“Touching Virtual Agents - Embodiment and Mind”

eNTERFACE’13

Project Core Team
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Abstract

The aim of this project is to develop a virtual conversational agent that has the ability to touch the user using haptic interfaces. The focus is on generating believable communicative behavior of the virtual agent based on mental models of human-human communication. We will work on generating scenarios, building prototypes of haptic interfaces, and evaluating the user experience with the system. An existing virtual agent platform based on Elckerlyc will be used for the generation of agent behaviors.

Keywords: Embodied Conversational Agents, touch, affective haptics, presence.

Project objectives

Embodied conversational agents attempt to approximate human face-to-face communication. However, the tactile modality, which can have strong affective consequences in human-human communication, is often overlooked in communication with embodied conversational agents.

We propose a project that will focus on virtual conversational agents that will have the capability of physically touching the user. The general aim of the project will be to incorporate the tactile modality into interaction with virtual agents through the use of haptic interfaces. The addition of touch to the communicative repertoire of a virtual agent is likely to enhance the agent's expressivity. We will use cognitive mental models for human-human communication to generate appropriate touching behavior by the agent. For example, when a user retells a painful personal experience, the embodied agent could offer a comforting pat on the shoulder, in combination with the appropriate facial expression and vocal utterance. This would be relevant for virtual and robotic agents in different scenarios, such as therapeutic settings, training, entertainment and gaming.

In this project, we will work on different aspects that are important in the interaction with a virtual agent capable of touching the user. Below we list the project goals, as well as some examples of how to achieve these goals. The extent we focus on specific elements of each goal depends on the skills and interests of the team members.

Goal 1: Construct a touching virtual agent system with believable touch behavior.
Description: For the system to be usable, a first requirement is that the user perceives the virtual agent to be the one applying the touch. Therefore we will investigate what sort of behavior the agent needs to display, as well as what sort of haptic feedback should be given for users to perceive the touch as "agent initiated".

Goal 2: Gain insight into the similarities between of touch by a virtual agent and inter-human touch.
Description: The question here is to what extent touch by a virtual agent is comparable to touch by a human. We will explore the boundaries of touching virtual agents, by developing small-scale 'touch games'. For instance: can we make a user feel uncomfortable when he/she has to hold hands in a staring contest with a virtual agent?

Goal 3: Gain insight into the parameters that influence user perception of the touching agent
Description: Here we will use variations of elements described in the first two goals. For instance, we can vary the location and type of touch, the expressions of the agent, as well as introduce incongruences between the touch and visual (bodily, facial) behavior of the agent.

Goal 4: Study agent touch in scenario-based experiment.
Description: Based on what we've learned, we will conduct a small-scale experiment that investigates agent touch in a specific scenario. Scenarios can include counselling in a healthcare setting, negotiations, competitive versus collaborative tasks, etc.

Background information

From psychology research it is well known that physical contact between humans is of vital importance for the cognitive- and social-emotional development of infants, is the foundation for the forming of affiliative behavior and provides a mechanism for the formation and maintenance of social bonds (Gallace & Spence, 2010; Morrison, Löken & Olausson, 2010). Moreover, touch between co-located individuals can be used to communicate affective states (Hertenstein et al., 2006a; Hertenstein et al., 2011; Hertenstein & Keltner, 2009) and can influence the liking, trust, and compliance to requests by the one being touched towards the person applying the touch (Guéguen et al., 2007; Hertenstein et al., 2006b).

Recent advances in haptic technology have spurred the development of prototypes that aim to mediate touch between individuals (Haans & IJsselsteijn, 2006). Mediated touch has been found to have effects similar to those of real touch (Bailenson et al., 2007; Haans, De Nood & IJsselsteijn, 2007; Haans, & IJsselsteijn, 2009; Smith & MacLean, 2007). Moreover, the tactile modality can be used to enhance the communicative repertoire of virtual conversational agents. Mediated touch in shared virtual environments has been demonstrated to enhance the feeling of copresence (Sallnäs, 2010), and can give users an enhanced feeling of control during a competitive task (Brave, Nass & Sirinian, 2001). Direct physical contact with a virtual agent can communicate the affective state of the agent and can enhance feelings of empathy towards the agent (Bickmore et al., 2010). Furthermore, when users can touch virtual agents, they employ specific touch behaviors for female and male agents, touch different body locations differently and use different touches for non-human objects compared to virtual agents. Finally, these types of studies using virtual agents are highly comparable to studies into tactile human-robot interaction (Argall & Billard, 2010).

