Personal Quizmaster: A Pattern Approach to Personalized Interaction Experiences with the MiRo Robot

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ABSTRACT

In Human-Robot Interaction, personalization has been proposed as a strategy to increase acceptance for social robots. The present paper describes how behavioral design patterns can be used to tailor the interaction experience to the individual user's characteristics and needs. To demonstrate this approach, we designed a quiz game application for the MiRo robot. The robot acts as the quizmaster and shows different behaviors (coach-like/empathic vs. challenging/provocative) depending on the type of user who is playing the game (community-focused vs. competition-focused player). We describe the process of creating the two quizmaster personalities and related behavioral patterns as well as the technical background for integrating them with the interaction model for the quiz game. The result is a Wizard-of-Oz demonstration of the personalizable quiz game that is accompanied by an interactive video prototype remote for user studies and demo purposes.

CCS CONCEPTS

• **Human-centered computing** → **Interface design prototyping**; • **Computer systems organization** → **Robotics**.

KEYWORDS

social robot, behavioral patterns, multimodal behavioral expressions, personalized Human-Robot Interaction

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1 PERSONALIZED INTERACTION FOR SOCIAL, DOMESTIC ROBOTS

Human-Robot Interaction (HRI) research is constantly working towards making robots more social, so that they can be integrated in our daily lives and take the role of personal assistants, teachers, carers or companions. In this connection, there has been an increased interest in applying robots in domestic environments for assistive and entertainment purposes. In order to do so, it is important to carefully design the robot's appearance and behavior, so that people will actually accept and use it in their personal home.

It has been proposed that personalization of HRI can promote the applicability and acceptance of a robot in real-life settings [8, 18]. This means that the behavior of the robot is tailored to the user's individual needs, characteristics and abilities. Personalization has been shown to have positive effects on user experience as well as the attitudes towards and perception of the robot [4], and, thus, increases long-term acceptance [12].

So, how can we create such personalized interaction experiences in HRI? As a first step, it needs to be examined in which situations different types of users need the robot to show different behavior. To do so, relevant user characteristics have to be identified and aggregated in a user model [11]. The user model can be individually filled in with the specific parameters for a specific user, thus creating an individual user profile. Users with similar profiles might be grouped into user types. In a second step, a behavioral variant needs to be designed for each individual user profile or user type. This variant specifies the behavioral expression of the robot that matches the user's characteristics best. Finally, an algorithm has to be implemented that selects the matching variant for the user profile of the current user in a given interaction context.

2 A PATTERN-APPROACH TO BEHAVIORAL DESIGN FOR SOCIAL ROBOTS

Personalized interaction design, as described above, requires a sustainable and well-structured documentation of the variants of the robot behavior. In the field of human-computer interaction (HCI) – and more recently also in HRI design – design patterns have been discussed as an approach for documenting reusable design solutions. A pattern is defined as follows: "Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such way that you can use this solution a million times over, without ever doing it the same way twice. [...]" ([1], p. x). Based on Alexander's pattern language for architectural design, HCI pattern languages have been proposed for different interactive systems such as websites [20], museum exhibits [3] and robots [10].

In the NIKA project (user-centered interaction design for context-sensitive, acceptable robots; German: Nutzerzentrierte Interaktionsgestaltung für Kontext-sensitive, akzeptable Roboter), we propose a pattern approach to document appropriate behavioral expressions for social robots. The project is aimed at promoting the independent living of older adults by introducing social robots that are helpful and easy to interact with. In this connection, the focus lies on developing comprehensive and pleasant behavioral expression for

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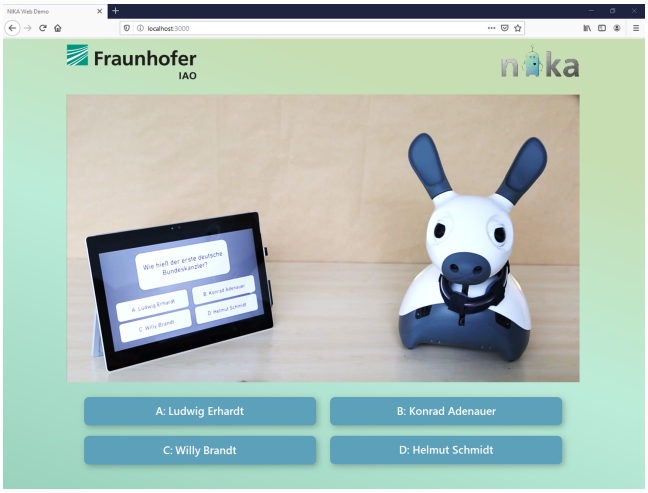

