Using Persona Descriptions as a Communication Tool in Interdisciplinary System Design

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***Abstract*— Designing, implementing and testing novel systems for the elderly requires researchers from a wide range of research areas to cooperate and communicate. It is especially important that medical experts and system designers reach an agreement on a user definition, which is understood by all participants. In system design, the Persona method has proven its worth as a tool to communicate and clarify abstract user descriptions and their goals. In this paper, we tailor the Persona methodology to the Gerontechnology domain, by investigating the adaptations needed to model elderly target groups with Personas, and using a clustering algorithm to generate clusters on which the Personas are based.**

I. INTRODUCTION

THE percentage of people in Europe over 65 is expected to increase from 16% in 2000 to 28% in 2050 [1]. This demographic shift leads to an increased prevalence of chronic morbidity and disability [2]. As a consequence, human resources will not be sufficient to assist all elderly and disabled people in the future. An alternative is to provide Ambient Assisted Living (AAL) solutions, in which the aim is to ``extend the time during which elderly people can live independently in their preferred environment with the support of Information and Communications Technology" [3].

Designing, implementing and testing novel systems for the elderly requires researchers from a wide range of research areas to cooperate and communicate. Medical doctors and caretakers provide knowledge about the needs and capabilities of the target group, and the system developers who implement the system provide knowledge about the capabilities and limitations of state-of-the-art technology. The first group is usually called the `application domain experts', and the latter the `solution domain experts' [4]. Each of these groups has their own language. In addition, the user has to be able to articulate his needs and goals during the design process.

When designing a system, it is important to consider the target group: whom is the system being designed for? The target group definition should be useable and understood by both the application and solution domain experts.

Medical doctors most commonly use assessment techniques to describe the condition and the requirements of patients [5]-[7]. For system developers, who are not familiar with medical assessment terminology, the results of such evaluations are often hard to understand. In this paper, we investigate the use of Personas for target group definitions for systems targeted at the elderly. The main contributions of this paper are 1) investigating how the Persona methodology must be adapted to the context of elderly target groups and 2) grounding our Personas on patient clusters, which are generated using a clustering algorithm.

The rest of this paper is structured as follows. In the next section, we will describe the Persona methodology, and give an example of a Persona. In Section III, we explain the adaptations needed to develop Personas in the context of elderly target groups. Here, we also describe the technique used to generate clusters from real data [8]. We conclude with Section IV.

II. THE CONCEPT OF PERSONAS

The usability of a system can be characterized by how well it fits the user's intentions. Therefore, a goal-directed design process, which explicitly takes these intentions into account, is a valuable method to develop useful systems. To this end, Cooper introduced the concept of Persona [9]. Personas enable designers not only to build precise narrative descriptions of the potential users of a system, but also the goals they want to achieve.

Personas are realistic archetypes of users, and represent certain subsets of a target group. A set of personas is useful for system design i) if each persona represents an archetype of a user whose goals are in focus of system design, ii) if its characteristics and descriptions are complete and feasible and iii) if the set covers the target group of the system [10].

Personas are narrative descriptions, in which domain-specific language is omitted, so that every expert involved in the design process can understand the specifics of the persona.

The following example for a persona is developed and published in [11]. "Rhonda is a 36-year-old RN who has worked at several skilled nursing facilities. She started out in acute care but moved to long-term care so she could have more autonomy. Rhonda was promoted to Unit Coordinator four years ago because she is very competent and generally well organized. Rhonda is entirely overwhelmed and is drowning in paper, even more so than the average nurse. She often misses eating with her boyfriend because she has to work late, filling out forms and reports. Rhonda's goals are:

- **Spend more time on patient care and staff**

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supervision, not paperwork

- **Be proactive.** Rhonda needs to understand trends in order to solve problems before they happen, instead of just reacting in crises.
- **Know that things are being done right**. Rhonda supervises the unit because she's good at what she does. If nurses aren't following procedure or documenting things, she wants to know right away."

A. *Personas in System Design*

The design process of Personas consists of 5 steps [12]. First, to develop feasible Personas it is important to have a comprehensive and realistic overview of the potential users and their needs. To determine the users' needs, an ethnographic observation is done. Observing and interviewing potential users are combined to i) reduce the amount of misinterpretation of observed behaviour and to ii) lower the dependence on the self-reported behaviour.

