Shybot: Friend-Stranger Interaction for Children Living with Autism

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Abstract
This paper presents Shybot, a personal mobile robot designed to both embody and elicit reflection on shyness behaviors. Shybot is being designed to detect human presence and familiarity from face detection and proximity sensing in order to categorize people as friends or strangers to interact with. Shybot also can reflect elements of the anxious state of its human companion through LEDs and a spinning propeller. We designed this simple social interaction to open up a new direction for intervention for children living with autism. We hope that from minimal social interaction, a child with autism or social anxiety disorders could reflect on and more deeply attain understanding about personal shyness behaviors, as a first step toward helping make progress in developing greater capacity for complex social interaction.

Keywords
Robotics, uncanny effect, friend-like interaction, autism

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

Interventions for children with autism are usually institutional and behavioral. In this paper, we present an alternative way: we develop a personal robotic technology that allows children living with autism to naturally unfold their social capability during a process of interactive play.

We seek ideas from the literature and from nature (i.e. Mimosa Pudica, the "Shyness Plant") as our starting point. We also consider from psychology that the *uncanny effects* [1] render an object with a vivid feeling, which can be used to engage more attention in the interactive play. In recent robotics development, Kismet [2] demonstrated that creature-like robots could be socially engaging with a model of emotional states and facial expressions, and with simple gestures like appearing curious and switching eye contact between people and an object of joint object. The Keepon robot [3] presents a minimal style to animate certain human characteristics, and exhibits the uncanny effect from interacting with people through joint attention and rhythm-tempo interaction. In [4], a robot demonstrates hide-and-seek play with children. Robota [5] is a doll-shaped mini humanoid robot that functions as an imitator to encourage the imitation ability of low-functioning children with autism. Robota is deployed as a therapeutic robot for behavioral assessment; however, we believe a robot can play a more active and fun role to encourage its user to understand and engage more confidently in social experiences. In [6], robotics is deployed as tools for diagnosing the criteria of autism. They found individuals on the autism spectrum exhibit a different visual search strategy. In [7], social-emotional prostheses are developed for understanding and measuring emotional expressions for people with autism.

This paper proposes Shybot as a techno-socio intervention for children living with autism. We would like to address the possibilities of using interactive physical objects with simulated social characteristics. Shybot is a creature-friend-like robotic toy for children to interact with. A child may engage it through simple social interaction and be recognized as Shybot's friend or as a stranger to it. Shybot may also encourage peer interaction as an object of shared attention that interacts with 2 or more people, and illuminates the stranger-friend roles. In the following paragraphs, we would like to present the journey that leads us to develop Shybot.

Shyness

Shyness can be the first social expression to any social situation. When interacting with a stranger, especially in an unfamiliar environment, people may feel shy. Leary [8] suggests that shyness is an affective-behavioral syndrome characterized by social anxiety and interpersonal evaluation. Shyness is a combination of subjective anxiety and behavioral inhibition. Encounters with strangers have a special power to cause people to feel socially anxious, causing feelings of shyness and anxiety in a high percentage of the population. From Leary, a further study for interacting with strangers found that subjects provided with information-seeking instructions reported feeling more confident and less awkward than subjects not provided with instructions. Shyness is one of the first few reactions when facing an uncertain social situation and it could slowly fade out when a subject becomes more confident in the situation. We take shyness as our

starting point to further investigate how it can be represented in a systematic way.

figure 1. Mimosa Pudica has the Chinese name "Shyness Grass." Its leaves close up when encountering touching or (non-contact) thermal or photic stimuli.

How can we make an analogy of shyness to non-human behaviors? In figure 1, Mimosa Pudica has the Chinese name *Shyness Grass*. Its leaves close up under stimuli like touching, warming, or shaking. Its rapid responsive movement renders it uncanny to young children. In a sense, this plant exhibits minimal social characteristics, giving the illusion of shyness. How can technology enable us to think about and build an interactive and minimally social machine giving this illusion?

