Mobilität als Gemeinschaftsaufgabe – Assistenztechnologie zur Bewältigung von Mobilitätsbarrieren Mobility through Collaboration – Assistive Technology to Overcome Mobility Barriers

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Kurzfassung

Die Mobilitäts-Assistenz Plattform MoNA zur Unterstützung der Außerhaus-Mobilität von Senioren wird dargestellt. MoNAs zentrale Merkmale sind: Fokus auf Mobilität in der Nachbarschaft und näheren Region, die Betrachtung von Mobilität als Gemeinschaftsaufgabe, sowie die Unterstützung von Mobilität durch Bereitstellung relevanter Information. MoNA wird in enger Zusammenarbeit mit einem Unternehmen entwickelt, die häusliche Unterstützung für ältere Menschen anbietet. Im Beitrag werden folgende Aspekte dargestellt: (1) Präsentation eines prototypischen Szenarios des Service-Workflows des Unternehmens, in den MoNA integriert werden soll; (2) Darstellung der Ergebnisse einer empirischen Expertenbefragung aus denen zusätzliche Anforderungen an das System abgeleitet wurden; (3) Beschreibung der Systemarchitektur von MoNA; (4) Diskussion der beiden zentralen Komponenten des Systems – eines Dienstes zur Vermittlung von Mobilitätspartnerschaften sowie eines GeoWikis zur Präsentation von Information über zeitlich begrenzte sowie dauerhafte Mobilitätsbarrieren.

Abstract

We present the Neighborhood Mobility Platform MoNA which supports outdoor mobility of seniors. MoNA's focus is to support mobility in the neighborhood and nearer region. Special features of MoNA are that mobility is considered as a community task and that it aims at overcoming information barriers. MoNA is developed in close cooperation with a company offering home care for seniors to support independent living. In the contribution the following aspects are covered: (1) Presentation of a prototypical scenario of the service workflow of the company in which MoNA is to be integrated; (2) description of the main results of an empirical survery from which requirements of the system were derived; (3) introduction of the system architecture; (4) discussion of the two central components of MoNA which are a match-making service to establish mobility partnerships and a GeoWiki to present information about temporal and permanent mobility barriers.

1 Introduction

A crucial factor to maintain quality of live in old age is outdoor mobility. Mobility is associated with personal freedom and autonomy and it is shown to have positive effects on physical and mental well-being (Mollenkopf, 2005). Most important, mobility is a precondition for many activities of daily living, such as meeting material needs (shopping), access to health care, maintaining social relations, and participation in cultural and sportive activities.

Empirical studies show that elderly people mostly are spending their out-of home time in the nearer neighborhood and that shopping is considered as an important activity (Scheiner, 2006). Older people prefer to visit places which they can reach by walking over travel by public transportation or car (Scheiner, 2006).

Impairments of mobility in older age often result from bodily handicaps such as restricted ability to walk or poor eyesight. Other causes for mobility restrictions can be cognitive impairments, anxiety, or monetary constraints. A crucial factor which restricts mobility even for older people with none or only mild impairments is social isolation. While older people could enjoy many activities of daily living as well as leisure activities together with neighbors, friends, or family members, they refrain from such activities when they are alone. Finally, limited access to information can present a further mobility barrier. For example, having no knowledge about changes in bus schedules, newly established construction sites, or availability of adequate toilets can result in insecurity or even anxiety and thereby in abdication of outdoor activities.

Technological approaches to support mobility of elderly people mainly address either mobility in larger regions – e.g., trip planning (Subasi & Reithner, 2012) – or support of indoor mobility – e.g., robot assistance (Martins et al., 2012). Furthermore, the majority of AAL applications focus on the development of smart devices to maintain autonomy, such as remote monitoring (Noury et al., 2000).

In contrast, the approach presented in this paper addresses *mobility in the neighborhood* and provides standard and artificial intelligence *technologies to overcome social isolation* by providing a platform for organizing neighborly support and joint activities. To *overcome information barriers*, we provide a GeoWiki for information about permanent and temporal mobility barriers.