To further develop the complete communicative repertoire of virtual conversational agents, it is essential to have mental models based on human-human communication. Communication is a complex mix of signals between multiple autonomous agents. These signals can take many forms, but they have one thing in common: meaning. Grounding (e.g. Clark & Brennan, 1991) can provide meaning to utterances. Interpersonal relations (e.g. Goffman's face (Goffman, 1967) and Leary's rose (Wiggins, 1996) between humans or humans and agents are important, as they provide a meaningful link between communicating parties. They also influence the willingness to communicate. As one agent signals the other (e.g. a smile) this has an effect on the other (e.g. he likes me), which in turn can lead to a return signal (e.g. a smile): the smiles mean something. In addition, one signal is often accompanied by other congruent signals from different modalities. The recognition of virtual agent behavior is better when the agent displays congruent behavior over different modalities, for example in expressing emotions through face and posture (Clavel et al., 2009). Sending a communicative signal often means a specific return signal is expected. The timing or lack of return signal means something. Without the exchange of signals and the taking of turns, there is no communication. One of the core works on turn-taking, focussed on speech and language, is the SSJ paper (Sacks et al., 1974). It has its flaws and shortcomings (e.g. O'Connell, 1990; op den Akker & Bruijnes, 2012), however it still provides an elaborate view of when people say something. People know not only what to signal, but also when (not) to, whether this is patting on the back or saying something funny. Communicative signals are not only facial or vocal expressions, but can also be communicated through touch. This will be the focal point of the project.

Technical description

Virtual agent
For the generation of agent behaviors we will use the open source Elckerlyc system (van Welbergen et al., 2010), which is available on git. Several agent embodiments will be made available: we have one female (Armandia) and we plan to have an additional female, male and a child. An affective turn-taking dialogue system (Bruijnes, 2012) is available as a starting point for generating agent conversations. The components communicate by means of ActiveMQ.

Haptic interface
For the haptic component of the project we plan to bring the TaSST (Tactile Sleeve for Social Touch)(Huisman et al., 2013a; 2013b). Furthermore, we will bring some basic components for physical prototyping such as Arduino boards, vibration motors, and servo motors so that we can prototype different haptic devices. Other equipment for prototyping (fabrics, additional wires, etc.) can be purchased on-site.

Evaluation
Evaluations of interactions with the touching agent system can be done using standard "Inclusion of Other in Self" scales, as well as telepresence scales. Furthermore, we can employ emotion measurement scales such as SAM, PANAS, and PrEmo. Finally, we plan on bringing at least one Affectiva Q-sensor to measure users' emotional arousal during interaction with the virtual agent.

Resources needed
We encourage participants to bring their own laptop to work on different elements of the project. However, the availability of at least one computer with ample processing power for rendering the virtual agent is required. We require a quiet room equipped with at least two computer monitors for conducting experiments.

Project management
See profile of the team.

Work plan and implementation schedule

Preparation
Prior to the workshop, we will prepare the initial integration of the Elckerlyc system with (haptic) devices based on Arduino. This will provide a basis on which we can build agent behaviors and haptic feedback. The connection will be implemented over ActiveMQ.

Work plan
The work plan follows naturally from the project goals. The separation of topics over the weeks need not be as exact as proposed in the plan. Small groups of participants might prepare or finish different tasks over the course of the project. Despite that reporting is mentioned explicitly only in week 4, it will be encouraged to report on the progress at the end of every week (in presentations and on paper).

Week	**Goal**	**Description**
1	Creation of believable agent-touch interface	- Group members introduction; - Introduction to the general outline of the project; - Detailed planning of the project components; - Introduction to the hardware and software; - Work on creating believable agent-touch interface.
2	Human-human vs human-agent touch	- Refinement of agent-touch interface; - Generation of scenarios for investigating human-human vs. human-agent touch; - Build ‘touch games’ to explore human-agent touch.
3	Parameters relevant for agent-touch	- Based on insights gained from touch games, determine parameters of agent-touch to be manipulated; - Set up small-scale experiments to explore effects of parameter manipulations.
4	Scenario based experiment + reporting	- Use insights from previous weeks to construct a scenario to study agent-touch; - Set up scenario-based experiment; - Finalize project report.

Benefits of the research

The use of touch in interaction with conversational virtual agents is relatively unexplored. Our aim is to explore different elements of tactile interaction with virtual agents in order to provide the research community with insights into the role of the tactile modality in interaction with virtual agents. By incorporating touch into human-agent interaction virtual agents are able to communicate to the user through an additional modality. This can in the future result in more natural and richer communication. As touch has proven to have positive effects on human well-being applications in healthcare are abundant.

This workshop will give the research community knowledge and tools to start researching the coupling of virtual agent system and a haptic interface by providing:

- Prototypes of haptic interfaces for agent touch which can be further refined
- Elckerlyc animations for specific agent touch behaviors
- Informal experiments/studies/games to explore touch in human-agents interaction
- Experimental scenarios for incorporating touch by virtual agents
- Data from pilot studies that can help set up later formal experiments

Profile of the team

Project Leaders

Gijs Huisman (PhD Candidate, University of Twente, 4 weeks)

My PhD research revolves around the questions "How can we enable people to engage in physical contact over a distance, and how does that influence people's emotions?". In my research I investigate whether the emotional effects of co-located human-human touch also occur when someone is touched at a distance. This involves creating prototypes that allow two people to communicate a touch at a distance through sensors and actuators. My main interest is to use these prototypes in experiments on the impact mediated social touch can have on people's emotional state. My hope is that this will aid in making mediated communication more like communication as it occurs between people in the same room.