Figure 1: Screenshot of the interactive quiz demo with the MiRo robot, currently executing the pattern "listening".

social robots that can be reused across different interaction scenarios, such as mental training, physical exercising games or schedule management. An additional goal is to explore how patterns can be employed to realize personalized interaction within these use cases. In the NIKA project, patterns are being developed for three different types of robots: Pepper[1] (humanoid), MiRo[2] (animoid), and Roomba[3] (abstract).

The present paper describes how patterns can be used to enable personalized interaction experiences in the scenario of a quiz game with the MiRo robot [5] (see Figure 1). We outline how, based on user research, we developed behavioral variants for two versions of a quizmaster robot: one with a coach-like, empathic behavior, and one that challenges the quizee in a cheeky, provocative way. We then present our demo scenario that shows how the appropriate quizmaster variant can be selected for an individual user and how the designed behavioral patterns are implemented on the MiRo.

3 A PERSONAL QUIZMASTER ROBOT

We started the development process with the goal to create a quiz game that can be adjusted to individual user characteristics and preferences. The quiz game was developed as an playful application for brain training. Older adults who frequently engage in brain training activities show a decrease their cognitive decline [2] and increase the probability for healthy brain aging [17]. Playfulness and pleasant interaction during a quiz game can be used to motivate users to frequently engage in the brain training quiz game. It is important that health-beneficial activities are carried out on a regular basis, in order to promote their positive effects on fitness and well-being [14]. We consider involving a robot in the quiz game as a motivational factor that can encourage regular brain training. This idea has has already been used in previous research where robots were employed to play trivia with the user [19] or that acts as a quizmaster or a jeopardy game [13].

For the personalization of the quiz game, we especially wanted to focus on a personal interaction experience rather than providing personalized content such as pre-selected quiz topics or questions. The quiz game should further be engaging and motivating for the user to promote the positive effects on health and well-being mentioned above. When looking at different quiz shows (such as "Who will be the billionaire?"), it became obvious that the quizmaster plays an important role in motivating the quizee and making the game entertaining. While quizmaster in game shows also aim to entertain the audience, our quiz game application is designed to entertain a single user and encourage her to play the game on a regular basis. We therefore decided to explore how we can personalize the quiz game based on the personality of the quizmaster, and to examine how a specific quizmaster personality can be expressed in the quizmaster robot's behavior towards the quizee. Thus, in the present paper, personalizing the quiz game means that the robot can take on a different personality and show a different behavior during the quiz game, depending on the user's individual profile.

We carried out the following three steps to develop the quiz game application with a personal quizmaster: User Research, Pattern Creation and Implementation of the Interaction Flow.

3.1 User Research: User Characteristics for Personalization

We conducted a a user study to uncover user needs and characteristics that could be relevant for personalizing the quiz game scenario. From interviews with ten older adults (seven females, 75 to 87 years old, all living in assisted living facilities) we gained initial inspiration for potential user characteristics. In the interviews we asked them about their daily live and activities and assessed their experiences with and reasons for engaging in leisure activities within their apartment complex. We also included questions to gain insights about their personality traits. Based on these insights we deduced two main themes that motivate people to play games. These two main themes were based on the answers to the interview questions of the particular interviewees and are meant to serve as an initial inspiration to develop different robot personalities to enable a personalized quiz game.

The first theme is community: People enjoy playing games because they can spend time with other people and socialize. The second theme is competition: People like to challenge themselves by competing with others and experience positive emotions by showing their skills and winning the game. We related these two themes to four main user characteristics: neuroticism, prevailing mood and the psychological needs for competition and relatedness. A community-oriented player type would score high on neuroticism and relatedness, low on competition and tend to have a rather negative prevailing mood. A competition-oriented player type would score low on neurotiscm and relatedness, high on competition and tend to have a positive prevailing mood.