In the second step, user specific behaviour patterns are identified based on the results of the ethnographic observation. Such patterns consist of different variables that influence the behaviour of a user. These can also be demographic variables like age or technical skills that affect the behaviour in a certain situation. For instance, a unit coordinator might want to know if something is going wrong, whereas a nurse might only want to know what to do next. So, whereas the first user wants to get information about quality of service, the latter one is more interested in its quantity. In addition, the unit coordinator does not like to use novel technologies, whereas the younger nurse has more experience with them, and welcomes them. These differences are then represented on an arrow, each end illustrating one goal.

After all variables have been identified, the behaviour of all interviewed users is mapped against them. This means that all interviews are evaluated with respect to the variables, and are mapped to a relative position on the variable arrow. The resulting partitioning of the different users is analysed to detect similarities between different interviewees. If 6-8 variables are detected that are similar for several interviewees, these represent a behavioural pattern for a persona.

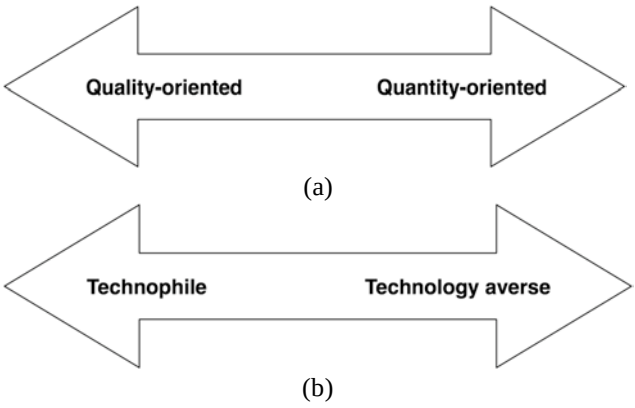

Fig. 1. Examples of behavioural variables.

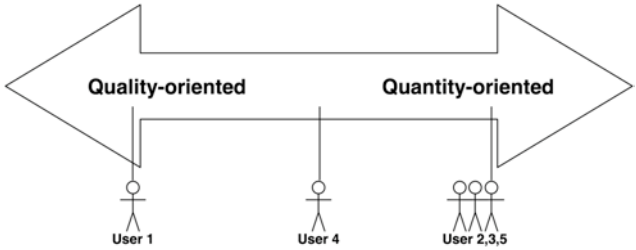

Fig. 2. Users mapped against a behavioural variable.

Finally, the resulting combination of a behavioural pattern and its description is used to write the narrative description of the Persona.

B. *Advantages of Personas*

Without abstract user descriptions, system designers may have a vague or contradictory vision of the intended user. Often, this leads designers to envision users or scenarios similar to themselves and their own experiences [13]. This is especially a problem in gerontechnology, where there is usually a large difference between the developer and the intended user.

By creating Personas, the team of medical experts and system designers are brought together to develop a shared vision of target users. This helps to reduce miscommunication and to establish proper expectations and goals throughout the team [14].

In our opinion, the most important aspect of using Personas in gerontechnology is their function as a communication tool for the application and solution domain experts. These groups have very different areas of expertise, and different languages for describing this expertise. By using Personas, both groups are forced to explain their knowledge in a way that the other group understands, thus facilitating communication.

Furthermore, Personas can engage designers. For instance, the fact that "40% of the patients in this hospital have a Barthel index lower than 90" may not help system designers much, whereas "Anne can walk by herself, but is not able to climb stairs anymore" enables them to extrapolate how this could affect the user's behaviour, and therefore what the requirements of the system are.

C. *Criticism*

One of the main criticisms against Personas is that they have no relation to real user data, as they are fictional descriptions [15]. It is therefore difficult to assess if a Persona represents a large enough part of the user population. We address this problem by generating clusters from actual user data using an unbiased clustering algorithm, as described in Section III.A.

It is also criticised that the Persona method is not scientific [15]. As a Persona is a fictional description, it cannot be falsified by any data. Therefore, it falls outside of the scientific method, and cannot be verified. Although these theoretical considerations hold, in practice we have found that some type of abstract user definition is necessary as a communication tool, providing a common language for medical experts and system designers.