Our approach is developed in close collaboration with SOPHIA living network GmbH, a provider of services and technology which supports independent living at home. In this paper, we present a technology, the Mobile Neighborhood Mobility Platform MoNA, which addresses the challenges of mobility in the neighborhood. The main technical contributions are the following:

- We provide a description of the service workflow into which the assistive technologies are integrated (section 2).
- We present and discuss the results of an empirical survey from which additional requirements are obtained (section 3).
- We discuss implications for design and describe the general architecture of the MoNA platform as it has been implemented (section 4).
- We describe lessons learned from implementing the two main MoNA components: the match making system (section 5) and the GeoWiki (section 6).

2 Information Design for Neighborly Collaboration

2.1 Application Background: Providing a Mobility Package for a Social Care Company

The prototype system presented in this paper is developed in tight cooperation with SOPHIA living network GmbH. SOPHIA is a provider of technology and services which supports independent living at home including activity monitoring and 24/7 reaction to emergency calls. In contrast to other providers, SOPHIA includes regular personal social contacts as obligatory component of its services. These social contacts are established by a network of volunteers who are integrated in the work-flow of the company. Quality control is maintained by regular screening and training.

SOPHIA wants to extend its existing IT based infrastructure with a software solution supporting a package of novel mobility services. For paying customers, the mobility package offers assistance for different types of everyday activities. The assistance is provided by volunteers and limited to the immediate geographic neighborhood. Examples include help with carrying shopping bags, escort in public transportation to facilitate boarding and changing between buses, a drive by the car to meet a health care appointment, or escort to a cultural event.

The Mobile Neighborhood Mobility Platform MoNA is designed to support the information management for the mobility service package. It manages (1) the process of matching demands for assistance by the customers to volunteers who could provide the assistance, (2) the process of keeping track of local mobility barriers and informing the customers about how to deal with the barriers.

Some general requirements for MoNA were specified explicitly by SOPHIA. For process (1), the match making, all relevant information about registered customers as well as registered volunteers has to be managed by MoNA. The data needs to include personal information such as addresses of customers and volunteers since the matching process has to consider spatial nearness and availability times of volunteers. Different user groups should have access to the data and the matching service. Typically, the data is handled by a staff member. However, volunteers can manage their own data, e.g. change availability times, if they want to do so. Matching requests of customers are typically handled by a volunteer working in the SOPHIA office or by a staff member. However, a customer or an elected proxy should also have the possibility to search for a mobility volunteer on her or his own initiative. These requirements imply a complex model for role handling to allow for the desired flexibility of use while guaranteeing safety of the stored data.

With respect to the process (2) which deals with mobility barriers, the general requirements relate to the management of geographic information. This process provides the staff operating the service with geo-referenced information about the environment of the customer. One type of data MoNA needs to handle is geographic base data, that is, information about the location of points of interest such as the customer's home, nearby shops or bus stops.

Another type of data is about mobility barriers. As these barriers may be of a permanent nature (e.g., a pathway with stairs) as well as of a temporary nature (e.g., road works), the major challenge consists in up-dating the information. In addition to the barriers, MoNA manages information about how to deal with them. It should, for instance, be possible to inform a customer with walking impairments how to best change a daily shopping route which has become impassable because of road works. Only part of the information needed for such tasks is currently maintained at the service provider SOPHIA. The support for the integration of geo-data from other sources such as the local administration or the property owners is, therefore, a central requirement.

Unfortunately, for most temporary mobility barriers, no central authoritative geo-data source exists. Such data is best provided in form of volunteered geographic information (VGI), that is, by volunteer contributors. In the following, we call the system which provides the geo-information management services in MoNA, the GeoWiki, since a geo-enabled Wiki technology is used to meet the geo-information management requirements.

2.2 A Prototypical Scenario

In order to gain a better understanding of the service workflow that MoNA has to support, we conducted on-site interviews with the staff operating the currently existing service. From an analysis of this data we derived the prototypical scenario described in the following. It involves stake holders (S1) to (S3) and activities (A1) to (A8). Note that



Figure 1: Service provider work place: Assistive information on multiple screens including MoNA (design study).

the stake holders of the new MoNA workflow identical to those of the existing workflow.