While we acknowledge that, naturally, there are many other possible user profiles with different combinations of characteristics, in the present work we decided to focus on these two, rather extreme types of community-focused and competition-focused players for

[1] https://www.softbankrobotics.com/emea/en/pepper
[2] https://www.miro-e.com/
[3] https://www.irobot.de/roomba

Table 1: Overview of the behavioral patters created for the robot quizmaster.

Pattern	Pattern type	Communication Goal
active	generic	I am ready to perform an action.
listening	generic	I am recording spoken information from you.
explaining	generic	I am explaining something to you. Direct your attention at me.
getting_ready_to_play	generic	I am getting ready to play.
showing	generic	I am showing you information. You should take a look at it.
not_understanding	generic	I know that you just provided some information, but I do not understand.
happy	coach	I experience positive feelings.
annoyed	challenger	I am not content with the outcome.
empathic	coach	I feel with you.
joyful_arrogant	challenger	I experience schadenfreude for your failure.
encouraging	coach	I encourage you to show good performance in the upcoming action.
questioning	challenger	I doubt your skills.

demonstration purposes. All other types are beyond the scope of this paper and the demo.

3.2 Pattern Creation: Personality and Behavioral Variants for the Quizmaster Robot

We used the method of Essential Use Cases [7] to decompose the interaction course of the quiz game into "user actions" and "robot actions". As our approach focuses on personalizing the robot's behavior, we use the "robot actions", i.e. the interaction steps of the robot, as a starting point for the pattern creation. Thereby, we found that the personality of the robot becomes especially obvious right after the user provides his or her answer to the quiz question. The quizmaster has to react to the user input and provide feedback on whether the answer is correct or not. Afterwards, there is room to include some encouragement and motivation for the upcoming question. We characterized the quizmaster personality best suited for community-oriented players as a coach who provides feedback in an encouraging, empathic way, emphasizing companionship in both, success and failure situations. Competition-oriented players, on the other hand, can best be motivated by a quizmaster acting as their opponent or challenger, pushing them to show their best performance by questioning their skills with cheeky behavior.

We created behavioral patterns for the MiRo robot for all required actions of the quizmaster during the game. To do so, an eight-step process was followed that was described in our earlier work [16] and that builds upon the idea to use inspiration from interactions with humans, animals and technology to create behavioral expressions for social robots. Patterns always have a name and communication goal that indicates what the robot wants to express with the pattern. As shown in Table 1, the result was a set of behavioral expressions for the quizmaster robot, including two types of patterns:

- General patterns are applicable for all users. They are used for general communication during the quiz to make the robot's current state transparent and ensure an overall intuitive and comprehensible interaction.
- Specific pattern are the variants for the two different robot personalities for the interaction situations of providing feedback and motivating the user right after her answer.

3.3 Implementation of the Interaction Flow: Integrating User Profile and Patterns in the Quiz Application

To realize the personalized quiz as an interactive application, two aspects have to be implemented: On the one hand, a mechanism to select the best fitting behavioral pattern based on a specific user profile is required. On the other hand, we need to define the application specific interaction flow, in order to arrange the behavioral patterns in a meaningful order. For both aspects, we used and adapted concepts from the MyUI approach [15].

The pattern selection is based on a user profile that represents the systems' knowledge about the current user, i.e. the parameterization of user characteristics as presented in the user profile. Taken from user research (as described above) a set of rules is used to derive a user interface profile. While the user profile contains the characteristics of the user, the user interface profile describes the characteristics of the interactive system, i.e. which quizmaster personality should be presented to the user.

In order to orchestrate the behavioral patterns into the meaningful interaction of a quiz game, we used the concept of an Abstract Application Interaction Model (AAIM) [15, 21]. It defines the application-specific course of interaction by referring to design patterns from a model similar to a statechart. The basic AAIM of a quiz game with MiRo is presented in Figure 2. At runtime, an interpreter reads this model step-by-step and executes the respective behavioral patterns that are implemented as individual functions using MiRo's Python library [6]. To be able to use the quiz game in controlled lab-based studies, we decided to use a Wizard-of-Oz implementation, whereas the role of the "wizard" is to process the user's speech input. Thus, there was no need to implement automatic speech analysis and production, which also eliminates the potential impact of speech recognition errors in user studies.