III. Application to Patients with Age-related Disabilities

The group of elderly users is a very heterogeneous one, especially when it is extended to people who are suffering from more than only age-related impairments. Co-morbity and the change of conditions over time complicate the definition of the specific target users. In addition, the combination of different impairments does not necessarily mean that the global disability can be defined by only adding them up.

Personas are therefore developed by considering differences in ability and disability, rather than (combinations of) impairments. In our approach, we base Personas on qualitative profiles of disability, which are the output of a knowledge-based clustering technique by [8], which we summarise in the next section.

A. Clustering of Patient Data

Clustering is the unsupervised classification of patters (observations, data items of feature vectors) into groups called clusters [16]. Hierarchical clustering algorithms start by considering each data item to be a singleton clusters.

In each iteration, two clusters, whose union minimises the change in a given objective function, are united. This procedure is repeated until a stopping criterion, usually a dissimilarity threshold, is satisfied. An example of this procedure is depicted in Fig. 3, where the seven data elements shown in Fig. 3(a) are clustered. The resulting dendogram, a tree-based representation of nested grouping of patterns and similarity levels at which groupings change [10], is presented in Fig. 3(b). In this example, each grouping is based on the Euclidean distance between each cluster, and in each iteration, the two closest clusters are united forming a new one.

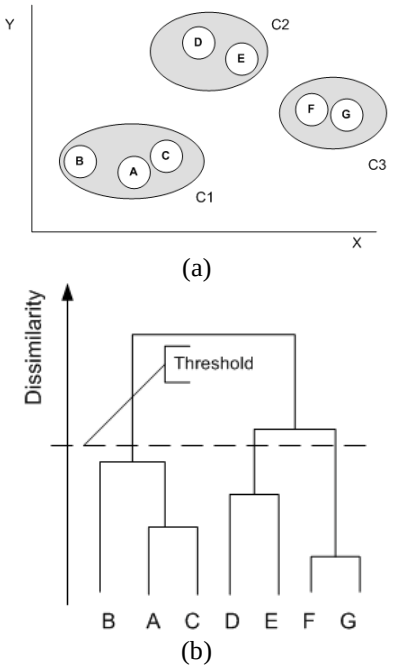

Fig. 3: Example of a typical hierarchical algorithm. (a) the initial data elements (A,B,…,G) and the final clusters (grey ellipses) obtained after applying the dissimilarity threshold. (b) the corresponding dendogram

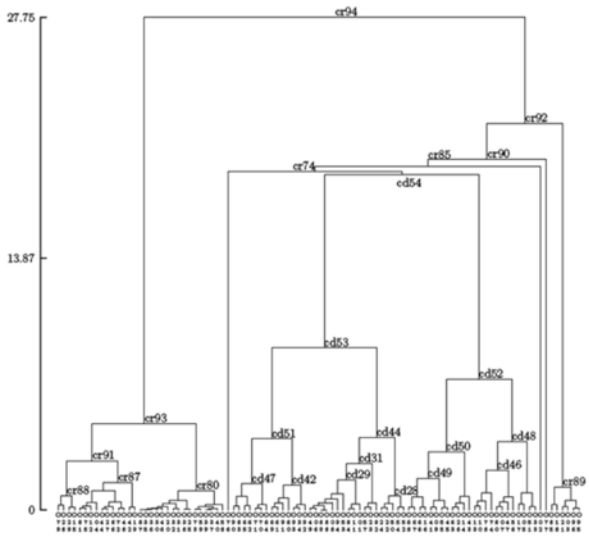

Fig. 4: Clusters that are computed by applying the algorithm on real patient data. Image taken from [9, p.839]. The cluster Cr89 (bottom right) is used as an example throughout the paper.

Finally, the three clusters highlighted in grey in Fig. 3(a) are obtained. A further attempt to group existing clusters (i.e. DE – FG) will surpasses the given dissimilarity threshold and therefore the clustering algorithm is terminated.