(S1) The Care Volunteer: Heike Meier is 58 years old and works as volunteer one day a week at the SOPHIA office. Her task is to contact several customers by phone and inquire about their well-being, to talk about topics of interest of the customer and to ask for requests of mobility support in the coming week.

(S2) The Service Customer: Sophia Huber is a senior citizen, aged 78 years and living alone in the Meyer'sche Gärtnerei, a residential district of Bamberg. She is a registered Sophia customer. Therefore, she wears an emergency bracelet which monitors her body signals and has access to 24/7 emergency calls. In addition, she is contacted each Wednesday morning by phone by the care volunteer Heike Meier. Ms Huber's son, Michael Huber, lives in Munich and phones her about twice a week. Ms. Huber has no access to internet. She owns a mobile phone. Michael Huber has internet access via his desktop and his smart phone. He is registered as proxy for his mother with Sophia.

(S3) The Mobility Volunteer: Peter Bauer is 66 years, a retired engineer. He gives some of his time to volunteer work for Sophia. He drives his own car and he has internet access at home.

The activities of the scenario describe a typical phone session of a SOPHIA staff member or care volunteer (see figure 1). The sequence of activities provides the main success scenario in the sense given to this term in use-case analysis, that is, the intended sequence of service events. Other variants of the workflow are obtained by modifying individual activities or by rearranging them.

(A1) Preparation Phase of Care Volunteer: Heike Meier looks at her phone schedule for the day. Her first contact will be Sophia Huber. Heike Meier prepares for the call by querying the customer database. Then she logs in into the MoNA System. There she sees the GeoWiki, presenting a map of the surrounding of the Sophia office building. She reads some current information about events for senior citizens in Bamberg during the following week.

(A2) Proxy Login for Client: Then she logs in as proxy for Sophia Huber. The GeoWiki now offers a map of the area surrounding the address of Ms Huber. She sees that a volunteer has entered a construction site next to the bus stop with the approximate time frame of one month. Furthermore, she sees that there is still an open request of Ms. Huber for an escort to a theater performance at the weekend.

(A3) Identification of Needs for Mobility Support: Now Ms. Meier phones Ms. Huber. She inquires about her wellbeing and their plans for the week. Then she asks Ms. Huber whether she has already seen the construction site next to the bus stop opposite her house. Ms. Huber tells her that she had seen it already and that this is really inconvenient because the bus stop will be to serviced until end of the following week. She had planned to go with a bus to a shopping center at Friday. However, the next bus stop is too far away for her for walking.

(A4) Requesting a Mobility Volunteer: Ms. Meier offers to look for a volunteer who could drive her by car. At first Ms. Huber does not like this idea because she wants to shop at leisure and would feel rushed if somebody is waiting for her. Ms. Meier propose to look for somebody who can drive her to the shops and pick her up later again. Ms. Huber agrees and they specify the times for pick-up at home and at the shopping center.

Ms. Meier enters the request in the system, specifying, location and time for pick-up at home, location for time and pick-up at the shopping center, and that a car is needed. Since the shopping tour is already planned for Friday, two days ahead, she also fills in a time for response. Ms. Huber wants to know whether the trip can take place latest Thursday afternoon.

(A5) Committing to a Volunteer Service: The system returns two volunteers who match the request. Ms. Meier selects the first in the list – Mr. Bauer. She already knows Mr. Bauer from prior services and knows that older women feel comfortable to drive with him. The system sends out the information to Mr. Bauer. Ms. Meier makes a note to check for response of Mr. Bauer before she leaves the office. In case of a positive answer, she will then phone Ms. Huber again. Otherwise, she will write an electronic message to the SOPHIA staff that there is an open request

terminated until Thursday 5 p.m. And that Ms. Huber needs to be notified until then.

