

Personalized and Adaptive Navigation based on Multimodal Annotation

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Abstract

Although much effort is spent in developing navigation systems for pedestrians, many users with special needs are mostly excluded due to a lack of appropriate geographical data such as landmarks, waypoints, or obstacles. Such data is necessary for computing suitable routes because the best route might not be the shortest or fastest one. In this paper, the concept of multimodal annotation of geographical data for adaptive and personalized navigation is described. Direct input by the user is combined with data derived from the observation of the user's LOM-Modality (Location, Orientation, Movement) to annotate geographical data. Based on this data and data derived from other users of the same user group, suitable routes even in unknown territory can be calculated.

Introduction

Carrying out an independent and autonomous life seems usual for most people around us. However, many disabled people and elderly people face immense problems in overcoming difficulties imposed by our common environment. For example, for people restricted in their mobility due to an impairment, a task including covering a specific distance for buying daily life products may become a heavy burden.

Travel aids and assistive technologies have been developed to guide elderly people and blind people in unknown environments. For example, the MOBIC travel aid [6] is based on geographical information systems (GIS) and the Global Positioning System (GPS) for guidance during macro-navigation which mainly covers distances greater than 50 meters. The system also provides a component for pre-journey planning, on which the later navigation relies. The MOBIC system proved successful for macro-navigation although distances between micro-navigation (up to 10 meters) and macro-navigation are not supported. Other approaches also used for indoor navigation incorporate beacons which provide additional information about the environment. Although promising results have been reported [5], such systems require immense investments regarding necessary infrastructure and may therefore only available at special places.

Using current GPS systems, promising results have been reported for navigational support for instance for visually impaired people [3]. However, one of the most important problems – as was also reported for the MOBIC system – is the acquisition of specific data including obstacles, specific waypoints, and landmarks [2,4]. The additional information is necessary to adaptively calculate the best route for people with special needs and provide accurate route descriptions. Although the direct and shortest route might seem the best choice for people without impairments, for instance blind people try

to avoid crowded cross-ways. Consequently, a route avoiding such cross-ways – though it might be of longer distance – becomes more suitable.

The concept of multimodal annotation

As current navigation systems do not fulfil most of the requirements of disabled users, the annotation of the underlying geographical data such as the position of obstacles, landmarks or waypoints as well as information about the adequacy of routes for specific users offers new potentials for macro-navigation and micro-navigation as well as for distances in between.

The acquisition of annotation data is based on two integral parts, namely direct input by the user via different modes such as pen or speech input combined with input derived by analysing the users' LOM-Modality (Location – Orientation – Movement). The LOM-Modality, in contrast to solely considering the location of the user as context, combines information of location, orientation and movement and the corresponding histories into one modality. Annotations can be obtained either by using the users' direct input or the derived LOM data isolated or the combination of both respectively. For example, the user might provide the location of a mailbox by using speech input. Using the LOM-Modality, specific routes can be assigned with weights indicating the suitability for the user. If the user needs significantly longer than the average for covering a specific distance, the route might therefore not be suitable for him. Deriving isolated annotation data by analysing the users movement, stops, locations and orientations might lead to improper conclusions regarding the weighting of routes as the system is not able to determine the actual reason for any difference which varies significantly from the average. Therefore, additional information derived by direct input can help to rate the initial results leading to multimodal input for the annotation of the underlying geographical data.

Personalized and stereo-type based navigation

Most geographical information systems allow for adding the location of individual waypoints and landmarks of the user. As described in the introduction, this data is not sufficient for calculating the best route for people with special needs. Consequently, the navigation problem is extended beyond the problem of finding the shortest or fastest route to a given destination. Additionally, not only the profile of a user must be considered when calculating routes but also the actual situation of the user. For example, it becomes crucial whether a blind user only uses a white cane – and consequently is able to use escalators – or is accompanied by a guide dog which in contrast is not able to use escalators.

As described in the previous section, geographical data is annotated in a multimodal way leading to data directly related to the individual user. This approach works for environments of the user's daily life, however, in unknown territory only well-known geographical data will be available. One possible solution is the concept of stereo-type based navigation. By using data derived from users of the same user group, suitable routes can also be calculated in unknown environment. Therefore, the problem of giving the user required navigation information must be solved, as the system must decide whether directions for micro-navigation, macro-navigation or for distances in between are most important for the user's current situation. In detail, it becomes crucial whether to

provide the user with a description of the next 20 meters or the overall direction. For example, for partially sighted users obstacles within the next 20 meters may be of higher importance compared to a change of direction 100 meters later. Although for example the MOBIC system incorporates a pre-journey component for planning a route, the guidance during the actual journey is not adaptive, that is, neither the user's actual behaviour (except his current location) nor the switching between information concerning micro-navigation and macro-navigation is considered.

Conclusion and Outlook

As yet, first results have been reached on accessibility issues concerning small devices such as mobile phones and smart phones and their potential applications[7]. Concerning location-based services – besides an accessible presentation of the corresponding information – the personalized and adaptive generation of appropriate directions is one of the main problems due to inaccurate data provided by state-of-the art navigation systems. A personalization of information and services is one of the key requirements for navigation systems to be successful for a wide range of different users [1]. We thus believe that an application of the concept of multimodal annotation for both the acquisition of data as well as for the calculation of adaptive route descriptions has the potential to aid in particular users with special needs in carrying out their life more independently regarding their grade of mobility.

As this research is still in an early stage, only basic concepts and a general architecture for the system have been developed. We are currently gathering user requirements for the system. Based on these requirements a refinement of the concepts as well as a basic implementation allowing for first evaluations is currently in progress. Concerning the development of a prototype, the extension of a commercial navigation system with the above described functionality is intended allowing an easy use for many people without the need of buying special and potentially expensive hardware.

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