The clustering technique used in this paper for building Personas is based on a hybrid technique of Statistics and Artificial Intelligence (AI) called Clustering Based on Rules (ClBR) [17]. Initially, there is an AI process that manages a knowledge base (KB), which includes prior medical knowledge. The KB is used to induce a first structure to the data by identifying certain groups of patients, called rules-induced classes [9]. An example of these rules used in the clustering of the patients used in the following subsection is:

$$r_i\text{: IF } A \text{ is in } [interval], \text{ THEN } C$$

where *A* is an item from the World Organisation Disability Assessment Schedule II (WHODAS II), *[interval]* is an score interval related to *A*, and *C* represents a medical inference based on *A* and *[interval]* (e.g. Emotional Problems) . After the rules-induced classes are generated, a hierarchical clustering algorithm is applied. The group linkage objective function is based on Ward's criterion, which uses the increase in the total within-cluster sum of squares as a result of joining two clusters. This traditional clustering technique is extended by adding a qualitative measure argument to the objective function, resulting in the "Gibert mixed metrics" [18]. The result of applying this clustering algorithm to real patient data is depicted in Fig. 4.

The following qualitative description is taken from [9, p.838] and describes the cluster Cr89, which is the cluster containing the behavioural patterns for the resulting Persona.

> ***Cluster:*** *Cr89 (mean ± SD standardized global score: 34.1 ± 15.4): (B2) moderate physical health, (B9) mild or moderate worry or distress,*

(S1) extreme difficulty in standing up for 30 minutes, (S7) extreme difficulty in walking for a long distance, (S8) extreme difficulty in toileting the whole body and (S9) dressing, (R1) extreme difficulty related to physical problems, (R2) moderate difficulty related to emotional problems, (B1) 100 percent of the subjects reported some physical problems, and (B3) none reported emotional problems.

In the following subsection we present how we integrate the real data extracted by using the ClRB technique into a Persona description. As a result, we are able to specify characteristics of a Persona from quantitative data as the centre of each of the resulting clusters.

B. Modified Process of Persona Development

In order to adapt the traditional development process of Persona descriptions to the specific characteristics of the elderly target group, group-specific information is integrated at several stages of the process.

First, the behavioural variables are also analysed with respect to physical and cognitive impairments and common age-related changes by identifying the frequent impairments and age-related changes in the target group. This is based both on data about the target group and on experience of the medical experts.

Secondly, the outcome of the clustering process is integrated into the Persona development process by incorporating its information at several steps in the traditional process. The cluster that is similar for the users sharing the behavioural pattern of a Persona is determined. The specific qualitative description of the user is thus extracted. This qualitative description is then used to enhance the assembly of the Persona description. We now give an a qualitative description based on the cluster presented in Section III.A.

Qualitative description: *Silvio is in a moderate physical health condition and his main problem is his impaired mobility. He has extreme difficulties standing up for 30 minutes, and also in walking longer distances. In addition, it is extremely difficult for him wash his whole body and dressing. As he is only suffering from mild to moderate worries, his problems are extremely related to physical problems. Emotional problems are only affecting him little.*

In addition, a narrative description is added that is based/ inspired by the qualitative description and characteristic for the target group. This description is based on the general variables specific for the user sample and common knowledge about the user group provided by the health care experts.

Narrative description: *Silvio is a 74-year old retired shop assistant. He is used to having many social contacts and likes to meet other people and have a chat with them as often as possible. He is suffering from normal age-related changes like presbyopia, so reading a book is sometimes difficult for him. Due to his age, he is not used to interacting with new information technologies much. He is now also suffering from certain diseases that affect his daily living. In addition, he is in an acute phase after a case of illness and lives in a hospital for elderly people in Rome. His cognitive capabilities are not impaired, so he is still able and willing to plan is own day structure and to follow it. He only needs assistance when he has to take a shower or a bath and to dress him up. He can still brush his teeth or wash his hands/face on his own, but he needs some assistance to be prevented from falling. He also does not get lost in the hospital and does not need any help to find his way from room to room.*

Finally, the whole expert team proofreads the resulting Persona description to check its scope and language level. The description is refined until a consensus is reached. The result is a holistic user description that can be easily understood by all experts involved in the system development process. In addition, the vivid description can be used to build feasible scenarios, and improve empathy.

IV. Conclusions

Holistic user descriptions that are understood by all experts in an interdisciplinary development team are a key factor for effective system design. Personas have proven to be a useful tool for communicating such user descriptions. In this paper, we discuss the adaptations needed to apply the Persona method to elderly target groups. We also present a method for deriving Personas from clusters generated from real patient data by a clustering algorithm. The result is a set of holistic user descriptions that i) reflect real data, ii) comprise the specific user needs and goals, and iii) are understood by all experts in the development team.

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