(A6) Acceptance of an Assignment by the Mobility Volunteer: Mr. Bauer checks his Email account Wednesday evening. He finds a request from SOPHIA for a car transportation giving date and times. He logs in the system and accepts the appointment. Afterwards, we gets information about the name of the client, her home address and her phone number (as her preferred means of communication).

(A7) Information of the Client: On Thursday morning, a SOPHIA staff member logs into the system and finds the acceptance notification. The staff member phones Ms. Huber and tells her the name of the volunteer who will drive her to the shopping center on Friday.

(A8) System access by proxy: On Thursday evening, Michael Huber phones his mother and tells her that he will visit her on the weekend. Ms. Huber tells him of the planned shopping trip and that she planned to go to the theater at the weekend but had not found somebody who will accompany her. The son offers to go to the theater with her. He logs into the system and cancels the request, leaving a comment that Ms. Huber will go to the theater with her son.

2.3 Extensions of the Mobility Service Package

The prototypical scenario for the MoNA platform is based on the mobility service package offered to the standard paying customer. Only registered customers and volunteers certified by SOPHIA appear as stake holders. The MoNA system guarantees data privacy and offers a number of additional services beyond those described in the prototype scenario, for instance, calls of notification.

To satisfy the needs of other project partners, most notably, housing associations being property owners interested in improving mobility, the requirements analysis was extended to include a number of free services. The matchmaking service is offered in a free access variant, with senior citizens as target group who are looking for partners for joint activities such as going for walks, shopping, or participating in cultural events.

Similarly, the GeoWiki is used in an extended scenario by social housing associations for planning and communication purposes. Opening the GeoWiki to different groups interested in (senior) mobility such as the tenants of an appartment building or all the inhabitants of neighborhood, turns the tool into a communication medium. The additional scenarios, however, are out of the scope of the present paper. It suffices to note, that as a consequence of additional scenarios, the Wiki technology needs to take care of advanced access rights, a feature which standard Wiki technology does not provide.

3 Results of an Empirical Survey of Mobility Needs and Barriers

The MoNA system has to offer support for maintaining and facilitating mobility in the neighborhood for elderly people. The application context determines the following aspects for mobility support:

- Assigning volunteers to help to meet specific mobility needs,
- bringing together elderly people for joint activities ,
- informing about physical mobility barriers, and
- informing about locations of supportive artifacts.

To gain insight about the domains in which elderly people perceive the largest need for support and information, we conducted an empirical survey.

The survey was conducted in May 2013 in Bamberg, Erlan-

gen and Nuremberg. Questionnaires were sent to housing societies, senior council groups, and non-profit organizations supporting seniors. The goal was to obtain information about the above named aspects from active seniors who are engaged in senior citizen work and thereby have awareness and knowledge not only about their own needs but about the needs formulated by other seniors in their respective communities. The questionnaire was answered by 22 participants, 16 female and 6 male, with a median age of 63 years.

3.1 Needs for Mobility Support

To assess specific needs for mobility support, participants were presented with a selection of 14 outdoor activities for which they should rate how important it would be to get support to be able to maintain this activity. Example activities covered in the questionnaire were: shopping, visit of physician, going to the train station, visiting a cultural event. A four-point scale with labels "not important", "somewhat important", "important", "very important" was used. Besides the rating scale, an open question was stated to obtain information about further activities which the participant thinks important. A further open question concerned the type of support.

As types of support, participants named in the order of number of mentions: transport service, escort, support for mastering stairs, and nearness of bus stops.

The activities judged as most important to maintain (20 to 16 times rated as important or very important) were – given in rank order: visit of physician, taking walks, shopping, visit of banks or offices, visiting friends, going to the hairdresser. The activities judged least important were holiday trips (rated unimportant 20 times) and window shopping (rated unimportant 18 times).

The results were incorporated in the design of the matchmaking service in the following way: the types of support – transport, escort, help with stairs – were included as categories for volunteers as well as help seekers. Volunteers can select one or more categories to indicate which kind of help they want to offer. A help request is classified by the same categories. The activities themselves are currently not categorized for help seeking. Because the relation between help seeker and volunteer is asymmetric, for the volunteer it is not relevant which activity she or he is supporting.

