Behavioral Persona for Human-Robot Interaction: A Study Based on Pet Robot

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Abstract. With the advancement of technology robots have become more common in every day applications, like Paro and GOSTAI Jazz for health care or Pleo and Genibo for entertainment. Since these robots are designed to constantly interact with people, during the development process it should be considered how people would feel and behave when they interact with those artifacts. However there might be some issues in collecting this type of data or how to efficiently use it in the development of new features. In this study we report a process for creating Personas that will help in the design of subject-focused applications for robots interactions.

Keywords: User modeling and profiling, Human-Robot Interaction, Personas.

1 Introduction

Human-Robot Interaction (HRI) is a subfield of Human-Computer Interaction (HCI). HRI studies how people behave while interacting with robots and it tries to extract the best result from that. Beside of how well a robot can help a person or how easy it can be used to accomplish a task, it should be considered how that person will react while interacting with it. According to Young et al. [1] the way people interact with robots is very unique and different from their interaction with other technologies and artifacts since robots provoke emotionally charged interactions. Our goal was to address these emotions and the way people behave when they interact with a pet robot in the creation process of new applications.

But there is a problem to make the information about the costumers' profiles, expectations and preferences useful to the development team. The adopted solution was to create Personas which are characters that represent a group of subjects (people that will interact with the robot) based on their characteristics. Those characters help the development process since the team can base on their costumers preferences instead of their own. Some of the methods used for gathering data to create the subjects' profile include: interviews; capturing the people's action while using the system; applying questionnaires.

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Thus, in this study we focus to present the methodological approach for creating Personas to be used in design of new features for robots. In this process we conducted tests with users using a methodological approach based on Koay et.al [2] to collect data. This was obtained from questionnaires, video analysis and a real time feedback given by the participant through a device called Comfort Level Device. For the tests we used the pet robot Sony AIBO ERS-7 also aiming to see how participants would react to it because of its resemblance with a real dog. The results were Personas that address people's personality and their expectations and reactions towards the robot we used, which can be of benefit for the development of new robots' features focusing on the subject. Also we present some analysis about people's behavior relating to this AIBO in comparison with other robots of a different type which were used in Koay et.al [2] study.

This paper goes first with an explanation of Personas and how it has been used on the HRI field (Section 2). Then we begin to explain the process of creation of the Personas starting from the data collection, detailing all the components and techniques that were used (Section 3), after we present the tests with users (Section 4). After that we explain how the obtained results were used with the cluster algorithm Q-SIM and present one of created Personas as an example (Section 5). In the end we discuss the observations on the participants' behavior in comparison with Koay et.al [2] study and we talk about how this study can be helpful for future studies (Section 6).

2 Personas

In psychology, Jung [3] defined Personas as people capability to assume different behaviors depends on scenario or situation at the moment. Cooper et al. [4] faced a problem during Human-Computer Interaction (HCI) projects, which is how to attempt all user diversification on it. Due to that, Cooper adapted Jung's Personas concept to HCI and redefined Personas as hypothetic archetypes of user. This means that each Persona can represent a group of real users. That definition helps designers to reach a biggest number of real users analyzing just a few profiles. Other works specify Personas as fictitious characters once it contains information like a real user as picture; name; demographic and behavior and preference information format like a bio description [5], [6]. Personas have been applied in many HCI project since Cooper with focus on better user experience than before. This entire appliance occurs due to the easy communication about Personas needs between designers. Because of this, some works have been developed it also into Human-Robot Interaction (HRI) with aim to improve robots behaviors during interaction.

However, many HRI researches have been exploring Robot Personas that change the focus. Robot Personas are robots, which assume some profiles designed to get direction between interactions with people. It works like a mental model for robots [7-9]. This kind of approach is interesting, although it is not completely a user-centered approach. It helps to improve the robot interaction, but not considered the user behaviors and the feeling of them about to interact with robots directly. To really keep a great interaction between robots and humans we need to attempt not only for

the robot personality, but also for human personality and how these different personalities interact with each other. So, to complete the cycle of interactions between robots and people considering the focus on people, we need to create also People's Personas and analyze how these Personas interact with Robot Personas or just with a specific robot. With this approach in mind, this paper presents an adapted methodology for creating Personas from HCI to HRI [6], [10]. It will help to create more social robots centered on subject.

3 Methodological Approach

From the tests with people until the definition of the personas this study followed a sequence of events illustrated in figure 1. The first step is to conduct user tests to collect data as presented in the section 4. All the data obtained from cameras, CLD and pre/post questionnaires are stored for the post analysis. After that the data from the participants is grouped using the Q-SIM algorithm. With the groups defined the researchers analyze the stored data to identify characteristics of the Personas. With the analyzed data researchers are able to address participants' psychological traits and how their behavior when interacting with the robot to the Personas.