An Illusion of Shyness Interaction

How could we design this imaginary and believable effect on objects? From [1], Freud mentioned that Jentsch identified *the uncanny* as bound up with a feeling of uncertainty, particularly regarding whether something is animate or inanimate, like wax figures and life size automata. Freud further discussed why uncanny is surprising: because it is *not* known but familiar. In robotics, 'The uncanny valley' [9] is a hypothesis introduced by Masahiro Mori in 1970. Mori argues that a humanoid robot can be so similar to a human, but it still falls into the 'uncanny valley' where this humanoid is more like a zombie than a real person. When can machines enable people to perceive them as social? In this paper, we focus on a typical social situation that when a person faces a stranger, he/she feels shy and tries avoiding face contact. Shybot is designed to embody this situation of being shy.

figure 2. A person is hiding and revealing his face with Shybot.

Shybot as a therapeutic tool is inspired by several deep-seated ideas that have been successful in many domains. *Replay* [10] is a therapeutic technique to encourage a child to re-experience stressful stimuli in a context of playful, exaggerated, and symbolic re-enactment. *Replay* enables a child to re-enact (usually stressful) experiences and view them from the audience perspective, overcoming those aspects that can cause so much stress. In [11], Piaget suggests that playing is an important medium to develop sensorimotor intelligence, and in [12], Turkle suggests that artifacts may evoke innate feelings that provide companionship with people. All of these ideas influenced our design of Shybot's play-and reflect companion behavior style.

Shybot is developed so that individuals with autism can begin to understand the behavior of shyness from the

audience perspective during *play*. By putting the child outside the situation of being shy, s/he could get a better understanding by watching and interacting from a particiapnt viewpoint. In Figure 2, a person is playing a kind of "peek-a-boo" hiding his face and getting closer to ShyBot, but when he uncovers his face, ShyBot activates its motor to run away from the face.

For children with autism, they often have rapid, intense and negative emotional and behavioral reactions to seemingly small events such as looking at a face, and have difficulty managing and regulating their emotions. We focus on shyness and approach this issue by designing Shybot in an abstract way with certain minimal social-like characteristics. By selecting a primitive social situation like being shy to strangers, ShyBot plays an interactive companion that represents this social situation. When a shy child approaches ShyBot, it displays the runaway behavior. ShyBot thus sets up the opportunity for a child to experience stressful situations in a playful mode, encouraging reflection via associating their outward observations with their inward feelings, all while having fun.

Implementation for Uncanny Interaction

Shybot is a robotic toy car covered by a translucent cover (as shown in figure 3) and is controlled by an Arduino Bluetooth electronic I/O board with proximity sensors, a motor, and a wireless camera. Shybot transmits VGA images and sensor data wirelessly to a laptop computer for analysis in order to have real-time expressions, including nervous heartbeats, shy movements, and exciting spins (as shown in figure 4).

Nervous Heartbeats

Shybot has LED lights that accelerate when its camera and face-detection software detect a stranger's face or when its proximity sensors detect sudden actions. From the wireless camera, it retrieves images and processes them with the OpenCV Face Detection (using frontal view and a Haar-like casade of features) for detecting people's faces. Whenever a face or a sudden movement is detected, Shybot accelerates the blinking rate of the heartbeat LED and slowly decreases the rate when undisturbed. *Nervous Heartbeats* represent the internal state of the Shybot while *Shy Movement*s reflect the reaction of the internal state.

figure 3. Shybot is a reactive robotic toy car covered by translucent plastic with a propeller.

