Character Mediated Communications

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ABSTRACT
In this paper we present a broadband connected child's toy, capable of facilitating games, reading stories and hosting remote communications. It is embodied as a wireless plush starfish, with a variety of sensors and outputs to create a rich character-based interaction. We define a new class of Character Mediated Communications, describe our design and the resulting implementation. We then highlight two specific questions exploring Character Mediated Communications, on which we seek the perspectives of others.

Keywords
Character Mediated Communications, Connected Characters, Telepresence, Robotics, Identity, Children's Toy, Play

INTRODUCTION
With the ever decreasing costs of computing and the increasing ubiquity of wireless broadband networks, the conditions are ready for the widespread adoption of ubiquitous and tangible computing. Our work has recently been focused on how this may be used in young children's toys. We have been concerned here with understanding the benefits and pitfalls of network enabled toys and how that capability can be leveraged to encourage fun and imaginative creative play. We have not looked specifically at educational outcomes, although this is clearly relevant.

A visit to any toy shop today will present a mind-boggling range of electro-mechanical toys, frequently with synthesised voices and a variety of moving parts. While a few toys allow networked play and some can be updated via the Internet, most remain disconnected.

In this paper we describe our design of a broadband connected character, aware of interactions and its environment. This takes the form of a plush starfish with actuated arms, an LED face, an RFID reader, movement sensors, a speaker and microphone; all wirelessly connected via Bluetooth to a broadband connected PC. The next section gives our definitions of Character Mediated Communications and Embodied Interaction; the related work, design, play scenarios and implementation follow. Finally in the discussion we highlight two specific questions arising for the workshop.

CHARACTER MEDIATED COMMUNICATIONS
The focus of this work is to explore "Character Mediated Communications". By this we mean a consistent and identifiable character that facilitates a range of communications, both locally with the user and with remote participants. In the context of a plush toy, the character is embodied by the toy, with multimodal expression to convey its identity and emotions. By using a character otherwise complex interactions can be established by social norms.

There seems to be a tension between the use of strong characterisation for local interactions and the virtual "possession" of the character in remote communication. Socially this could be interpreted very negatively. That said, radios and telephones have almost universal acceptance, but do not present a character.

From this perspective our definition of Embodied Interaction emphasises the embodiment of the robot's cognition and its physical form, interacting socially with the child in their environment.

RELATED WORK
The plush toy, and notably the teddy bear, has been a favourite with children since the later half of the 19th century. Since the 1980s electronic elements have been introduced, for instance Teddy Ruxpin (Worlds of Wonder, 1985) and since then the Furby (Tiger Electronics, 1998) and most recently the Alive Cubs (Wowee, 2008). They have become increasingly sensor-rich and animated with more developed characters.

Currently few commercial toys connect to the network, with the notable exception of the Nabaztag (Violet, 2006), a robotic Wi-Fi pet rabbit that presents online content, giving ambient alerts, reading back email and weather reports. Most recently the Nabaztag/tag (Violet, 2007) reads back children's books, using RFID to identify the story.

The use of character to facilitate interaction has been established by robots such as Breazeal's Kismet and Leonardo [1, 3] and Scheeff's Sparky [7]. All of these robots have expressive faces and bodies.

A number of works have previously explored the role of characters in communication. The Cellular Squirrel [6] is an interactive call handling agent that uses social signals to represent incoming calls and events such as voicemail being left. The character mediates the status of the call, but not the real-time conversation. The Huggable [9, 5] is an ambitious robotic teddy bear that embeds sophisticated sensors and actuators to create a companion for healthcare applications. In addition to an autonomous character, the bear can be controlled remotely through a web-based puppeteer interface; this allows scenarios such as a parent reading a story, appearing to be embodied within the surrogate.

We seek to investigate how an embodied expressive character can switch to being a surrogate for a remote person in a play scenario. This paper describes the platform we have built to investigate Character Mediated Communications.

DESIGN

In this section we consider the means by which a character is created and the specific play scenarios that demonstrate Character Mediated Communication and have driven the implementation.

Creating a Character

The character that the toy presents is created by the combination of every aspect of its behaviour. The Starfish is a playful form that allows a good deal of articulation and sensing with five arms. We considered that a humanoid would raise the expectations of the interaction past its capabilities and potentially into the uncanny [2]. Stern et al used a similar form with the Sensor Squid [8], a large plush squid for collaborative group interaction with an onscreen game. However the squid does not express its own character.