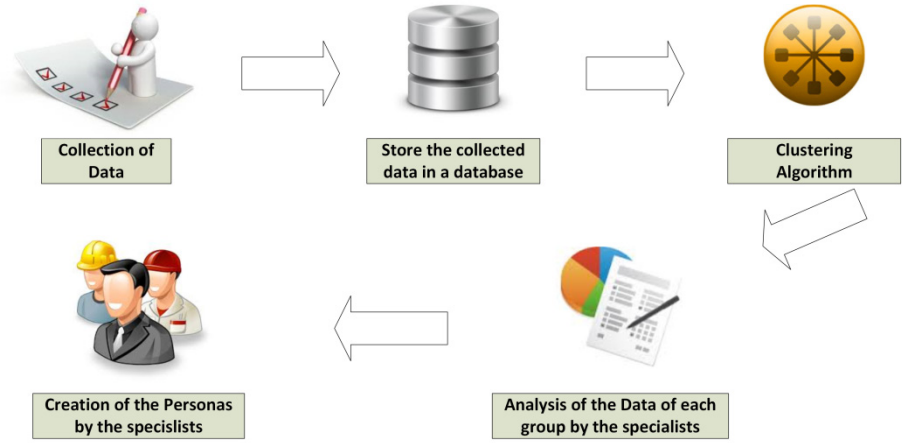

Fig. 1. Illustration of the five steps of creation process

As mentioned the methodological approach for data collection was based on Koay's study [2] and that was because it would provide researchers the means to collect the require data to create Personas and better take advantage of it. This data was collected from four different sources: Pre-Questionnaire, with questions about the participant's personality (the big five technique), age, genre and previous experience with robots; Comfort Level Device, an application running on a smartphone that participants used during the test to inform if they were comfortable or not; Interaction recorded video, that enabled to see the participants' reactions and what happened at the times that AIBO (which was been controlled by one of the researchers) let them

uncomfortable; Post-Questionnaire, with questions about how was the experience of the interactions and in which tasks were more comfortable. The following is a description of the techniques and tools that were used during the tests and creation of the Personas.

3.1 The Wizard-of-Oz

During the tests AIBO was controlled by one of the team members using the Wizard-of-Oz method. This technique can be used to simulate functions and behavior of a robot. Therefore is common used by researchers to test the viability of a system to be implemented and also at studies centered on human behavior (which is the application for this study) [11]. A person plays the role of the "wizard" by remotely controlling the robot while the participants of the test interact with it. It's important to establish a set of actions for the wizard to perform and the person practices it so the interactions fell more naturally. In our study we used the AIBO Entertainment Player software to control the robot and auxiliary camera to give the wizard a better visualization of the environment. Through the Entertainment Player the wizard could control AIBO's movements and have access to its camera, speaker and microphone. During the interactions AIBO was controlled to behave like a dog by responding to commands (i.e. sit, stand up, catch, come here), barking, and perform a dance while playing a music which is a robot like action.

3.2 The Big-Five Technique

One of the parameters that we used to create personas was the participants' psychological traits, and to obtain these we used a tool called Big Five, that is according with [12] "a hierarchical model of personality traits with five broad factors, which represent personality at the broadest level of abstraction". The reason why we choose this tool is because the Big Five framework is the most widely used and extensively researched model of personality by the community and has a considerable support [12]. Besides [13] says that this theory of personality can also be used as a framework to describe and design the personality of products and in particular of robots.

The data used to classify the participant's personality was obtained in the first part of the test, where they had to fill a questionnaire. We used questions from the Big Five which measures five dimensions of people's personality: Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness to Experience. It was used the TIPI (Ten-Item Personality Inventory) as the instrument to collect these data and it contains ten questions about the participants' personality, where the questions used a Likert-scale ranging from one to seven. The TIPI was adopted because it was quickly to answer, so the participant didn't fell bored before the interaction with AIBO and [12] suggest that these very brief instruments can stand as reasonable proxies for longer models (240-item for example, that takes about 45 minutes to be completed).

3.3 Comfort Level Device

To capture the participant's comfort level while interacting with AIBO we used an adaptation of the Comfort Level Device (CLD) that was used in Koay et al. [14]. Our CLD was an application for smartphone which allowed the participant to inform if he or she was or wasn't comfortable during the interaction. It had three buttons: happy face; unhappy face; end task. The button with a happy face meant that the participant was comfortable and the one with the sad face that wasn't. The button at the top of the screen meant that the participant had finished the present task so we could keep control of the comfortable recordings for each task. This information was displayed to the researcher that was operating AIBO and recorded. Before the interaction started the researcher that was conducting the study entered the participant's control number and explained how to use the application.

