Modeling Human-Robot Collaboration in a Simulated Environment

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ABSTRACT

In this paper, we describe a project that explores an open-sourced enhanced robot simulator SIGVerse towards researching a social human-robot interaction. Research on high level social human-robot interaction systems that includes collaboration and emotional intercommunication between people and robots requires a big amount of data based on embodied interaction experiments. However, the cost of developing real robots and performing many experiments can be very high. On another hand, virtual robot simulators are very limited in terms of interaction between simulated robots and real people. Thus we propose using an enhanced human-robot interaction simulator SIGVerse that enables users to join the virtual world occupied by simulated robots through immersive user interface. In this paper,we describe a collaborative human-robot interaction task where a virtual human agent is controlled remotely by human subjects to interact with an automatic virtual robot with implemented artificial emotional reactions. Our project sets the first steps to explore the potential of using an enhanced human-robot interaction simulator to build socially interactive robots that can serve in educational, team building, and collaborative task solving applications.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation (e.g., HCI)**]]: User Interfaces— *Interaction styles*; H.1.2 [**Models and Principles**]: User/Machine Systems—*Human information processing*

Keywords

Multimodal interaction; social robotics; robot emotions; human-robot collaboration

1. INTRODUCTION

Human-robot teams are becoming commonplace nowadays. However, the idea of a socially interactive robot collaborator still poses many challenges from a research perspective and requires a big amount of experimental studies performed with different types of robots in different collaborative scenarios. Typical human-robot interaction (HRI) research is conducted in a laboratory. However, large scale HRI experiments are required to collect big data of social interaction features and models. Such large scale studies usually induce high costs, both financial and time related. In this paper, we propose using an open source enhanced simulator that enables conducting HRI experimental studies with a high number of human subjects from any place in the world. The simulated environment enables researchers to model different HRI tasks and scenarios.

HRI'15, March 2–5, 2015, Portland, Oregon, USA.
ACM 978-1-4503-2883-8/15/03.
http://dx.doi.org/10.1145/2701973.2702035.

2. SYSTEM FRAMEWORK

Our work on a collaborative HRI task was developed based on a simulation platform named SIGVerse [1]. This platform provides a possibility to model the robot agent and the 3D virtual environment for embodied HRI. The entire system framework is presented in Figure 1 and consists of a Server side, Client side and Service Providers. On the Server side, SIGServer is the main part of the simulator that runs core calculations. Agent Controllers are executed on top of SIGServer and simulate agents' intelligence. The agents do not just behave as they were programmed - they can also act on the basis of instructions of various forms given to them by human operators in real time, or on the basis of interaction with their environment. Human users interact with a simulated world and agents via SIGViewer on the Client side. During an HRI simulation, the user is able to controls his/her own virtual human avatar through various User Interfaces: GUI, text messages etc. Services Providers offer additional multimodal forms of interaction with a simulated environment, such as sensor processing or image processing.

3. EXPERIMENTAL SETUP

In our project, a collaborative table setting task scenario was designed and developed in the simulator. The objective of the task was to pick up the required tableware and dishes from the blue cabinet and set them on the table according to the given table setting. A robot avatar was working in pair with a human agent to simulate the collaborative interaction. In this experiment, the collaborative pairs had to work together to bring eight required tableware and dishes from the blue cabinet, and arrange them in the given table setting order as shown in Figure 2.

The human avatar was controlled by human participants using Kinect and Wii Remote devices, as shown in Fig-

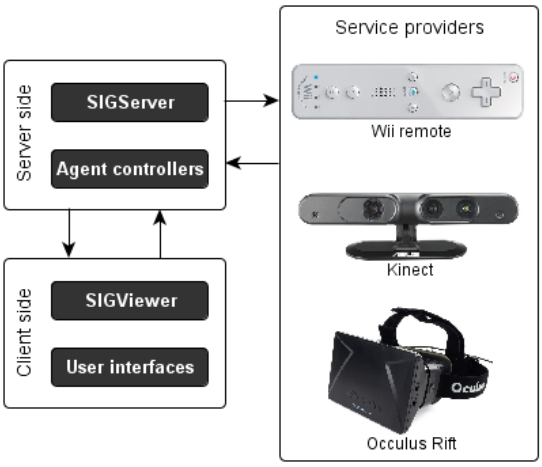

Figure 1: The entire SIGVerse system consists of a Server side, Client side and Service Providers.