In conveying character a face allows emotions and intentions to be powerfully communicated [1, 7]. The LED display we designed contains 92 LEDs: 30 green for the eyebrows, 30 blue for the eyes and 32 red for the mouth. This allows a variety of emotional faces to be made. To reduce the complexity of the driving circuit, the eyebrows are mirrored and the eyes are cloned. See Figure 1.

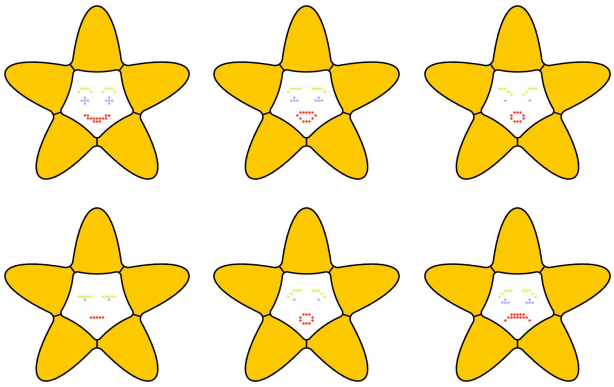

Figure 1 Facial expressions

Each of the tips of the five arms can be positioned between resting on the floor and raised in upright, allowing a range of expressive movements; they are not intended to give the robot locomotion.

When the Starfish speaks, the same voice is used to create a consistent character.

Secondary animations and "signs of life", such as blinking, add to the sense of the character's presence in addition to the basic reactive behaviours.

Play Scenarios

To inform the design of our connected character we developed a number of play scenarios of which three will be described here.

Scenario One: Interactive Stories

A book with lift-out elements, such as "Splishy, Splashy, Sparkly Sea Life" (Dorling Kindersley Preschool, 2007) is used to speak back the words from the pages. Each element, e.g. a puffer fish, is electronically tagged such that it can be recognised, allowing the story, sound effects and accompanying animations can be played.
This scenario requires that objects can be recognised, such that related content can be retrieved across the network and played back through the toy.

Scenario Two: Simon Says

Two Starfish toys are linked together wirelessly over the network in the houses of two remote friends. Each friend's voice comes through the speaker in the remote toy. One child calls out "Simon says…" at which point their friend poses their starfish as per the instruction by moving the arms. Their actions will be mimicked in real-time on the remote toy, to show that the action has been taken.

This scenario requires a real-time audio connection for the conversation, sensors to detect the manipulation of the arms, a real-time data connection between the toys to manipulate the arms.

Scenario Three: Remote Story Telling

A parent can tell a story remotely through the toy, directing its actions through a PC application or on-screen widget and relaying actions made by the child on the toy. This scenario is similar to that proposed by Lee et al [5].

This scenario requires a remote software interface to the toy that allows all the actions of the starfish to be initiated, in addition to the requirements of Scenario Two.

IMPLEMENTATION

This section describes the hardware and software implementation of our connected character Starfish toy.

Hardware

The Starfish is build around an Arduino Bluetooth board, containing an ATmega168 microprocessor running at 16 MHz and a Class 1 Bluetooth radio with a Serial Port Profile. Bluetooth enables data to be exchanged with a local PC and in turn the broadband network. The skeleton is constructed from polystyrene and is covered in a soft felt body; see Figure 2.

Figure 2 The Plush Starfish

The 92 super-bright LEDs of the face are diffused through the material body to form a soft display.

Each of the five arms is controlled by two control cables routed either side of a central flexible spine enable each arm to move. A Firgelli linear actuator pulls on the guided control cable attached to the tip of the arm. A mirrored counter sprung control cable provides tension that enables the arm to return to its relaxed position, once the actuator is fully extended. A pair of flexible bend sensors detect up or down bending of the arm; either by the actuator or a child moving it. See Figure 3.

Figure 3 Actuators and driver boards

A tri-axis accelerometer allows the detection of the toy being picked-up and moved around; currently only the z (up) axis is used.

An ID-2 RFID module allows tagged objects to be identified and recognised at a range of approximately 5cm. The aerial is around the perimeter of the face to support the explanation that the starfish is "shown" the object.

A speaker and microphone allow audio capture and playback, via a Bluetooth Audio Profile.

The Starfish is powered by a 7.5V Lithium-ion battery (2.2AH) mounted internally. At peak activity it draws approximately 2 amps. The Starfish sits on a wired base for charging.