3.2 Joint Activities

In a similar fashion as above, the types of outdoor activities which seniors might want to do in company of other seniors were assessed: The importance of 18 activities was rated on a 4-point scale. In addition, further activities were assessed in an open question. Furthermore, different sporting activities were presented and participants should judge whether they are typically realized by senior citizens or not.

As most important were rated: going for walks (18 times



Figure 2: Permanent mobility barrier (steps) and temporary mobility barrier (snow cover)

rated as important or very important), visting cafes (17), palour games (15), visting cultural events (12). Least important rated were visting a cinema (17 times rated unimportant), visting sport events (19) and take a sauna (20). The sporting activities considered to be of most interest for seniors were: gymnastics, swimming, and (Nordic) walking.

While the concrete activities which are supported are irrelevant for matching help seekers and volunteers, they are highly relevant for matching partners for joint activities. Therefore, the activities rated as important in the survey are used as basic concepts in the similarity matching framework described below.

3.3 Mobility Barriers

A major task of the GeoWiki component of the MoNA platform consists in managing geo-information about mobility barriers. While the research literature describes what constitutes barriers to the mobility of elder people, much less is known about the spatial and temporal extent of these barriers. These, however, are critical design parameters for any system managing geo-referenced objects which may change with time. More specifically, we were interested in two questions: What type of geo-object does the GeoWiki need to manage? What temporal focus should the information update mechanism focus on?

The survey asked the participating domain experts about barriers in their local surroundings that restrict the mobility of elder people. They specified how *often* the barrier occurs, how *long* it persists (for temporary barriers) and how *important* they consider its impact on mobility.

| r | Barrier type | Geo- | Temporal |
|---|-------------------|--------|-----------------|
| | | object | extent |
| 1 | Steps | 1-dim. | permanent |
| 2 | Glaze ice | 2-dim. | hours to days |
| 3 | Curbstones | 1-dim. | permanent |
| 4 | Temp. bottlenecks | 2-dim. | weeks to months |
| 5 | Road works | 2-dim. | days to months |
| 6 | Snow piles | 2-dim. | days |

Table 1: Barriers

As could be expected, steps and curbstones were named by nearly all participants as very restrictive permanent mobility barriers which appear often. More surprising were the findings about temporary mobility barriers. Icy roads, temporary bottlenecks, constructions sites, temporary gravel roads, as well as snow piles were considered to appear often, staying several days to weeks and being very restrictive. On the other hand, fallen leaves and branches as well as locked fence doors were seen as less important.

In free text form the participants added pot holes and loose paving stones to the list of important mobility barriers.

Interestingly, the temporary mobility barriers are considered having as much impact as the permanent ones. Figure 2 shows examples for a permanent and a temporal mobility barrier. Table 1 shows the 6 most frequently mentioned barrier types rank ordered by the number of experts listing them.

The survey results imply that it is not sufficient to encode just point-like geo-objects as standard GeoWikis do. In addition to points (0-dimensional), at least linear (1-dimensional) and plane (2-dimensional) objects need to be modeled. This makes geo-data management much more complex, because it could, for instance, involve topological queries.

With respect to the temporal extent of barriers, the survey makes clear that the primary focus should be on barriers that appear (and disappear) within days or weeks. Furthermore, the temporal extent obviously strongly varies with the type of the barrier. Glace ice, for instance, constitutes a high impact barrier. But, because of legal regulations, it triggers almost immediate action towards its removal. In the neighborhoods covered by the survey, this type barrier rarely exists for more than a few hours. The update mechanism of the GeoWiki uses the information from the survey for setting data aging parameters which depend on the type of barrier.

3.4 Supportive Outdoor Artifacts

The GeoWiki not only manages information about mobility barriers but also provides a medium to publish information on how to best deal with the barriers. Changes in the environment not always deteriorate mobility conditions. To the contrary, considerable effort is put into deploying objects such as benches that are meant to improve accessibility and viability. However, such changes will have no impact on mobility unless they are communicated – a task that the GeoWiki should support. We were therefore interested in learning which stationary geo-objects are considered important for improving (or sustaining) the personal mobility of elder people.