3.4 Data Clustering

To discover patterns into a database many researches have been use a technique called Data Clustering. This technique works in a simple way, it tries to group information based on similarity rules. Usually, the similarity rule used is the Euclidean distance, but it can be choose others similarity measure [15]. Once Data Clustering is used as a manner to discover groups with similarity, we can use it to help on creation process of Personas, grouping the most similarity user profiles. Many works have been use Data Clustering as a way to identify user profile for HCI projects [16]. Especially in Personas works, some researches use k-means algorithm to help on this process. However, k-means has a problem for creating Personas. Designers not even know how many groups exist into a dataset with user profile information and this is essential information to execute k-means, once it needs to be informed how many groups the designer wants [5], [6], [10].

To solve the problem of k-means in Personas creation process and user profile analysis, Masiero et al. [10] presents a new algorithm for Data Clustering. It calls QSIM (Quality Similarity Clustering). QSIM finds groups in a different manner. Designer informs the minimal desire similarity between element groups. QSIM uses a concept called Related Set to find groups; this concept is disseminated on Case-Reasoning Based studies. In the first results presented, QSIM demonstrated an algorithm with better results for user modeling, at least, than k-means, DBSCAN and Affinity Propagation [10]. Because of this, QSIM was adopted as the main algorithm to guide the methodology of Personas HRI creation presented at this paper. The next section will present the methodology with more details.

4 Tests for Data Collection

The studies were conducted in a laboratory at the university Centro Universitário da FEI; figure 2 explains the settings of the environment.

The participants were students, employers and visitants from an open event that was held at the university. There was a total of 39 participants, 10 children with age

ranging from 4 to 12 years old and 29 adults with age ranging from 15 to 43 (from these there were 16 men and 13 women). Each test went through the following sequence of events.

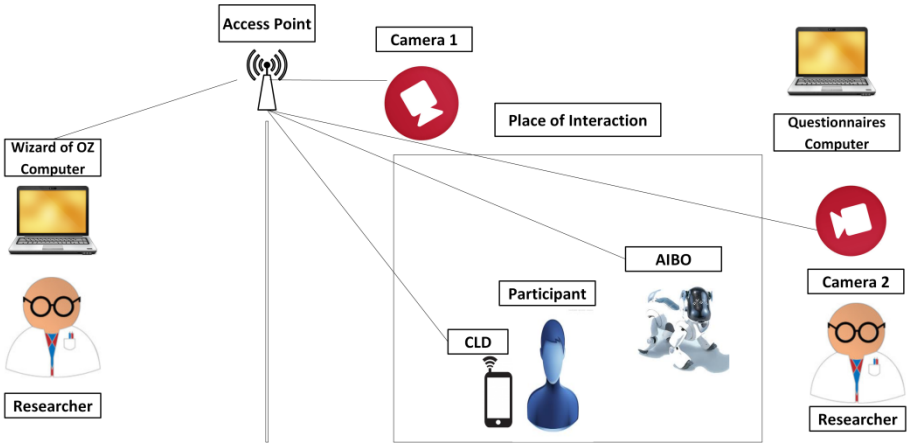

Fig. 2. Environment settings for the user tests

First there was a greeting, where the examiner explained the objectives and procedure of the study to the participant. After giving its consent for the test, the participant answered to a pre-questionnaire, which had the purpose of knowing his or her expectations about interacting with AIBO, profile and personality (the ten questions from the big five technique).

Second the participant was introduced to the CLD and the examiner explained what tasks would be done during the interaction. Before starting each task the participant read its description in loud voice. There were a total of 6 tasks divided in two groups of 3 tasks: no interaction, where the participants didn't give any instruction to the robot; physical interaction, were they had to touch the robot to make it execute the task; voice interaction, when they had to give a voice command to the robot. The first group was tagged as Human in Control (HiC) and the second as Robot in Control (RiC). During the HiC tasks if the participant felt uncomfortable with AIBO it would not move any closer, but during the RiC it wouldn't stop AIBO from getting closer. After the explanation the participant interacted with AIBO performing the tasks listed below:

First Task (No Interaction, HiC) – During this task there were no interaction between AIBO and the participant. The participant just watched AIBO walk by it, and go to the evaluator to get the bone. Second Task (Physical Interaction, HiC) – In this task, the participant waited for AIBO to get close with the bone in its mouth, and the participant had to cuddle the pet robot (in the head or back), so the robot opened its mouth and released the bone for the participant, after that AIBO walked away. Third Task (Voice Interaction, HiC) – Now the participant waited the robot to get close and gave one of these commands to it: Bark; Sit; Lay; Screech head; Wave tail. Fourth Task (No Interaction, RiC) – In this task, AIBO walked until get close to the participant, and

then performed a dance. Fifth Task (Physical Interaction, RiC) – After the dance in the fourth task, now the participant "evaluate" the performance, to do that the participant had to cuddle AIBO in its head (if the participant liked the dance) or in its back (if the participant didn't like the dance). And at last AIBO gave a feedback to the participant: the leds in its face got in two colors, green if the participant had cuddle it in its head or read if the cuddle was in its back. Sixth Task (Voice Interaction, RiC) – The last task was like the third one, the participant waited the robot to get close and gave one of these commands to it: Bark; Sit; Lay; Screech head; Wave tail.