4 DEMO APPLICATION: PLAYING WITH THE PERSONAL QUIZMASTER ROBOT MIRO

The initial demo application was set up as a Wizard-of-Oz prototype that enables users to play the quiz game with MiRo. During the game, the robot adjusts its personality and behavior based on the user information obtained during the introduction dialog. This

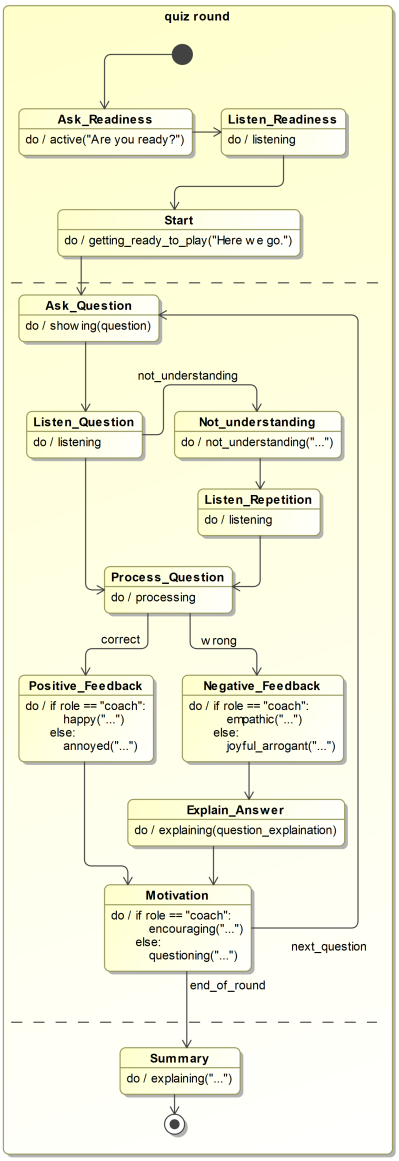

Figure 2: Statechart representation of the Abstract Application Interaction Model (AAIM) for the personalized quiz demo.

demo showcases the different patterns and makes the personalization mechanism graspable and testable for potential users. Still, this application was limited regarding its applicability for user research and the promotion of our pattern and personalization approach. On the one hand, the Wizard-of-Oz prototype requires some significant amount of time before the demo can be started. In the other hand, the demo is locally bound to our lab and the robot would have to be relocated to carry out the demo elsewhere, which appears to be limiting in the age of remote work and online studies.

Thus, we developed a second version of the demo application that can be launched over a website from anywhere and without additional effort: an interactive video prototype. It is based on the existing web-based MyUI runtime implementation [9]. Thus, the quiz game AAIM of the original Python-based robot demo can be reused. Instead of executing behavioral patterns on the robot it shows prerecorded video-snippets of MiRo showing these patterns. In each state, the video to be shown is determined by a combination of the referred pattern and the parameters defining which sentence(s) the robot should speak.

Only slight modifications are required due to the Wizard-of-Oz design of the original prototype. While the "wizard" would decide if the spoken answer given by the user was correct or not on behalf of the robot, in the interactive video prototype, the possible answers are displayed as buttons to the user directly (see Figure 1) and thus can be processed by the runtime environment in order to select the video snipped with the appropriate robot behavior.

5 FUTURE APPLICATION OF THE PATTERN APPROACH

With our demo, we showcase how the behavioral patterns for social robots developed in the NIKA project can be applied to enable personalization of the interaction experienced, based on the example scenario of playing a quiz game with the animoid robot MiRo. As outlined earlier, the idea of the pattern approach is to create reusable behavioral expressions for social robots. Thus, in the future, we want to create demo applications for additional entertainment-related use cases (e.g. physical games such as charade or other brain training games such as memory) which demonstrate how the same patterns can be used across various scenarios. While for these new scenarios we will be able to build upon the same user profiles, they will, most likely, require the extension of the presented pattern set to be able to provide personalized interaction in different contexts.

In addition, we plan to use both demos in future user studies, in order to evaluate the comprehensibility and pleasantness of the created patterns and as how well the two robot personalities really match the identified user types.

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