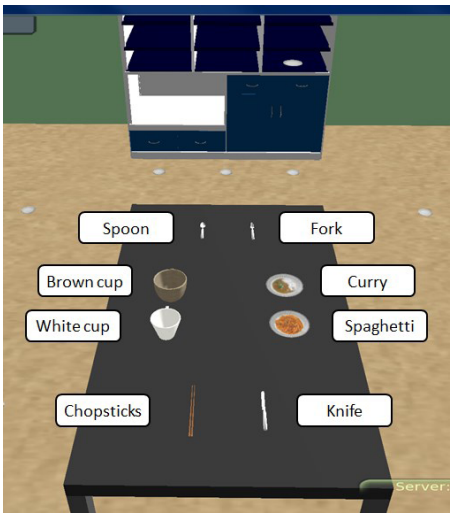

Figure 2: A sample table setting order of the experiment.

ure 3. Wii Remote sensor was used to control the walking movements of a human avatar, so that subjects could move around the room. Kinect sensor was used to control the upper body of a human avatar, so that subjects could grasp objects and perform gestures. In addition, human subjects were wearing Oculus Rift head-mounted display in order to both enhance the effect of interaction with a simulated environment and collect the data on subjects' visual attention while performing the task. The robot avatar was programmed to perform the tasks in a pre-scheduled order. We designed two communication styles for the robot avatar in order to investigate abilities of social communication between the robot and the human subjects, motivated by our previous research [4] : (1) robot agent declares its internal state and intentions using text messages (2) robot agent declares its internal state and intentions using both emotional reactions and text messages. Emotional robot reactions were modeled according to the scheme described in [2].

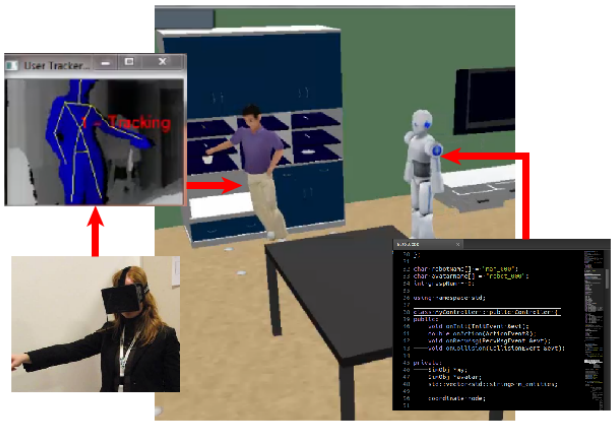

Figure 3: A user is controlling the human avatar through Oculus Rift, Wii Remote and Kinect. The robot avatar is controlled by a pre-programmed controller, executed on a server side of SIGVerse.

In our experimental study, we used two emotional reactions - surprise and happiness - to enrich a social communication between the robot and human subjects. The reactions consisted of emotional body expressions, designed according to the scheme discussed in [3].

4. CONCLUSIONS

In the described experimental study, we focused our effort on exploring and investigating the potential of using an enhanced HRI simulator to model collaborative interaction with socially intelligent robots. A system framework was proposed to integrate the HRI into a 3D simulation platform SIGVerse to achieve multimodal social interaction between people and robots. The paper on site will further describe data analysis results and experimental investigations on the behavior of the subjects during a collaborative task and the performance of the socially interactive system.

5. REFERENCES

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