Folksonomies for real things

Tagging objects with RFID as a source for context-awareness

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Abstract: Tagging the environment gives users the possibility to explicitly construct and define parts of their spacial context. The tags assigned to RFID-identified objects in the environment can be used to enrich formalized domain-specific context-models with user generated keywords to take community- and user-generated meanings into account. These references in space help to navigate information and services about the identified objects and provide a source for adaptation. We've chosen the domain of fitness and health to build and evaluate a RFID-based software-prototype. This paper presents aspects of this work and reflects it on the theoretical background of context and context-awareness.

1 Introduction

The representation and use of context information is an important problem in the design of context-aware systems. Especially in mobile and ubiquitous applications the range and dynamics of possibly relevant context dimensions is rather high, which leads to fundamental questions regarding the problem of formalizing, an in dealing with ambiguity and dynamic changes in the field of the design of appropriate context models. In the second chapter, we present a short summary about the discourse on the term 'context' in the field of human-computer interaction, followed by a discussion on the relationship between different context modeling and context representation techniques. The third chapter describes a prototype of a context-aware and service-oriented application framework that enables users to construct personal and community-based context models by choosing or creating hierarchically structured keywords. Based on the experiences with the presented prototype, potentials of the 'tagging' approach are taken into account to provide a complementing view on formal ontology-based context models and the informal taxonomies called 'folksonomies' [BOMW04], [Vos07]. In both cases, RFID seems to be a good technological basis to bring real-world objects and places in relation to their representations in the context model.

2 Context and Context Awareness

Context Awareness is a key issue in the field of adaptive applications. Context-aware systems reflect the current situation of the user and apply reactions to situation changes e.g. by predefined rules. To apply context awareness to software systems it is important to understand how context in this domain is defined.

The aim of these definitions is to provide a classification for the design of context-aware applications. These definitions are based on a review of earlier definitions, which are criticized as too concrete [SAW94], not operational enough or only synonymous [Bro96] [WJH97] [DRD+00] where[Pas98] and [SAW94] are the closest to the definition by Dey that we discuss in the following sections.

2.1 Definitions

Introducing the term *context-aware,* Schilit and Theimer [ST94] refer to context *"as location, identities of nearby people and objects, and changes to those objects"*. This type of definition that defines context by example is difficult to apply. If we want to determine whether a type of information not listed in the definition is context or not, it is not clear how we can use the definition to solve the dilemma. However, Schilit et al. claim that the important aspects of context are: where you are, who you are with, and what resources are nearby. This point of view is important for our approach of real-life tagging described later on.

Context awareness has gradually been extended to include all kinds of situational properties, i.e. *"any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves"*. [Dey01] Thus, context-aware systems exploit their surrounding context to increase the fit of a service or an application to the user's needs beyond the user-centered evaluation. However, from the perspective of the end user, most of the implementations provide tools and architectural support only for the *design and development* of context-aware applications [SDA99].

In all proposed and accepted definitions, context is understood as given facts in the environment of the user and his application. The facts can be measured, modeled and their relevance can be rated. Dourish reflected context under the different intellectual traditions of *positivism* on the one side and the *phenomenological* view on the other side [Dou04]. He denotes the difference in these two approaches by formulating two different questions. With his words the *positivistic* question is *"what is context and how can it be encoded?"* The other *phenomenological* perspective he proposes is represented in the question *"how and why, in the course of their interactions, do people achieve and maintain a mutual understanding of the context for their actions?"*. This description is important in two ways: It focuses on possible *activities* that a user can perform, not on environmental states, and it interprets all descriptions as *inter-subjective*, not objective entities.

1.2 Context Modeling

For the design of context-aware applications, it is necessary to model context dimensions. There are different approaches to model context. Strang and Linnhoff-Popien [SLP04] provide an overview of different modeling approaches. They check each approach against relevant criteria for UbiComp: *distributed composition, partial validation, richness and quality of information, incompleteness and ambiguity, level of formality, applicability to existing environments.*

Key-Value Models are easy to manage, but lack capabilities for a sophisticated structuring. *Markup Scheme Models* provide a hierarchical data structure consisting of markup tags like XML. *Graphical Models* like the general purpose modeling instrument Unified Modeling Language (UML)–especially UML diagrams–are also appropriate to model the context, due to its generic structure. *Object-Oriented Models* employ the main benefits of any object oriented approach–namely encapsulation and reusability–to cover problems arising from the dynamics of the context in UbiComp environments. *Logic-Based Models* consequently define context as facts, expressions and rules, contextual information is added to, updated in and deleted from a logic-based system as facts or inferred rules in the system. *Ontology-Based Models* provide a uniform way for specifying the model's core concepts as well as an arbitrary amount of sub concepts and facts, altogether enabling contextual knowledge sharing and reuse in an ubiquitous computing system [dB03]. This contextual knowledge is evaluated using *reasoners*.