The participants of the survey rated mobility facilitating stationary objects. Park benches, wheelchair-accessible public restrooms, and sheltered bus stops were considered as important by almost all and, at the same time, as rare or missing. Additional free text mentions missing crosswalks and parking lots.

The design implications of these findings for the GeoWiki are different than from those about the temporary barriers. Geo-objects acting as mobility facilitators are meant to stay. The challenge for geo-data management consists less in the update process than in detecting the change and in determining the users that need to be informed about the change.

4 The Neighborhood Mobility Platform MoNA

MoNa is a web-based social collaboration platform which enables the inhabitants of a neighborhood as well as other stake holder to access and provide information about outdoor activities and their geographic surroundings to establish mobility chains. The Rails¹-based web application can be used with any modern web browser from desktop computers as well as mobile devices. Its mobility partnership component, the match making service coordinates activities and matches customers with needs and volunteers. The Geo-Wiki component acts as mobility network which provides information about mobility barriers and changes in the geographic environment.

In section 2, the prototypical scenario has identified three stake holders who interact differently with MoNA. While the care volunteer (S1) and the mobility volunteer (S3) directly access the system, this is often not the case for the service customer (S2). Typically, the service customers are senior citizens, many of them without computer and internet access. They will the help of some trusted person acting as a proxy for interacting with MoNA.

In our case, the service provider SOPHIA offers telephone support for their customers on a regular basis. This means that the system will be used by a number of different user groups:

- Care services and volunteers
- Housing facilities
- Senior citizens (some of them customers of a care service)
- Inhabitants of a district (all ages, with and without mobility restrictions)
- others (e.g. visitors, relatives)
- shops, event organizers

This is taken into account by the system architecture (see



Figure 3: Architecture of the Mobile Neighborhood Mobility Platform

Figure 3): The profile and customer management component distinguishes between the *user* who is identified by login and password and the *profile* which holds the personal data of a person. By default a user is associated with his or her own profile. Special users, for example the volunteers or employees giving telephone support may take over the role of their customers by switching to their profile. The system monitors the user login as well as the profile used, at any time, therefore it is documented for any edit *who* did *what* for *whom*.

5 Establishing Mobility Partnerships by Matchmaking

In MoNA matchmaking for mobility partnerships is realized for two different requirements, The first requirement is defined by the application context of SOPHIA GmbH and addresses mobility support for registered customers as described in section 2. The second requirement is to provide a platform for senior citizens to find partners for joint activities. Both applications offer technological support for overcoming mobility barriers by social collaboration.

The user interface complies to basic design principles for seniors (e.g., Wirtz, Jakobs, & Ziefle, 2009) with special focus on easy and intuitive use. The user interaction is based on the wizard pattern, that is, the user is guided step by step. To take account of the fact that currently only about a third of people of 65 years and older are using the internet², the interaction with MoNA can be performed by trustworthy proxies by means of a complex role model as described in section 4.

In the following, first matching of help seekers and volunteers is described. Afterwards, the modification of the approach to match seniors for joint activities is presented.

5.1 Matching Help Seekers and Volunteers

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Matching is based on information about mobility volun-

¹ http://rubyonrails.org/

teers and registered clients stored in a database together with information about a current request for mobility support. Matching-relevant information about mobility volunteers consists mainly of the time frame volunteers assigned for their volunteer work, that is: regular weekly time slots, non-availability times and a maximum number of hours a volunteer wants to spend per week. In addition, the home address of the volunteer is used to calculate distances and thereby travel times from the volunteer to the location of the help seeker. Finally, the volunteer provided information in accordance to the types of help she or he wants to give. The volunteer can select escort, transport (with own car), and whether she or he is able to support a person when climbing stairs (based on te results of the empirical survey reported in section 3). Database information from the help seeker mainly concerns the home address.

