Knowledge-Oriented Approach to Requirements Engineering in Ambient-Assisted Living Domain

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Abstract. This paper sketches HBMS(Human Behavior Monitoring and Support), an Ambient Assisted Living (AAL) approach deriving cognitive behavioral models from individual behavioral processes and using this knowledge "learned" to compensate individual memory gaps. In the context of HBMS individual behavioral processes represent the requirements to customize an individual assistive system.

Keywords: ambient-assisted living, requirements engineering, knowledge, behavior modeling.

In the context of demographic aging in the western world improving the quality of life for disabled and elderly people is an essential task for our society. Facing these challenges technological innovations can enhance the quality of life of older and impaired people and contribute to independent living and quality of life.

Ambient Assisted Living (AAL) solutions are developed to help elderly to live longer at the place they like most enhancing their safety and security, giving them assistance to carry out daily activities, monitoring their activities and health, getting access to emergency systems and facilitating social contacts [1,2].

So far little attention has been paid in AAL research to give persons aid to memory to carry out their daily activities although memory gaps are very typical to evolve in an advanced age. Especially elderly people often need support carrying out activities such as using technical devices(e.g. washing machine, TV-set), dealing with administrative duties, using electronic banking tools, using online-shops or simply to remember all steps of their daily life activities. Existing assistive technology systems for cognition are forcing compliance with standardized processes defined by third parties [3] and neglect established user habits. Thus the user acceptance level of such systems is often rather low. The possibility to use established cognitive behavioral processes as requirements to assist the individual later on would improve user acceptance.

Human Behavior Monitoring and Support (HBMS) [4,5] is an approach to derive cognitive behavioral models from individual behavioral processes. Knowledge "learned" in this way is stored in an "artificial memory" and can be recalled later in time to compensate gaps in the episodic memory of the respective person and to technically assist his or her activities.

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Over time a person takes two different roles in HBMS: *knowledge holder* and *knowledge user*. As a knowledge holder the person affects how the knowledge user will be supported later in time. This means that the knowledge holder acts as a stakeholder and his or her knowledge acts as a set of requirements customizing HBMS for the knowledge user.

Hence requirements engineering in HBMS has some characteristics, which lead to differences compared to typical requirements engineering activities [6]:

1. *Requirements Elicitation or Gathering*: traditionally requirements are to be discovered from different system stakeholders. HBMS is supposed to support one individual using his or her own knowledge as set of requirements elicited to customize the assistive system; hence in the HBMS requirement engineering process there is no need for dealing with different knowledge holders. Currently requirements elicitation in HBMS is done observing person's behavior by a psychologist, who writes a textual description of the monitored behavior of the person. In future automated observation techniques are planned to support individual behavioral process elicitation.
2. *Requirements Analysis and Negotiation*: this activities usually include checking requirements and resolving stakeholder conflicts. Hence in the HBMS requirement engineering process there is no need for negotiations between different knowledge holders. But as several behavioral processes can lead to the same result HBMS has to handle behavior process integration and inconsistencies.
3. *Requirements Validation*: in a traditional requirements engineering process this activities are checking that the documented requirements and models are consistent and meet stakeholder needs. In HBMS an integrated requirements model should also be validated. But instead of a formal validation this could be done using simulation technology or converting the behavioral model into a human readable textual description.
4. *Requirements Management*: traditionally this means managing changes to the requirements as the system is developed and put into use. In HBMS people's behaviour can alter and therefore requirements change. So behavioral evolution has to be recognized, documented and managed.

In contrast to most traditional requirements engineering processes requirements in HBMS are not only building a model of a system to be developed but a model of individual knowledge to be used to customize an existing assistive system. Therefore a formal requirements description model and notation is essential. HBMS decided to elaborate a special Human Cognitive Model (HCM) based on KCPM (Klagenfurt Conceptual Predesign Model) as it was designed for reusing domain knowledge in requirements analysis [7,8].

To show the applicability of the proposed HBMS approach, a graphical modeling tool HCM Modeler was elaborated. It is based on Eclipse platform and therefore cross-platform and highly modular. There were elaborated extensions for model analysis including model transformation, model simulation and calculation of complexity and completeness metrics.

The HCM Modeler allows reusing existing model fragments, and provides the possibility to create more fine-grained models by creating sub-models. Behavioral models can be transformed to a textual list of requirements or to an individual ontology. The textual representation of the requirements are used to ensure that the model is correct and fits knowledge holder's needs. The individual ontology is used for integration and reasoning purposes supporting knowledge user later on.

The development process of HCM Modeler is still in progress. To enhance it the following activities are planned for the next future: refine existing requirements analysis and validation techniques, elaborate additional metrics to measure model's quality, implement the proposed model versioning and integrate semi-automatic procedures based on natural language processing of the textual descriptions to automate models creation.

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