Prior to my PhD position, I obtained a Bachelor's degree in Communication Science, and a cum laude Master's degree in Communication Studies: New Media, Research, and Design, both at the University of Twente. During this time I was involved in the creation of the LEMtool, an interactive tool to measure emotions in visual interfaces.

Merijn Bruijnes (PhD Candidate, University of Twente, 4 weeks)

The topic of my PhD research is social signals in interaction between humans and artificial agents. I work on the model-based generation of consistent emotional turn-taking behavior in virtual human conversations and the evaluation of this behavior. Natural interaction with an embodied conversational agent (ECA) is something that has proven to be difficult to achieve. In particular, turn-taking in a conversation between an ECA and a human is often very unnatural. Agents that immediately halt speech when the user speaks are abundant and the same goes for systems that only pay attention to the user at a system-determined time. This needs to be better for many applications such as tutoring applications. My research will be applied in a training simulator for the police. Here, trainees can practice their conversational skills with an artificial conversational agent. My vision is that in 20 years, I will be able to just sit down with a virtual agent and have a good conversation.

I received my master's degree at the department Cognitive Psychology and Ergonomics (CPE) in 2011, studying development of spatial mental representations in an embodied artificial neural network using sequential and egocentric data (thesis). After graduating, I joined Human Media Interaction (HMI) to do my PhD research.

Additional team members

Merel Jung (PhD candidate, University of Twente, 4 weeks)

Currently I am a PhD candidate at the Human Media Interaction department where I research technology mediated touch interaction. In order research the effect of touch, touch can be studied in isolation or in combination with other modalities such as vision and audio. Specific instructions can be given on how to interact with the device or users can be given the opportunity to play/ communicate freely. I also investigate whether different degrees of touch receptiveness are distinguishable from the way people interact with a touch device. Furthermore, I focus on touch interaction for entertainment immersion, by introducing a mediated touch

device users can use touch to tease each other during a scary movie. This can be done either when watching physically together by discretely using the device to maximize the chance of scaring the other or to have a feeling of enjoying a movie together while being apart.

My background is in psychology, I received my bachelor's degree and master's degree (Cum laude) at the department of Cognitive Psychology and Ergonomics at the University of Twente. My master's thesis was focused on the detection of deception through body motion measured by Xsens motion sensors.

Aduen Darriba Frederiks (Researcher, Amsterdam University of Applied Sciences, pending)
I am currently a researcher and lecturer at the Digital Life centre of the Amsterdam University of Applied Sciences. My research focuses on tactile and tangible interaction in healthcare settings, specifically care for elderly people. Besides my research interests, I am also active as an artist exploring the combination of technology and fashion. My work has been exhibited in the Netherlands, Denmark, Italy and Austria.

I have a background as an interaction designer, did my minor in Arts and Information Design at Kyushu University (Japan), and obtained my Master of Arts degree at the Open University (United Kingdom).

Senior researchers (available for consult)
Dennis Reidsma (Assistant Professor, University of Twente, 4 weeks available over Skype)
His current research activities focus on two main topics. He supervises a number of BSc, MSc, and PhD students on topics of computational entertainment and interactive playgrounds, runs several research projects in this area, and is regularly involved in the organization of conferences such as INTETAIN and ACE. In addition, he has published many papers on interaction with Virtual Humans, and consolidated the results of this joint work with Herwin van Welbergen in the release of Elckerlyc, a state-of-the-art Open Source software platform for generating continuous interaction with Virtual Humans.

Ronald Poppe (PostDoc, University of Twente, 1 or 2 weeks)
Ronald Poppe received a Ph.D. degree in Computer Science from the University of Twente, the Netherlands in 2009 on the topic "Discriminative Vision-Based Recovery and Recognition of Human Motion". In 2009, 2010 and 2012, he was a visiting researcher at the Delft University of Technology (DMIR - Delft Multimedia Information Retrieval lab), Stanford University (AIR - Artificial Intelligence Research lab) and University of Lancaster (IEU - Psychology Department), respectively. He is currently a postdoctoral researcher in the HMI - Human Media Interaction group of the University of Twente. His research interests include the analysis of human motion from videos and other sensors, the understanding and modeling of human (communicative) behavior and the generation of communicative behavior for virtual characters in human-computer interaction.

Other researchers needed

There is plenty of room for participants in one or more of a number of topics listed below. Depending on the expertise available, the focus of the workshop can shift to or from one or more of the topics. We welcome participants with a variety of backgrounds, including computer science, electrical engineering, psychology, gaming industry, healthcare, etc.

Virtual agents & Robotics

We need participants who have experience in working with Embodied Conversational Agent platforms or their robotic counterparts. Advanced programming skills, specifically in Java, are highly desirable.

Touch

We invite participants working on (mediated) affective touch, affective haptics, and related fields. Experience with electronic engineering is desirable.

Game

There is a possibility for the workshop to focus on implementing virtual agent touch in a game if there are participants from this area.

Healthcare

There is a possibility for the workshop to focus on implementing virtual touch in a health care or counselling setting if there are participants from this area.

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NOTE: The literature marked with an * is recommended reading material for participants of the workshop.

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