

The Design of Intelligent Virtual Agents Using User-Centered Design Methods

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1 Introduction

This paper outlines my PhD thesis project about the design of intelligent virtual agents (IVA). Ferbs [6] defines an IVA as “a physical or virtual entity that can act, perceive its environment (in a partial way) and communicate with others, is autonomous and has skills to achieve its goals and tendencies”. IVAs have potential applications in many *shared spaces*, such as first-line customer support, guiding in museums, receptions, etc. The design of IVAs is multidisciplinary and focuses on different user-centred aspects such as presence, emotion, appearance, behaviour and dialogue. Yet, design choices regarding these aspects are often based on the “introspective examination of personal preferences” Isbister et al. [7] rather than any accurate reflection of the design goals or the qualities valued by the users.

2 Survey: State of the Art

In 2018 Norouzi et al [10] presented a systematic review of user studies published at the IVA conferences from 2001-2015. They showed that from 2001 to 2010 the number of user studies increased tenfold, 247 out of 579 papers described user studies. The reported studies provide important insights into various aspects of users’ perceptual, behavioural and cognitive responses to virtual agents, as gathered through experiments. Though these studies give important insights and general knowledge on how to model various aspects of agents, they do not easily transform into guidelines on how to create specific agents [4]. Other studies have shown that different user groups, for example children and elderly people have different preferences when it come to agent appearance [14]. We also know that culture and the application domain are important factors for interaction style [15, 8].

3 Thesis Problem/Question

There currently seem to be no standard methodologies in Virtual Agents research that focus on the involvement of users during the design phase. The design of IVAs tends to focus on the specific aspects (rather than the IVA in it’s entirety) and cannot be easily transformed into guidelines. Users are usually involved during the evaluation phase.

The aim of this thesis is to define recommendations for how to use User-Centered Design (UCD) methods in the design of IVAs for shared spaces, not only for evaluation, but also in concept generation and prototyping stages of the design process. Shared spaces in this case can be seen as a shift of focus toward supporting the context within which interaction with the IVA takes place. A space that spans the dimensions of a physical and synthetic environment [1]. The overarching research questions are:

- How might we do UCD of IVAs for shared spaces?
 - What current processes and methods are used to design virtual agents? To what extent and how are users involved in the design process of virtual agents?
 - What are the suitable ways of doing UCD of IVAs? What are the benefits and drawbacks of the methods?

4 Method

The first part was to explore the current methods used to design intelligent virtual agents. This involved a systematic review of the last 5 years of papers from the Intelligent Virtual Agent (IVA) Conference. The IVA conference is the largest in the IVA field and primarily focuses on the design and development

of intelligent virtual agents in all aspects. This ranges from neuroscience to machine learning, dialogue, motion, emotion.

The second part involved the use of a case study to explore the thesis problem. The first case study looked at the design of an Intelligent Virtual Receptionist of a university department. The case was divided into two phases (conceptual and prototyping). The conceptual phase involved two workshops: virtual bodystorming with members of staff from the department, and remote desktop walkthrough with university students. The design process began from the conceptual phase as it at this phase where it is decided on *what* should be designed and *why*. Early user involvement is beneficial for usability and user experience. It brings attention to practical functionality and how the system fits the context of use [9].

Bodystorming is a form of brainstorming using participants' bodily presence on the context of use to gain insight into the user experience [11, 13]. It takes advantage of embodied cognition and interaction as embodied design methods enable the use of all of a person's senses in an emergent design space [17]. The bodystorming workshop was carried out in virtual reality with a 3D model of the office building as the environment.

Desktop walkthrough allows for a quick simulation of a service experience using simple small figurines such as LEGO pieces to represent people or other elements of service [2, 13]. To emulate that, the desktop walkthrough was carried out in Miro and a combination of LEGO and other figurine representations, to achieve a look and feel that would be similar to an ordinary face-to-face desktop walkthrough.

The prototyping phase is of a multi-platform virtual receptionist which is based on the results of the conceptual phase. This will be followed by the evaluation of the prototype with the users at the university department.

5 Results

In the case of the systematic review of the last 5 years of papers from the IVA Conference, 14% of the publications indicate some form of user involvement during design. 8%(23 papers) explicitly mentioned user involvement and have details on the users and how they were involved. 9 of the 23 papers include one-time user involvement (at the initial stage of design) and 10 papers indicated iterative involvement. Details of the evaluation process can be found in the paper Chilufya and Silvervarg [5].

The ideas generated during the bodystorming and desktop walkthrough were structured into a Morphological Chart [12, 16]. The Morphological Chart structure is based on Burk's Pentad of human actions and motives [3]. With that, three design concepts (one main and two alternative) were created [4]. The concepts were created from the morphological chart using the following criteria:

- feasibility—is it feasible to design and implement?
- desirability—is it desirable from a user's point of view?
- novelty—is it interesting and original?

The main concept is a cross-platform virtual receptionist that provides information to all human agents through different media in a user journey across the user's mobile device, a large screen, and a physical robot. The concept is based on ideas that surfaced in both workshops. The second concept is a mystical (ghost-like) virtual receptionist. The receptionist provides details on the availability of members of staff to students (human agent) and allows students to book time slots on the members of staff's schedules. The receptionist is available in specified locations and can be accessed using a student card.

The third concept is a schedule custodian virtual receptionist that assists members of staff manager their schedule and room bookings. The receptionists helps enhance conversation in the coffee area as well. Detailed results of the conceptual phase can be found in the paper Chilufya and Arvola [4].

6 Conclusion

The systematic review shows that the IVA community mostly develop interactive agents without articulating the design methods employed. With very few studies that mention design details [5]. One hypothesis is that the design of some aspects does not need the involvement of users. In some cases, users might only be required during the evaluation phase. The design details could also be published elsewhere, or are not published at all [5].

The case study presents a combination of UCD methods that are novel in the area of IVA design. The work combines embodied but remote methods with morphological chart [4]. A working hypothesis is that bodystorming yields more aesthetically focused ideas about embodied interaction while the desktop walkthrough gives a more instrumental usability focus [4].

The concept of a cross-platform IVA is interesting for further research and prototypes are currently being created. This is followed up by the second case study which will look at the design of a IVA to help young students find interest in reading books..

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