Combining Touchless Interfaces, Robots, and Storytelling for ASD Children

Andrea Bonarini
Politecnico di Milano
20133 Milano, Italy
andrea.bonarini@polimi.it

Mirko Gelsomini
Politecnico di Milano
20133 Milano, Italy
mirko.gelsomini@polimi.it

Matteo Valoriani
Politecnico di Milano
20133 Milano, Italy
valoriani@elet.polimi.it

Franca Garzotto
Politecnico di Milano
20133 Milano, Italy
franca.garzotto@polimi.it

Luigi Oliveto
Politecnico di Milano
20133 Milano, Italy
luigi.oliveto@polimi.it

Abstract
Our research aims at promoting communication skills of medium functioning autistic children by combining four main ingredients: multimedia storytelling, touchless interfaces, human-robots interaction, and Augmentative Alternative Communication (AAC).

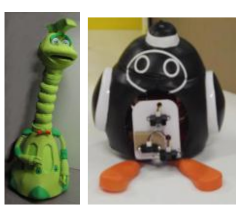
Author Keywords
Children; complex communication needs; autism; touchless interaction; robots

Context
Autism is a pervasive developmental disorder that is marked by the presence of impaired social interaction and communication and a restricted repertoire of activities and interests. The prevalence of autism has been estimated to affect 1 of every 88 children and is five times more common in boys than in girls (CDC, 2013). Children with autism show a great variance of symptoms, ranging from severe impairment in the use of nonverbal behaviors that regulate social interaction to a failure to develop peer relationships appropriate to age. Their impairment in communication is also marked and sustained and can affect both verbal and nonverbal skills. Children with autism may have a delay in or a total lack of spoken language. In children who do

Figure 1

Instructions can use the iconic communication language used by non-verbal kids, such as PCS.

Through motion sensing technology, we promote “kinaesthetic” forms of learning, promoting, through physical activity, not only motor capability but also social, communication and creative skills.



Small cheerful moving robots play as game partners and as learning facilitators.

speak, there may be a delay in the ability to sustain a conversation with others or a stereotypic and repetitive use of language. Our goal is to promote communication skills in medium functioning autistic children and to reduce abnormal behaviors that interfere with their functioning and learning [4].

Approach

Our 2-years experience on developing and testing systems for children with special needs have given us a vast understanding of pros and cons of many different technologies. Therefore, we decided to combine those that have proved to be most effective in a unique multidisciplinary/multi-technology approach.

Our approach combines four main ingredients: multimedia storytelling, full-body touchless interaction, human-robots interaction, and visual-auditory interfaces exploiting Augmentative Alternative Communication (AAC) approaches (Figure 1). Multimedia stories provide contents that are cheerful and engaging, and virtual characters whose gestures and behaviors children can imitate [1]. The capability of motion based interaction for learning is grounded on theoretical approaches that recognize the relationship between physical activity and cognitive processes, and are supported by a growing body of evidence from psychology and neurobiology [2][5][8]. Robots create a social context for rehearsing and experimenting with important skills for social and communication reciprocity. AAC provides tools, such as PCSs (Picture Communication Symbols) that relies on visual symbols and images as language elements and are appropriate for children with limited or missing verbal capability.

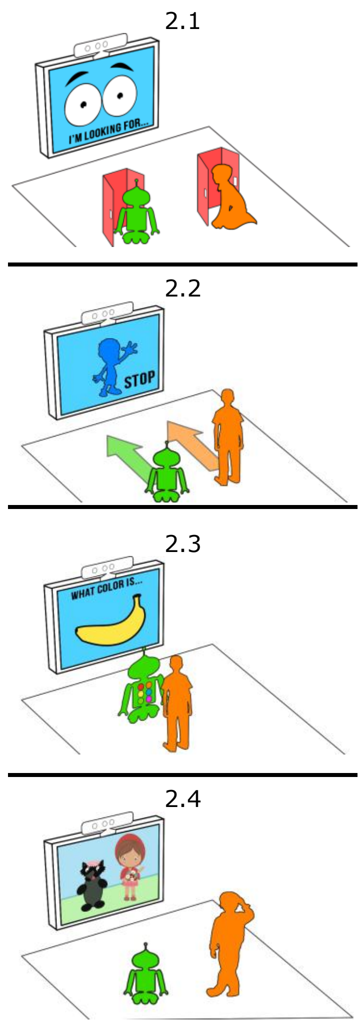
Our team involves a multidisciplinary group composed by engineers and designers from our lab, psychologists and motor/psycho-therapists at 3 therapeutic centers. Through the proposed approach, the learning goal is to improve fundamental skills such as:

- Understanding of simple narrative structures (cause-effect clauses)
- Mapping between pictograms (visual messages) and actions to perform
- Body control and schema awareness
- Recognition of sounds and spoken requests
- Comprehension of social queues and roles (turn taking activities)
- Imitation of robot’s executed gestures
- Repetition of robot’s voice commands,
- Reinforcement of communication with agents (peers)
- Assessment of robot’s feedbacks (sounds, light, movements)
- Taking the perspective of another agent
- Understanding appropriate behaviors in a given context.

Concept

Our preliminary prototypes are conceived as simple games and involve a single child. Concepts are inspired by activities that are frequently proposed to our target group in therapeutic centers: well-known physical games for young children, simple recognition tasks, and storytelling. Children’s movements and gestures, as detected by a Kinect camera, affect the behavior of the elements of a virtual world presented on a large screen. The robot acts out as requested by the situation that takes place in the virtual world, moving around inside the play area and giving sound or visual stimuli (e.g., verbally repeating what to do, or moving or highlighting some of its components) that enhance the child’s

Figure 2



understanding of the situation on display, promote imitation skills, provide engaging feedbacks to actions and positive reinforcement. Pictograms (PCS symbols) play an important role in suggesting the child which action to perform and when, or underline what is happening, so that the child can practice with the visual language and improve her vocabulary.

To guide the design activity, we have defined different functional roles for the mobile robot and have associated them to the different interaction relationships. In the *Feedback* role, the robot acts as a rewarding agent, it reacts to an action performed by the child (*robot → child).*
As *Facilitator,* the robot suggests what to do and when to do it, facilitating play (*robot → child; [robot + child] → virtual world).*
In the *Prompt* role, the robot acts as a behavior-eliciting agent enhancing the entire game play (*[child + robot] → virtual world).*
As *Emulator*, the robot supports the child's imitative reaction, either acting as the child or exhibing behaviors that must be emulated (*child ↔ robot*).
As *Restrictor,* the robot identifies the spatial constrains on the child's movements or offers a set of choice for actions and decisions (*robot → child).*
The robot plays one or more of these roles in the six game prototypes. Four of them, shown in Figure 2, are Hide&Seek (2.1), Statues (2.2), Colors (2.3) and Stories (2.4).

It is important to note that every child with autism is unique, and there is no such thing as an "average" child with autism. Each child manifests unique strengths and skill deficits, and treatment must be oriented to an assessment of the unique needs of each individual person, as [6] suggests.

Contributions to and from the workshop

We would like to share with workshop's participants our experience and the initial designs of our system, and to receive feedbacks on the played role by the different elements, in particular the virtual agents on the display and the robotic agents in the physical space.

Acknowledgements

We are grateful to the the children and caregivers at Centro Benedetta D'Intino (Milan), San Camillo Hospital (Turin), Ass. Astrolabio (Florence). This work is partially supported by the European Commission under grants "M4ALL-Motion Based Interaction for All" (# 2012-3969-531219 - Life Long Learning Program 2012) and by Politecnico di Milano – Polisocial Program 13-14.

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