✓ Implementing a humanoid robot based system for sign language tutoring
  ✓ the system includes survey part, training and test parts.
  - Physical robots
    - Robovie R3
    - Nao H25
Research Questions

We explore:

• The similarity of signs between robot and human (physical and virtual robot and human tutor)

• The effect of Interaction games on learning performance and motivation of participants
Robots in Videos

Nao H25:
• 25 degrees of freedom (DOF)
• 3 dependent finger

Modified Robovie R3:
• 29 degrees of freedom (DOF)
• 5 independent fingers
• Expressive face with leds
Experiment Setup

- Two versions of mobile interaction game:
  - For beginners
  - For advanced users
Interaction Game For Advanced Users

- 10 Turkish Sign Language words
- Choosing the robot (R3 or Nao)
## Participants

<table>
<thead>
<tr>
<th>For Beginners</th>
<th>Num of Participants</th>
<th>Age Range [Min, Max]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>16</td>
<td>[25 ; 31]</td>
</tr>
<tr>
<td>Children</td>
<td>5</td>
<td>[9 ; 11]</td>
</tr>
<tr>
<td>For Advanced Users (Desktop version of the game)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing Impaired Children</td>
<td>with Cochlear implant</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Severe hearing impairment</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>52</td>
</tr>
</tbody>
</table>
Results

Result of Adults [24 ; 31]
Results

Hearing impaired children
GAME DEMO
Game Demo

Otonom iSpy-uSign İşaret Dili Oyunu
ANNE
Game implementation in tablet PCs

- Enables the children to use the robot based game at homes and schools where physical robot is not available. Robot movies and related questions are placed in a children’s game.
Remote control of the Robot
Other studies

• Adaptive robot
  – Sign recognition by Kinect
  – Teach robot how to implement sign language by Kinect

• Putting limited versions of the games on Smaller household robots
Robotic Solutions are successful but hard to use in every school and household. To contribute the education of deaf people, also other computer-based tools and methods are implemented.
Literature Survey and Existing Solutions

- Writing Based Solutions
- Video and Graphics Based Solutions
- Avatar Based Solutions
Existing Avatars

Several signing avatars exist for non Turkish sign languages.

- The Forest for ASL
- The MAX for DGS
- DeafWorld as Clips
- Sign4me
- Handtalk.me
A Survey About Signing Avatars, Pros and Cons

<table>
<thead>
<tr>
<th>Style and Personality:</th>
<th>Emotionless, unnatural and robotlike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Movements:</td>
<td>Upper body movements are required with arms and hands. Unnatural.</td>
</tr>
<tr>
<td>Facial Expression:</td>
<td>Lack of facial expressions is uncomfortable</td>
</tr>
<tr>
<td>Movement Synchronizations:</td>
<td>Mismatch between durations of the signs.</td>
</tr>
<tr>
<td>Technical Observations:</td>
<td>Good scene and Control of the avatar is missing.</td>
</tr>
</tbody>
</table>
A Survey About Signing Avatars, Pros and Cons

Vote for most important aspects of the avatar.

<table>
<thead>
<tr>
<th>Important avatar aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial expression (7)</td>
</tr>
<tr>
<td>Natural movement (5)</td>
</tr>
<tr>
<td>Mouthing (4)</td>
</tr>
<tr>
<td>Emotions (4)</td>
</tr>
<tr>
<td>Body motion/posture (4)</td>
</tr>
<tr>
<td>Appearance (3)</td>
</tr>
<tr>
<td>Synchronisation of sign and mouthing (3)</td>
</tr>
<tr>
<td>Charisma (2)</td>
</tr>
<tr>
<td>Comprehensibility (2)</td>
</tr>
</tbody>
</table>
A new fully automated Avatar is being designed and implemented for TSL based on the issues mentioned.

This study is supported by the Scientific and Technological Research Council of Turkey under the contract TUBITAK KARIYER 114E263
Turkish Sign Language Avatar

TSL Avatar will be a platform which can perform even sentences in TSL using animation technologies.

It will be used in our text to sign language translation project supported by FATIH program in TURKEY to translate educational material for children.

TSL avatar will be designed to support different platforms and pluggable to different solutions.
TSL Avatar Design and Impl. Process

1. Creating 3D Model
2. Creating Animations of Model for Signs in TSL
3. Creating Runnable Software Using 3D Model and Animations
4. Modification and Refactoring in Model and Animations

Software Tools:
- Blender
- Unity
- S4R
- iPi Mocap Studio 2
- Leap Motion
- Kinect for Windows
TSL Avatar Prototype Mini Demo.
Conclusion

The deaf people faces serious difficulties in their education and social life.

Lots of research is made by people to facilitate their life using different methods.

It has been recognized that existing solutions have some drawbacks like effectiveness, cost or acceptance by deaf.

Avatar based solutions have potential to overcome this problems.

Turkish sign language avatar will be implemented considering all issues and when it is available it will benefit Turkish deaf people community in different platforms.
If you would like to play with us and learn sign language please feel free to contact us...

http://humanoid.itu.edu.tr

Thank you for your attention...