1.3 Folksonomies and Ontologies

In the survey of Strang and Linnhoff-Popien it is noticeable, that criteria like *incompleteness and ambiguity* and *level of formality* are evaluated in a way, in which less incompleteness and ambiguity and a higher level of formality are positively rated. Because of this, Ontologies and Object-Oriented Models have good results regarding to the above mentioned criteria. From a positivistic point of view and while asking the question: "*what is context and how can it be encoded?*" this thinking is quite self-evident. But from a phenomenological point of view this thinking can be questioned.

The question Dourish proposed *"How and why, in the course of their interactions, do people achieve and maintain a mutual understanding of the context for their actions?"* leads to a different understanding of the term context. Individuals and communities construct meanings during their interactions in their social settings. Therefore, in our opinion the design of any interactive context-aware system has to provide a way to let users express and articulate these meanings, e.g. through keywords in a language of their choice. Social bookmarking tools like *del.icio.us* [del08] are interesting examples for this approach. By collaborative tagging the URLs of websites, the *del.icio.us* community builds up a cloud of keywords around each bookmarked URL. With this, it is possible to search and navigate through a set of URLs sharing the same keywords. There are no constraints for the users in the process of creating new tags. That is, the meaning of certain tags is not explicitly modeled but implicitly constructed during the interaction like searching and browsing. Nevertheless, there is also a service for recommending keywords and a function for auto-completing keywords. Together with additional support for searching keywords (e.g. using a thesaurus), this functionality leads to a higher likelihood of an emerging standardization of descriptions and better matches when searching for keywords.

2 Real-life tagging in the field of fitness support

Based on an empirical study in the field of fitness and sports, we developed a context-aware service framework called CAMAeleon to implement 'tagging' concepts into the field of context and context awareness. The architecture of the CAMAeleon-Framework (named CAAS in earlier publications) supports the composition of context-aware service-oriented mobile applications [BHP+07]. CAMAeleon is an acronym for "**C**ontext **A**ware **M**obile **A**pplication-**E**nvironment **l**everaging from **E**clipse and **O**SGi" and also stands for the characteristics of the adaptivity of a Chameleon. According to the life-cycle states *installed*, *resolved*, *started*, *stopped* and *uninstalled* of OSGi-Bundles, the framework discovers component-based services on a mobile device and manages the life-cycle state of each service-component regarding to the situation the user is in.

