Industrial Human-Robot Interaction: Creating Personas for Augmented Reality supported Robot Control and Teaching

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ABSTRACT

In strong cooperation with small and medium-sized enterprises (SMEs), we research the simplification of industrial robot online-programming. For that, we extend existing programming interfaces with augmented reality (AR) technology. We proactively use personas as a tool for human-robot interaction design, the communication of study results and the discussion of findings with our industrial partners. While personas are popular in Human-Computer Interaction (HCI), their use is not well established in Human-Robot Interaction (HRI) [2]. We conducted contextual inquiries, interviews, and questionnaires with 80 industrial robotics professionals. From these qualitative and quantitative data, we now have a basis for describing the characteristics of persons working in the industrial robotics field. This work focuses on our approach to develop and share basic data-based personas for industrial robotics research. In this early stage we propose an initial list of variables suitable for personas in the field of industrial HRI. For our purpose we extend this variable list with AR related person characteristics. The future aim of this work is to provide a set of basic personas for industrial robotics usable in academic and industrial environments that can be adapted to particular usage scenarios.

Keywords

personas; augmented reality; human-robot interaction

1. INTRODUCTION

The way how industrial robots are programmed has not made much progress in recent years. The configuration of the system and the online-programming, also called teaching, is time consuming and needs to be done by experts. However, economic changes (e.g., the re-industrialisation of western countries), technological progress (e.g., the Internet of Things [5]), and emerging new robot types (e.g., lightweight robots), with changing interaction paradigms, demand new interaction modalities in the future. Furthermore, end-user expertise is more variable due to the introduction of low cost robotics solutions and production automation in SMEs. Robot programming experts are in very few cases affordable for SMEs, consequentially also untrained users (less experience, less practice) will have to interact with robots.

To overcome these challenges, our approach is to support in particular unexperienced end-users in industrial robot programming. In our research, augmented reality is the means to the end of simplifying the industrial robot online-programming process by supporting end-users with additional information, helping them to understand the current state of the robot, the task and the environment.

Augmented reality is computer-generated information overlayed onto the real world. With AR, task, robot, and environment related information can be visualized, which is not visible with the conventional interfaces. Therefore, it is necessary to build up a deep understanding of the user, in order to provide the right information at the right time. For example, our previous studies have shown that robot programmers with different expertise levels need different levels of information detail (c.f., expertise reversal effect [3]). To exploit this knowledge for prototype design and development was the initial motivation to integrate personas into our research. In this paper, we describe how the general format in which personas are typically described, needs to be adapted to the industrial robot programming use case.

2. BACKGROUND

Pruitt and Grudin [6], state that the persona method is an interaction technique with considerable potential for software product development. A persona is an abstract user representation. It includes a description of the fictional user and an archetypal photo representing this user. Billestrup et al. [1] mention that there exist several approaches for the creation of a persona. A persona can be created based on data, goal-directed (Cooper), role-based (Grudin, Pruitt and Aldins) or using the engaging approach. Alternatively, the persona is created not based on data, but from the designer's intuition and assumptions, i.e., with a fiction approach. The work of Moser et al. [4] acts on the assumption that there is no coherent approach for persona identification and creation. The authors focus on the creation of personas based on data and distinguish regarding the data collection process: a qualitative, a quantitative, and a hybrid approach. One big problem is the recruiting of people for data based persona creation in particular contexts, e.g., in the home context [2], or in our case the industrial context.

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3. PERSONAS: VARIABLES

Duque et al. [2] coined the term *persona variable*. In this work, persona variables are used to describe persons' characteristics relevant to the personas context. In our use case, we have collected data from 80 end-users. This data basis is coming from the qualitative and quantitative analysis of professional online-programmers (teaching) and maintainers (robot control) but also developers of such robotic systems are included. We gathered data starting with an extensive contextual inquiry and refined the data with questionnaire and interview data from our user studies. In Table 1 we show a preliminary set of persona variables beneficial for persona creation. This list helps to design the data collection process for a persona by selecting appropriate user characteristics depending on the application context. The first column lists variables from traditional HCI personas. The other two columns are derived from our research mentioned above. The second column presents persona variables that are especially helpful in the HRI context. Since the usage of AR is a main point in our research, the third column shows persona variables that influence the design of AR interfaces.

HCI	HRI	AR
age, gender, educational level	domain practice, skill level, knowledge	mobile app experience
residence, family	knowing robots from media	AR pre-experience
leisure activities, interest in travelling	attitudes toward robots (job fear)	understanding of AR
language skills	previous experience with robots	VR pre-experience
user's personality traits (Big Five)	comfort with robots	understanding of VR
social network experience	using robot at home	user's size
technology adoption	speed/accuracy motivation	wearer of glasses
professional growth, education, career	proxemics preferences	pre-experience gameplay
professional frustration/feel good points	mental rotation skills	motion sickness
professional motivation	key robotic tasks of the user	attitudes toward AR
capacity for teamwork	frequency of doing robotic tasks	

Table 1: List of persona variables

As example, Fig.1 represents a novice industrial robot programmer and shows one of our preliminary personas. It includes an image, a short textual biography, and a quotation. The other persona variables that we used are as follows: *HCI column:* demographic data (age, educational level, role, family, residence), personality traits (extra-/introvert, sensory/intuition, thinking/feeling, judging/perceiving), professional motivation (incentive, success, fear, social); social networks, goals, pain points and four adjectives representing the persona. *HRI column:* robotics skill level, mental rotation skills; *AR column:* pre-experience AR, user's size, pre-experience gameplay.

A novice and an expert persona were appropriate for the initial phase of our work. However, enhancements on them need to be done. We noticed that we had to add a persona for the intermediate expertise level (mainly to address SMEs). Furthermore, for initial personas we asserted that they lack any AR-specific variables. We learned in our previous studies that for example the user's body size can influence the choice of the AR marker for tablet-based AR systems, based on a different angle to hold the tablet and subsequent a changed viewing angle.

4. CONCLUSION AND FUTURE WORK

Although personas have proven their value in HCI [6], they have hardly found their way into HRI [2], nor have they been incorporated in industrial processes [1]. In an academic setting, access to domain experts is often limited [4], while in an industrial context knowledge about personas and their application is lacking [1]. New technologies and

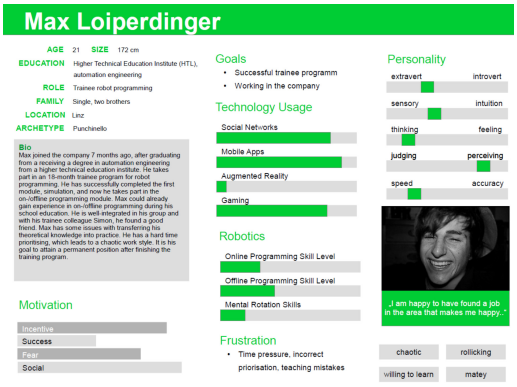

Figure 1: Persona: industrial robot programmer

collaborative robotics in HRI require to know the target user in order to build effective interaction and prototypes [5]. For these cases, personas can be of great value.

The creation of personas can be time consuming and costly, depending on how the underlying data is collected, on the user sample size, and method used [4]. However, in our experience, the usage of personas for developing HRI systems increases the overall system quality. It is not yet clear, whether it will be possible to create common personas for industrial robotics use cases, using the variables that we propose in this paper. In the future, we will evaluate our personas in several industrial robot programming scenarios. Our goal is to evaluate the usability of these personas in order to eventually publish a set of personas that can also be used by other HRI researchers.

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