KROG - Kinect-Robot Interaction and Gaming

Summary

Krog project aims to develop a number of games with a Kinect-Robot-Big Screen interaction paradigm. The project is mainly focused on children with autism disorders, althought experiments have been done with children showing different abilities. Main goal of this project is to develop children's capability of interaction and socialization in order to improve their quality of life.
The robot used in the project has been developed to have an acceptable body (shape and physical properties, such as color, softness, robustness size, ...), and interesting abilities. Free interaction with the robot has provided interesting results.
Kinect can detect the position of both the robot and people playing in its range and this information can be used to project on the screen elements of the game, so obtaining a mixed virtual-physical iteraction.
A few games have been developed and tested, putting in evidence the great possibilities of this paradigm.
The project is funded by Politecnico di Milano under the Polisocial grant program (http://www.polisocial.polimi.it/us/home/).

Low-tech, high-tech products, services and contexts for play

The robot (Teo) based on Triskarino (http://www.deib.polimi.it/eng/equipments/dettagli/131), an omnidirectional base developed at AIRLab - Politecnico di Milano in several copies for several purposes. It has three omnidierectional wheels 8cm diameter and a diameter of about 40 cm, and can run at up to 1m/sec. It can be easily moved by a child, since omni-wheels do not show resistence, and the base is lightweight (about 2 Kg) and quite stable (most of the weight is on the bottom). On this base a soft body is mounted, covered by a soft cotton fabric, on which velcro elements can be attached (e.g., eyes, mouth, tongue, arms, ...). The body is soft enough to be pleasant to hug, and robust enough to resist punches and kicks.
Sensors on the robot include distance sensors, accelerometers, and force sensors on the body. A hat can be added with push buttons (which can be personalized by cards inserted in them) and/or touch/proximity sensors. Actuators include a loudspeaker that can reproduce either pre-recorded or computer-generated sounds, a set of coloured LEDs, and the wheels for movement. The main computation onboard is done with Arduino Mega, and the robot can exploit the wireless communication link with an external computer to interact with Kinect and the screen. A remote control is also available through a standard bllue-tooth joypad, both to move the robot, and to produce a set of pre-programmed emotional patterns to be shown in (possibly automatic) answer to data from sensors and Kinect.
Kinect is used to detect the position of both the robot and people playing in its range. A big screen or a projector can be used in games to add elements.

The interaction sessions start with a familiarization phase both with the robot (free iteraction) and with its avatar o the screen, to explore the possibilities of interaction. Familiarization with the robot exploits a lot of interesting relationships and can be done both with a single child, or with a group of children also at different times.

After familiarization, games can be played. Games can be personalized and designed through a friendly interface on a PC. The games so far implemented exploit a few abilities. In the "Color" game, the child is asked for the color of an object appearing on the screen and has to push a button corresponding to the correct color. In the "Witch says colors" game, there is a mat with six blobs of different colours and the screen is asking to reach a color (different settings are possible, involving relationships between robot and child). In the "Position" game, avatars of both the child and robot are on the screen and they are asked to take relative position.

The original intended target group was autistic children with medium-low impairment, but the approach, upon suggestion of the operators has been successfully tested (mainly the free interation part) also with other kind of both physically and cognitively disable people.

The project site is http://hoc13.elet.polimi.it/polisocial/

The context of use

Interactive sessions

Type of play in this play system

Cognitive

Practice

Symbolic

Rule play (including videogames)

Social

Solitary

Associative
Cooperative

Objectives related to play according to ICF-CY

Play for the sake of play: Major life areas - d880 enagement in play

d8800 solitary play
d8803 shared cooperative play
d8808 engagement in play, other specified
d8809 engagement in play, unspecified

Community social and civic life - d920 recreation and leisure time

d9200 play

Play-like activities: Therapeutic and educational objectives

b1 Mental functions
b2 Sensory functions and pain
b3 Voice and speech functions
b7 Neuromusculoskeletal and movement related functions
d1 Learning and applying knowledge (learning through symbolic play, learning through pretend play)
d2 General tasks and demands
d3 Communication
d4 Mobility
d7 Interpersonal interactions and relationships

Number of participants

>20

Chronological Age

6-12 years

Development Age

3-6 years
6-12 years

LUDI Categories of disabilities

Mental/intellectual impairments::
mild
moderate
Partially hearing impaired
Communication disorders (speech and language disorders):
Physical impairments:
Mild
Autism Spectrum Disorders:
Multiple disabilities:

Explanation on the use of low-tech, high-tech devices, services or contexts

Explanation

No instruction, self-discovery of the participant/subject
Verbal instruction, language and communication fitting to chronological age
Visual and/or verbal instruction with AAC (Aumentative and Alternative Communication)
Visual instruction with pictures or drawings
Guided discovery: therapist/researcher coaches the participant so s/he discovers how to use the assistive technology
Modeling by peer
Visual instruction by peer
Verbal instruction by peer

Involvement

Adult: therapist/educator/researcher
Parent or significant others
Peer with disabilities

Role

Participatory observer
After the instruction, providing supervision during play

Summary of achieved effects

Analytic results on the first 22 children are still to be elaborated in details. Qualitative feedback is very positive from the operators and therapists. KROG can elicit operational behaviors, social interaction and emotional responses that normally do not occur using other methods, or that require a much longer time to be achieved. For example, an autistic child explicitly called a mate to play with Teo and the screen together: it was the first time he expressed the willingness to play in social mode. A girl with severe Hyperactivity Disorder relaxed in few minutes after meeting Teo, and she was able to concentrate on, and perform, a learning task (the “Colors” game) during the same session. Another autistic girl that never interacted with others invented a new game with Teo (make it following one of the possible add-ons: a tie) when she was alone with it in the familiarizazion phase, and then, when the others came in the arena, took the lead and showed them what was it possible to do.

The possibility to develop new games and ad hoc settings is very large, and the tools to do that well accepted by the operators.
The robot in itself can be used as a tool driven by the operator to interact with the children without personal involvement, and with a clearly not-human object that can have some personal reactions. Autonomous activity of the robot frees the operator from controlling it, but also freighten the operators that expect that something might happen that could not been recovered in the relationship. It is a question of both reliability of the autonomous reactions, and greater confidence in the still new tool.

Keywords

Human-Robot Interaction, Kinect, touchless interaction, robogame, autism.