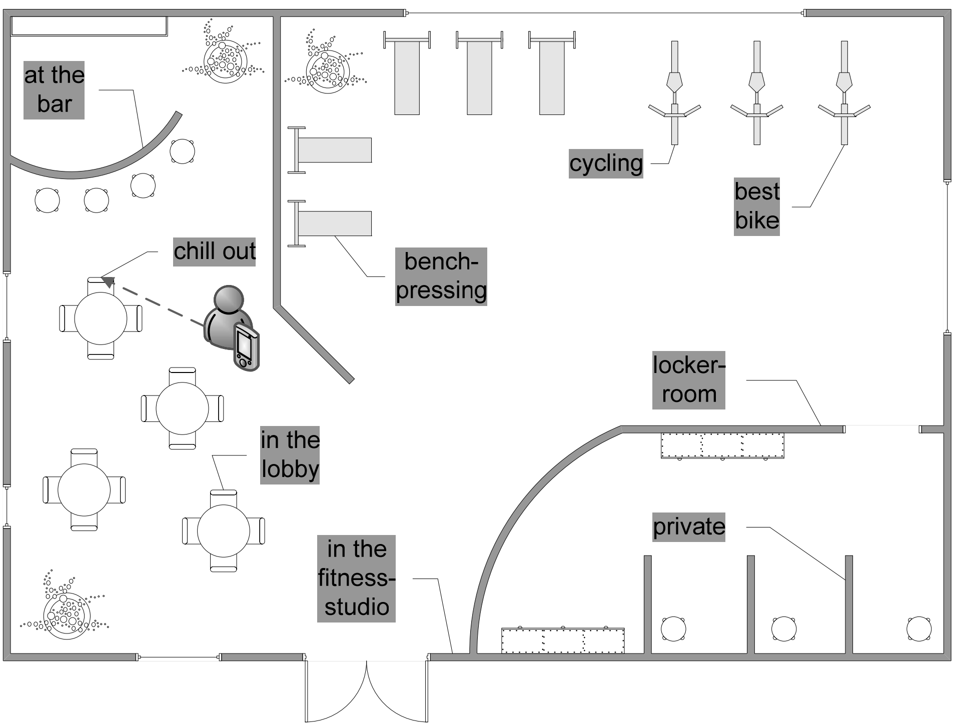

Figure 1 RFID-based real-life tagging in a fitness scenario

The mobile device running CAMAeleon is equipped with a RFID-reader, and RFID-tags are attached at certain objects and places in the user's surroundings. Each tag represents a spatial situation within the world of fitness studios, that is, if a user moves nearby a tagged object or place, the reader informs the framework about the detected place, which triggers a situation change. Every service owns a set of rules to adapt the above mentioned life-cycle state of each available service to the current detected situational change. The only structure the framework provides is a hierarchical order of the situations the user can be in. This hierarchy is an expression of part-of-relationships and is represented as a tree on the user-interface. The sub-situation *in the lobby* is part of the more general situation *in the fitness studio*. This structure is a result of the empirical work in the domain and the resulting requirements derived from statements by visitors of fitness studios [SvWRZ05] but not mandatory for our approach. Figure 1 shows an example of a fitness studio tagged with several situations. The tag language refers to spatial dimensions that could be explicated in an objective, quantitative way, but this would not be the level at which users associate meaning to the spatial dimensions they consider relevant in a fitness studio.

In a second step this simple approach has been extended by the possibility to give users the possibility to add new RFID-tags in their surrounding environment to further specify user-relevant situations for a certain place or object. The user interface of the framework provides an adaptation mode to let users integrate new or discovered unknown RFID tags into the rule sets of the services. The user has no constraints in creating and articulating a name for the identified situation. It is also possible to share new identified situations and associated user-generated behavior rules on a community platform. If users discover relevant, previously identified situations from other users they can use published and shared rules from others as recommendations. This feature is currently not implemented, yet, but technically feasible.

First results of an evaluation based on usability-testing indicate that users do not only choose names of places and positions while tagging their environment. They feel free to associate other types of situations like activities and moods in terms of verbs and adjectives to the objects and places they tag. Examples for such user-articulated situation names are *during the training*, *cycling*, *chilling* or *relaxed*. Some of the participants stated, this system could be useful in other domains and settings, too, e.g. in their private households, cars etc. Discussing the positivist vs. the phenomenological interpretation of context against these experiences it becomes clear, that there are context dimensions that neither objective nor well quantifiable. Some require a shared cultural background to establish an intersubjective meaning. It becomes also obvious that the clients in a fitness studio may have different, but overlapping context descriptions as e.g. fitness trainers or maintenance technicians.

3 Technologies

An automatic recognition of spatial context requires technologies like Wireless LAN, Bluetooth or Auto-ID systems that can identify contextualized objects within the nearby environment. The use of Wireless LAN and Bluetooth is only applicable if an infrastructure of devices already exists because the costs, size and maintenance effort of these devices are too high for tagging objects with them. However most of the current Auto-ID technologies e.g. barcode or ID-cards are cheap and easy to handle but not able to recognize several objects at the same time and require a direct contact respectively intervisibility between reader and reading object. On the other hand, these technologies maintain a specific haptic quality, which allows a stronger, more tangible relation between the 'virtual' context model and the real world. If we attach RFID chips to a training device, the chip will move with the device. This is a system 'feature' if the situation represented by the chip is associated with the device itself; it may be a system 'bug' if the chip would be associated with a situation where the device is just a part of a spatial arrangement.

RFID systems are Auto-ID systems that allow wireless identification of Objects (c.f. [Fin03]). An RFID system consists of a tag reader and a number of tags. The communication between reader and tags is raised by a defined radio frequency. Tags can be classified in passive and active tags. Passive tags operate without an own power supply and obtain their operating voltage directly from the electromagnetic field of the reader. Active tags, however, contain their own battery. The advantage of active systems is a higher reading range, but the tags are more expensive and bigger than passive tags and empty batteries need to replace after a certain period of time. A market analysis shows the heterogeneity of the existing systems complicating the choice of a suitable system. Thus for a first prototypical implementation of CAMAeleon we decided to use a low-cost high frequency reader with passive tags.