In the last part of the test the participant answered to a questionnaire which had the purpose of knowing how comfortable each task was, how easy was to perform the task and if AIBO attended his or her expectations. These questions used a four-point Likert scale. They also needed to elect two tasks where they felt most comfortable (one from the HiC and another from the RiC groups), write a free text about their thoughts on the interaction and finally we invited them to leave a contact to participate from future studies.

5 Creating the Personas

After the tests we separated the participants in groups to define the Personas using Q-SIM with four different percentage values of similarity (20, 40, 60 e 80). The groups were defined by their similarity of personality (big-five technique) and profile (age, gender). After we got those results we chose the one with 80% (see Table 1) of similarity because it was the one that better represented the participants of this study.

Table 1. Groups obtained from Q-SIM with 80% of similarity. Ex (extraversion), Ag (agreeableness), Co (conscientiousness), Ne (neuroticism) and Op (Openness to experience)

Group	Age	Gender	Ex	Ag	Co	Ne	Op
1	7	Female	5.0	4.5	5.0	4.5	6.0
2	11	Male	5.0	4.5	4.0	4.5	4.5
3	18	Male	4.5	5.0	5.5	4.0	5.5
4	23	Female	5.0	5.0	5.5	5.0	5.0
5	41	Male	5.0	4.5	6.0	3.5	6.5

With the groups defined we began analyze the information that was stored from each participant's test and to separate it in their respective groups. Firstly, we interpreted the scores from the Big-Five technique to define their traits of personality. Taking the conscientiousness values for example, it can be said that the Persona from group five is more careful, focused and self-disciplined than the one in the second group. Secondly we used the data from the CLD with the participants' answers in the post questionnaire to determine how comfortable they were during the interactions. Since none of the groups showed significant reporting of being uncomfortable we defined that they all feel comfortable around the robot. Finally we made video analysis of the interactions to be used with the post-questionnaire in the definition of the Personas' behavior. Below we present the Persona created with the information from the fourth group.

Lyanna is 23 years old and she loves dogs. She is an outgoing person that likes the fellowship of other people. Has a lot of energy and is proactive. Besides, she worries about social harmony, is honest, decent and trustful. Prefers to make plans rather them to act spontaneously, also being too self-disciplined. Rarely gets upset and is too calm. She is always looking for new experiences and thinks of a different way than other people. Her expectation for AIBO is that it will behave like a real dog, been capable to respond to her commands and seek for attention to play. She has never interacted with a robot before AIBO, but she had no difficult to perform the tasks with AIBO. During the interaction she kept saying that AIBO was cute and she was enjoying it. Her preferred tasks were the dancing one and the one that she gave voice commands to AIBO. After the test she said that AIBO attended to her expectations and would like to play with it again.

Fig. 3. Lyanna's Persona

6 Insights and Conclusion

Besides of the creation of Personas, during the analysis we observed that the participants of the tests felt more comfortable with AIBO in comparison with the participants that interacted with different types of robots in Koay et al. [2] study. It was reported that participants started to allow the robots to approach closer to them after five weeks of habituation. This opposes to our tests participants' reactions since only seven reported to be uncomfortable through the CLD even with AIBO getting very close to all them since the beginning of the test. In fact the only situation when they felt uncomfortable was when AIBO bumped at them while moving, but they didn't related to be uncomfortable in the post questionnaire. This proves that they weren't uncomfortable with AIBO itself or during the whole interaction but with that specific moment. One even asked if someone ever felt uncomfortable during the tasks and it was surprised when the evaluator answered yes. Other participants also had more particular reactions like a woman who felt so excited that kept touching AIBO constantly, even when she wasn't performing a task that required physical interaction. Also a young boy asked his mother if was possible to change his real dog for AIBO.

Another study [17] conducted to compare people's interaction with an AIBO and a humanoid ASIMO reported that the most visible difference between the participants' attitude towards both robots the way of giving a feedback to the robot; they tended to use expressions like "thank you" to ASIMO while they frequently touched AIBO to give the feedback. That among with the behavior of our participants leads to the conclusion that due to its characteristics, a pet robot makes people feel more comfortable than those with a humanoid or a machine like appearance.

Finally, this study outlines the methodological approach used to create Personas that address human behavior and psychological characteristics to be used in the development of new applications for robots. The required data was collected from different sources to have more complete and effectively results. Although a pet robot

was used in this study, as far as we know the methodological approach can be applied to a robot of a different kind by making some minor changes, such as adapting the tasks to ones that match the robot's functionalities.

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