Additional information for a current request is obtained by a wizard-guided dialog with the user: First, the activity which needs to be supported can be characterized. Users can enter free text. A type-ahead using all activities collected in the empirical survey and previously entered activities are used as proposals to facilitate the entry. Second, the type of help (escort, transportation, help with stairs) is specified (see Figure 4 for illustration). Third, the pick-up location is entered - this is the clients address from the database by default, but can be changed if necessary. The goal destination is entered either by an interaction with the GeoWiki or as text. Fourth, the time when the help is needed is entered. Here, the user has the possibility to select a fixed time - e.g., for a visit to the physician - or a variable time frame -e.g., for shopping. In addition, a time until feedback is requested can be specified. For example, when visiting a physician, the client may want to be sure that she or he is accompanied at least a day before the appointment. Fifth, the client can enter impairments such as use of a wheelchair. Afterwards, a summary of the request is presented and the search for a match can be started.

Matching of volunteers and seniors involves hard and soft constraints. Hard constraints concern the type of help needed and offered, the need/availability of a car, and whether a volunteer can deal with a person with a specific impairment. Hard constraints are matched using simple binary values where each correspondence returns value 1 and each disagreement returns value 0. We decided to use binary match values instead of a filter because volunteers who have only a partial fit by this strategy can be included in the match-list. This is a desired feature for the SOPHIA staff and care volunteers: Because volunteers are restricted to the nearer region, the pool of volunteers is not large and a partial fit is preferred to an empty matching request.

Matching with respect to time takes into account the availability times of a volunteer and the time requested by the help seeker. For fixed times, the match is calculated by a simple interval logic (Allen, 1983) based on the start and end times. If the time interval for the help is included in the time interval given by a volunteer, the match is 1, if the time intervals are not overlapping, the match is 0. If time intervals are overlapping on one side, the match is 0.5, if



Figure 4: Screenshot of the user dialog for an request for mobility support (English description see text)

the time given by the volunteer is included in the time interval for help, the match is 0.25. If the requested time is variable, e.g., "an hour on Tuesday somewhere between 9 am and 4 pm", the matching is reversed, that is, it is checked whether the availability time of a volunteer falls into the interval given by the help seeker. For variable times, all volunteers who have not surpassed their weekly time limit are considered.

Currently, the match of the location is not taken into account, since the prototype system is only implemented in one residential district. In general, the system should prefer to match such volunteers and help seekers who are living near each other. On the one hand, this is more convenient for volunteers because it minimizes the journey, on the other hand, thereby the establishment of an informal support network in the neighborhood is facilitated. Ideally, volunteer and senior can arrange future support in person, without the help of the system.

We plan to define the location match not only based on Euclidean distance between the starting locations of volunteer and help seeker but take into account topological information such as "same residential district" or "same side of the river".

The total match is calculated as weighted sum. Because matchmaking for mobility support is provided for preselected sets of users only, the total number of volunteers and help seekers will be small (e.g., between 100 and 500 users), all results with a t above 0 are presented to the help seeker in ranked order. If the user selects a volunteer, the volunteer is informed by email or SMS. He or she has to respond to the request before a fixed time, if this request was specified, otherwise the request is left open until the date for which help was requested is expired. If there is no response, the help seeker or proxy is requested to select an-other person.

5.2 Matching Partners for Joint Activities

While matching between volunteers and registered seniors is asymmetric and has to guarantee that personal data are secure, matching for joint activities is symmetric and open



Figure 5: GeoWiki-page

to everybody. Activity matching aims at involving senior citizens in a given residential district in common activities such as walking, shopping, going to church. For this requirement the matching strategy described above has to be extended to include semantic similarity. That is, matching involves first to identify requests addressing similar activities and only in a second step integrate information about time and location.

Since the user dialog should be as intuitive and simple as possible, we decided against offering categories for activities from which the user can select. Instead, users enter the activity they are interested in by type-ahead. Currently, in the type-ahead, all activities which were named in the empirical survey are available. In parallel, we explore the use of an ontology of leisure activities for senior citizens, similar to approaches in personalized recommendation systems (Morenoa et al., 2013). Especially, we developed an algorithm for self-extending of the ontology which is described in Schmid et al., (to appear).