4 Conclusion and next steps

The CAMAeleon framework is an example for assigning user-created tags to real-world objects and places using RFID technology. Based on first experiments we believe that folksonomies are–from a more user-oriented phenomenological interpretation of 'context'–an interesting possibility to use these tags as a source for the lifecycle adaptation of services and service compositions. During evaluation some users felt free to associate meanings to objects and places beyond simple location names. They choose activities, moods in terms of various adjectives and verbs as keywords and assigned them to self-applied RFID tags in the test environment, which points to interesting potentials for using tag-based interaction modes and informal context dimensions for service provision. The CAMAeleon-Framework gives users the possibility to generate rule-sets to combine the occurrence and detection of certain tags with simple life-cycle states of the services. Hence this, applications based on the services composed within the CAMAeleon framework are context-aware without a formalized context model, but a weakly structured user- and community-created folksonomy.

Formalized models like ontologies provide a rich semantic representation of the user's context, but tend to represent a positivistic perspective. Folksonomies on the other side are less formalized but equally open to individually or inter-subjectively constructed meanings. That is, from a phenomenological perspective, users can use folksonomies to achieve, maintain and retain an understanding of their context during the course of social and human-computer interaction. Future research should aim at delineating possible conflicts and mutual benefits for these perspectives.

References

[BHP+07] Matthias Betz, Mahmudul Huq, Volkmar Pipek, Markus Rohde, Gunnar Stevens, Roman Englert, and Volker Wulf. An Architecture for Adaptive and Adaptable Mobile Applications for Physically Handicapped People. In Constantine Stephanidis, editor, *HCI (5)*, volume 4554 of *Lecture Notes in Computer Science*, pages 335–344. Springer, 2007.

[BOMW04] Mark. A Blythe, K. Overbeeke, A.F. Monk, and Peter C. Wright. *Funology - From Usability to Enjoyment*. Kluwer Academic Publishers, 2004.

[Bro96] P. J. Brown. The Stick-e Document: a Framework for Creating Context-aware Applications. In *Proceedings of EP'96, Palo Alto*, pages 259–272. also published in it EP–odd, January 1996.

[dB03] Peter J. de Bruin. Using Ontologies - Enabling Knowledge Sharing and Reuse on the Semantic Web. Technical Report DERI-2003-10-29, Digital Enterprise Research Institute (DERI), Austria, October 2003.

[del08] del.icio.us. Website, May 2008. http://del.icio.us.

[Dey01] Anind K. Dey. Understanding and Using Context. *Personal and Ubiquitous Computing*, 5(1):4–7, 2001.

[Dou04] Paul Dourish. What we talk about when we talk about context. *Personal Ubiquitous Computing*, 8(1):19–30, 2004.

[DRD+00] Alan Dix, Tom Rodden, Nigel Davies, Jonathan Trevor, Adrian Friday, and Kevin Palfreyman. Exploiting space and location as a design framework for interactive mobile systems. *ACM Transactions on Computer-Human Interaction*, 7(3):285–321, 2000.

[Fin03] Klaus Finkenzeller. *RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identification*. John Wiley & Sons, Inc., New York, NY, USA, 2 edition, 2003.

[Pas98] J. Pascoe. Adding generic contextual capabilities to wearable computers. *Wearable Computers, 1998. Digest of Papers. Second International Symposium on*, pages 92–99, 19-20 October 1998.

[SAW94] Bill Schilit, Norman Adams, and Roy Want. Context-Aware Computing Applications. In *IEEE Workshop on Mobile Computing Systems and Applications*, Santa Cruz, CA, US, 1994.

[SDA99] Daniel Salber, Anind K. Dey, and Gregory D. Abowd. The Context Toolkit: Aiding the Development of Context-Enabled Applications. In *Proceedings of CHI'99*, pages 434–441, Pittsburgh, PA, May 15-20 1999.

[SLP04] Thomas Strang and Claudia Linnhoff-Popien. A Context Modeling Survey. In *1st International Workshop on Advanced Context Modelling, Reasoning And Management, 6th International Conference on Ubiquitous Computing.*, pages 33–40, Nottingham, UK, 2004.

[ST94] Bill Schilit and Marvin Theimer. Disseminating Active Map Information to Mobile Hosts. *IEEE Network*, 8(5):22–32, 1994.

[SvWRZ05] Gunnar Stevens, volker Wulf, Markus Rohde, and Andreas Zimmermann. Ubiquitous fitness support starts in everyday's context. In E. Goddman, editor, *Proceedings of the 7th International Conference on Ubiquitous Computing (UbiComp 2005)*, Tokyo, 11.-14. September 2005. Springer.

[Vos07] Jakob Voss. Tagging, Folksonomy & Co - Renaissance of Manual Indexing?, January 2007.

[WJH97] A. Ward, A. Jones, and A. Hopper. A new location technique for the active office. *Personal Communications, IEEE [see also IEEE Wireless Communications]*, 4(5):42–47, October 1997.