Shy Movements

Shybot demonstrates its ability to physically interact with people due to its calculation of 'Friendliness'. It interacts with people around it and categorizes them into *Stranger*, *Friend*, or *Master*. From the gentle approaches to sudden actions, and from the number of face contacts, Shybot rates the processes of interaction When Shybot categorizes a person as a *Stranger* with unfriendly interaction, it activates the engine to run away giving the illusion of having a nervous reaction. For recognizing familiar faces with gentle actions, it

categorizes *Friend* and presents itself as calm with normal and slow heartbeats. Shybot interacts with its *Master* differently. At this stage, we need to train an OpenCV Haar Casade for the *Master*'s face so that Shybot will be able to recognize him/her through the camera and react to its *Master* via a greeting gesture (i.e. fast-blinking LED lights) and *Exciting Spins*. (This is somewhat analogous to a dog that greets its master with excitement upon arrival.)

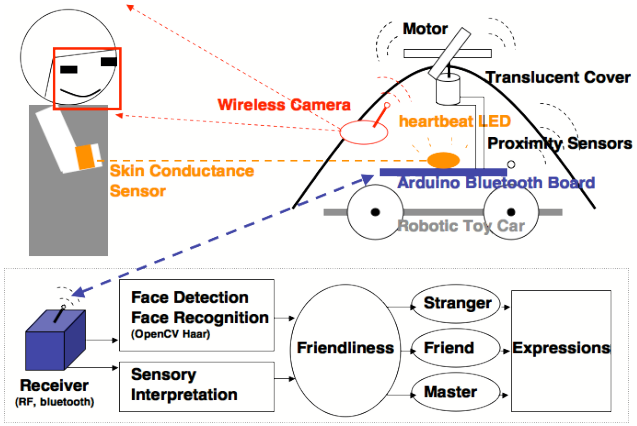

figure 4. This is a diagram of Shybot illustrating motor systems, the wireless camera with face detection system, and the skin conductance system.

Exciting Spins

Shybot reflects the excitement of its *Master* through *Exciting Spins* from the propeller on top of Shybot. The propeller spins when Shybot's Master gets aroused, which can be detected by the use of a wireless skin conductance sensor [13]. Presently, Shybot allows only one *Master* wearing a wristband skin conductance sensor. Shybot currently maps significant increases of skin conductance level to the angular speed of the motor. When the Master gets aroused, the motor activates and spins.

Discussion

Forging new relationships with machines

The Shybot project opens up an alternative way of considering human-machine interaction. Instead of focusing on how machines will do things for us, from a functional point of view, or how they can have enormous skills of cognitive-affective intelligence, we focus on what even minimal illusions of social behaviors can bring about. We expect certain uncanny effects to gradually emerge from interactions with Shybot, effects that do not deceive about the robot's limited social capabilities, but that shift the meaning of interaction to a higher level.

> *A range of possibility exists between ideas of the 'pet' and the 'alien'. While the pet offers familiarity, affection, submission and intimacy, the alien is the pet's opposite, misunderstood, and ostracized. --- Donne, A., Hertzian Tales*

In *Hertzian Tales*[14], Donne suggests a new sense of 'alienation' for electronic objects that don't have to fulfill people's expectation. Instead, they leave room for imagination. From the demonstration of Shybot, it invites a desire (for people who surround it) to model an imaginary friend behind it.

Externalization as representation

The concept of externalization is to represent people's innate feelings in the physical world. By externalizing things, it sets up a floor for people to communicate and to better understand things. It may make it easier to understand others when you can step outside of a

situation. It may also make the situation simpler when you can visualize it calmly from outside, instead of being in the overloaded insider position.

Future Work

This research opens up a series of questions that still remain untested in human-robot interaction and techno-intervention for autism. They are: First, does the child perceive and read the robot as acting shy, and connect this to his or her own shyness? Second, does the child enjoy playing with this interactive style? Third, how does the child play, and does his or her style of play lead to self-discovery and perspective-taking? Fourth, do the interactions with Shybot lead to measurable improvements in encountering new human social interactions, whether with familiar individuals or with strangers? Running these studies properly will require a careful technology control (so that we can see if it is the features of shybot that are effective vs. just a new techno-toy and an experiment) as well as many weeks of repeated observation and measurement.

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