6 Providing Mobility-Relevant Information by a GeoWiki

The GeoWiki component of MoNA is not the first geo-enabled Wiki. However, it meets a number of requirements that are not covered by existing technology. In general, a GeoWiki allows users to collaborate on spatial data through a web browser in a robust and traceable way. Roche et al (2012) discuss the wikification of geographical information and define a WikiGIS as a system that applies wiki management and integration strategies to geospatial objects. Priedhorsky (2010) defines a GeoWiki as a platform supporting volunteered geographic information (VGI) with the following features: (1) a graphical web interface with navigation operations, (2) on-line map editability – if data is editable it can be edited in the browser, (3) WYSI-WYG editing with a complete set of editing operators, (4) robust linking with explicit links between objects, and (5) comprehensive data monitoring with revision history and

change monitoring.

Both definitions focus on the collaborative editing of geographic entities in a wiki-like style. The GeoWiki developed in this project follows a broader approach. It combines the map-based presentation of geo-objects with a text-based description of the objects and the spatial environment. An example page of the GeoWiki is given in Figure 5.

From the user's point of view, the GeoWiki component of MoNA is a collaboratively editable web site which provides information about their local geographic environment.

Spatial information is important for sustaining personal mobility. The GeoWiki allows the users to easily map temporary barriers by placing markers depicting the type of the barrier and adding additional information. An example of a mapped barrier is shown in Figure 6. Dealing with temporary data involves dealing with aging and error balancing. The mapped data is temporary by definition and will have to be removed in (near) future. Any map of temporary objects has to deal with two types of errors. False positives are barriers shown on the map while the corresponding obstacle has ceased to exist in the environment. On the other hand false negative errors occur then a barrier which still exists is removed from the map. The system needs to balance these errors.

Therefore, any mapped barrier is attributed with an expire time after which it is first switched in an "to be removed soon" state, after which it is removed from the system if no further user interaction occurs. For an in-depth description see (Stein & Schlieder, 2013).

The main GeoWiki component is used for a more static description of the environment. The inhabitants of a district as well as the housing facilities, the care service, local shops and so on describe their surroundings with focus on mobility aspects in a Wikipedia-like style. Contrary to Wikipedia it is not only possible to include a map in each wiki page but to add arbitrary geoobjects on this map and to refer to them from within the text by geolinks.

MoNa-map is based on OpenStreetMap data. On one hand it has – at least for the cities participating in our project –



Figure 6: Mapped road works

the highest data quality and most details. On the other hand it allows all users, including but not restricted to the housing facilities, to modify and add data to the base map whenever needed.

7 Conclusions and Further Work

Assistive technologies have addressed the issue of improving the mobility of elder people at different spatial scales: from robotic aids that operate at home to travel assistants which support planning long-distance trips. We have argued that a number of issues are best handled at an intermediate spatial scale, namely, that of the *urban neighborhood* where hundreds, sometimes thousands of people live. The intermediate spatial scale has received little attention so far. We are not aware other approaches that specifically target the mobility of elder people in a neighborhood. This is surprising, since the prototypical scenario from our requirements analysis (section 2) shows that many important stake holders are present in the neighborhood.

We presented the design rationales behind the Mobile Neighborhood Mobility Platform MoNA which were based on the findings from a survey conducted in three neighborhoods (section 3). The architecture of the MoNA platform features two special-purpose components for the management of mobility information: a matchmaking service and a GeoWiki (section 4). Both components make use of a common profile and customer management which handles access rights to sensitive personal data. Finally, we have described the approaches of the match making system (section 5) and the GeoWiki (section 6).

The approach described in this paper is not just a blueprint for building a system. The implementation of the MoNA prototype has been completed recently. We expect to gain further insights from the starting deployment phase. Field testing will especially provide data on how to optimize operating parameters such as the ageing values which control the update mechanism for temporary mobility barriers.

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