Using Persona, Scenario, and Use Case to Develop a Human-Robot Augmented Reality Collaborative Workspace

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ABSTRACT

Up to date, methods from Human-Computer Interaction (HCI) have not been widely adopted in the development of Human-Robot Interaction systems (HRI). In this paper, we describe a system prototype and a use case. The prototype is an augmented reality-based collaborative workspace. The envisioned solution is focused on small and medium enterprises (SMEs) where it should enable ordinary-skilled workers to program a robot on a high level of abstraction and perform collaborative tasks effectively and safely. The use case consists of a scenario and a persona, two methods from the field of HCI. We outline how we are going to use these methods in the near future to refine the task of the collaborating robot and human and the interface elements of the collaborative workspace.

1. INTRODUCTION

With the emergence of affordable industrial collaborative robots it seems likely that SMEs soon will widely adopt such robots in order to achieve higher precision for specific tasks, free experienced employees from monotonous tasks, and increase productivity.

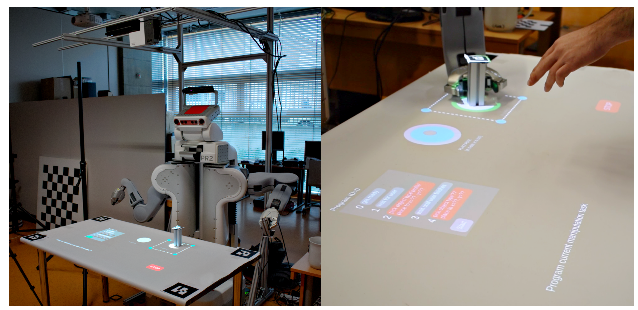
In a large-scale production, robots are usually programmed by an expert. For SMEs, batches are smaller and products may even be customized for a particular contract. Due to this, it would be beneficial to enable ordinary-skilled workers to program robots easily, without robot-specific knowledge. In this work, we present a new approach for simple robot reprogramming. The approach uses augmented reality (AR) to visualize the current program and the state of the robot's learning or execution, detected objects, instructions to a user etc. We describe an existing prototype[1], a use case of aircraft trolleys assembly and how we will apply HCI methods, in particular narrative scenarios and personas, in further development.

[1]The source code and technical documentation is available at https://github.com/robofit/ar-table-itable.

HRI '17 Companion March 06-09, 2017, Vienna, Austria

ACM ISBN 978-1-4503-4885-0/17/03.

DOI: http://dx.doi.org/10.1145/3029798.3038366



(a) (b)

Figure 1: Experimental setup (a): PR2 robot, top-mounted Kinect 2 and projector, table with AR markers. User interaction (b): adjusting place pose for the grasped object.

2. BACKGROUND

There exist various approaches to the problem of making robot programming viable for non-expert users, e.g., kinesthetic teaching [7] or visual programming [1]. Part of this problem is also the selection of suitable input modalities [6] and modalities for providing feedback to the user. One of the output modalities may be AR based on a hand-held device [8] or projected onto the workplace [4].

Scenarios are narrative stories about specific people and their activities in a specific work situation and context [5]. They describe key usage situations and they cover a multitude of aspects such as involved agents, user goals and background, work practices, system responses, tasks, context, and difficulties. Cooper et al. [3] developed the concept of personas to represent the hypothetical archetypes of users. Personas are not actual users but they represent specific users with their characteristics and work role [5]. They are given a name, a life, and a personality to make them concrete and appear *real*. Personas are an ideal instrument to design for the most relevant and common user classes.

Up to now, there are only few instances, where HCI methods were used in the field of HRI. For instance [2] uses scenarios and personas in the context of industrial robot programming.

3. AUGMENTED REALITY COLLABORATIVE WORKSPACE

The open source experimental setup uses the intrinsically safe PR2 robot as a demonstrator of a near-future collaborative robot and is centered around a table (see Figure 1a) where the HRI occurs. The interaction consists of programming a robot and collaboration on a programmed task. It happens through an interface projected onto the table using pointing gestures as an input modality (see Figure 1b or video[2]). The user is tracked by a Kinect sensor on the robot's head. Skeleton tracking is used to extract information about the user's position and pointing direction. Gestural control was chosen based on results of our previous experiment [6], where it was the fastest and highest ranked modality. We deal with uncertainty of pointing by highlighting pointed area on the table (circle of given radius) which serves as a visual feedback to the user. When this area visually collides with e.g. a highlight area of an object, the object is preselected. If the object is preselected for a certain time, it is selected. Objects in the scene are tracked using a top-mounted camera and AR codes on them. AR codes are also used for calibration of the whole system.

The interface contains various elements to visualize state of the robot and task as e.g. the currently loaded program. A robot's program is displayed to the user during both learning and task execution phases. Currently, the system supports basic instructions as *get ready* (move robot arms to a default pose) or *pick and place* (pick concrete object or object of given type from specified polygon and place it on given pose). The program structure is so far coded separately while program parameters (e.g. object type and place pose for *pick and place* instruction) are set by the user - the interface allows the user to select a program, set or adjust its parameters and then to collaborate on a programmed task with the robot. During program execution, the current program item is highlighted as well as e.g. objects to be manipulated by the robot.

4. USER-CENTERED DESIGN: USE CASE, SCENARIO AND PERSONAS

Based on our experiences from previous projects and discussions with industrial partners, we have defined our scenario as follows: *The user will teach the collaborative robot to assist him in the task of assembling aircraft service trolleys. He needs to show to the robot which parts are needed in every step of assembling, where holes must be drilled, and what parts should be glued together.*

We also defined a persona, who will act as a user in our use case: *Jan, a 22 year old man, recently graduated at technical-based high school. He works as an assembly worker at Clever Aero, a company focused on aircraft equipment. He has no experience with robots, but he loves new technologies and he is really keen into working with robots.*

These tools needs to be refined according to the demographic data, which has to be collected by observing and interviewing actual workers in real factories. Those data will then be transformed into well-defined persona(s), scenario and a use case, in order to update our current setup according to our personas' needs.

5. CONCLUSION AND FUTURE WORK

In our opinion, methods from HCI provide valuable tools to inform and improve HRI. With our paper, we recommend using methods such as scenarios, use cases and personas. Such instruments enable HRI solutions to better integrate user needs such as methods for simplified programming.

In the next step, we will include the results from using these methods (scenario, use case, persona) on our collaborative workspace.

In order to fulfill the defined use case and the corresponding scenario, it is now necessary to implement new robot instructions based on kinesthetic teaching as gluing and drilling. As the task is quite complex, it is inevitable to display the robot's program in addition to showing work instructions for users. The design elements as well as input methods of the user interface are adapted according to the needs of the refined personas. E.g. as our preliminary persona *Jan* often works with touch-based interfaces (phone, tablet) we will add a touch-sensitive layer on the worktable as an alternative input modality. We focus on making the system easily deployable, with multiple sensors and projectors. The user is enabled to switch between various interfaces based on the current task.

These system improvements result directly from our deployment of HCI methods in HRI. Having said this, we encourage other research groups to take a similar approach.

[2]https://youtu.be/yYNpKEClclA

6. ACKNOWLEDGMENTS

This research was supported by the IT4IXS IT4Innovations Excellence in Science project (LQ1602).

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