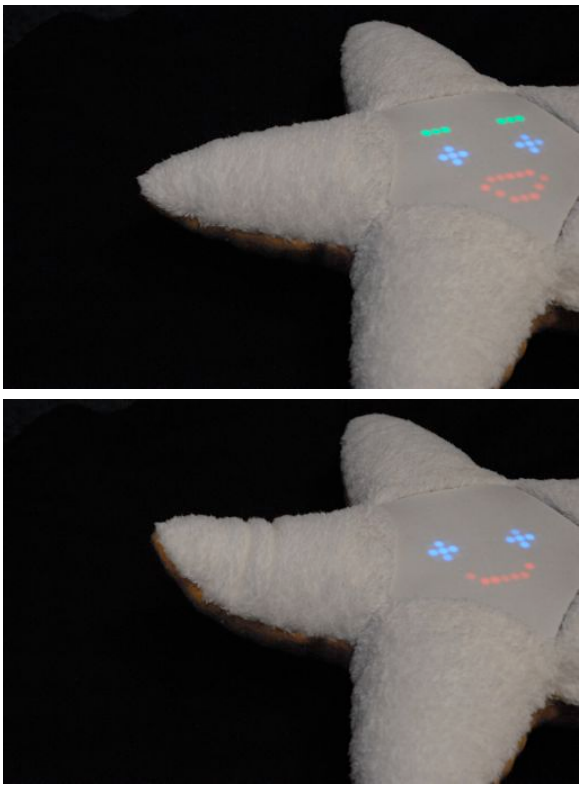

Figure 4 Animation of the Face and Arm

Software

There is a division of software that resides on the toy, on the local PC and services on the network.

Currently the PC defines and controls the complex interactions, querying sensors and initiating actions on the Starfish. For instance, managing the logic of the game in response to RFID tagged objects. In addition to managing this communication interface, the Arduino software manages basic reactive behaviours of the Starfish. The architecture is a simplified implementation of Brooks' subsumption architecture [4] in the Java language.

The subsumption architecture is implemented as a prioritised list of behaviours through which the process iterates, matching the appropriate behaviour to the current sensory inputs. The bottommost behaviour in the list is the

default and is active in the absence of any matching behaviours that subsume it. In this case control is deferred to the low-level behaviours defined on the Starfish itself; these include a waking and sleeping cycle, where there is inactivity for a period of time.

The network provides access to external resources such as audio files and remote communications. The PC based software manages the orchestration of these resources.

Using this architecture the three play scenarios, described previously, were implemented.

DISCUSSION

In this section we describe some early observations and pose two questions for consideration in the workshop. While we have yet to conduct a user study; we informally observed a five-year-old girl playing with the Starfish in scenario one - the interactive stories.

For a tagged-object to be recognised it has to be held in front of the face within a range of approximately 5cm, with increased reliability with proximity. In our informal trial we consistently noticed the tagged cards being held pattern towards the face at a short distance, but not in contact. One interpretation is that the child's intention was to hold the card towards the Starfish's eyes to be read, although this was not confirmed. If so, there is a mismatch between the characteristics of the metaphorical sense (sight) and the sensor (RF). The RFID reading performs better the closer the tag, but in the case of an eye an object needs to be placed at distance to focus. If this were the case, a better metaphorical sense would be that of smell, as used in the Nabaztag/tag (Violet, 2007).

In our current implementation of scenarios two and three a remote person uses the Starfish as a medium to speak and act through. This may be in conflict with the character the Starfish exhibited during other types of play where the toy acts autonomously, for instance in scenario one. In the worst case this mediated behaviour may be interpreted as a kind of spiritual possession.

Lee et al [5] recognise this and consider that, "Although the robot's physical appearance may not change[,] the change in idiosyncrasies may alter the user's belief of the robot's identity." This concern is more in the clear separation between the multiple identities.

Should our implementation be found to create a negative experience, alternative designs will need to be considered. If the problem is in the separation of identities then this may be reinforced using sounds, movement and facial display cues. However, if the embodiment of multiple identities in a single body is the issue, then it may be more appropriate to separate all external hosted communications; for instance to independent local speakers. This would allow the character to be seen as an independent third-party in the conversation, the subject of attention and action.

Our two questions are then: how might multiple identities be mediated unambiguously through a single embodied character? And, what alternative designs exist for Character Mediated Communications?

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