# Context Sensitive Navigation in Hospitals

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**Abstract.** In this paper we introduce an in-hospital navigation system suitable for motor impaired, visually impaired and elderly people. GPS localisation and WiFi triangulation are often not suitable in indoor environments due to poor signal or complicated calibration. We present a navigation system that does not depend on precise electronic localisation aids. User interfaces used are automatically accustomed to target user's abilities and preferences. Four different terminal types are used for the navigation system prototype.

**Keywords:** navigation; UI generation; context modelling; accessibility

## 1 Introduction

The way-finding in hospitals is a problem that is being solved in many hospitals around the world. A study of a major tertiary care hospital, conducted by the Robert Wood Johnson Foundation[1], calculated the annual cost of way-finding at $220,000 mainly due to the time spent direction-giving (more than 4,500 staff hours) by people other than information staff. Navigation and orientation in unknown environment can be a challenging task for people with limited ability of navigation and orientation. Especially motor impaired, visually impaired, and elderly people have difficulties with orientation in complex buildings like hospitals. Reducing the probability of getting lost and dependency on other people during navigation reduces the level of stress and increase the self-confidence.

We propose a navigation system NaviTerier UIP (NUIP) which focuses on navigation support for users with limited ability of navigation and orientation. In particular we target three main user groups - visually impaired, people using wheelchair and elderly people. The NUIP navigation system integrates results of our previous research. Navigation is based on our know-how in navigation of visually impaired in an unknown environment – NaviTerier project [2]. Generation and delivery of personalized UIs accustomed to abilities and preferences of individual users is realized using integration of the UIP platform [3]. NUIP navigation system addresses the following objectives. First, it provides a routing algorithm to generate an optimal route corresponding to user abilities. Second, it provides personalised descriptions of the routes. Finally, it generates user interfaces (UI) adapted to specific needs of our three user groups.

## 2 Related Work

Logic Junction system [4] is a navigation system deployed in the Cleveland Clinic's main campus. The navigation is realised by touch-controlled navigation panel. Avatars communicate with users in order to make the interaction more natural. The system is capable of providing turn-by-turn route description as well as presenting the route on a map. Route description can be also printed or sent to user's mobile phone. Logic Junction navigation system provides very good navigation for users without limited abilities of orientation and navigation. Unfortunately, the current version lacks accessibility features for visually impaired people and adaptive route planning for people with motor impairments. It is also questionable if the system is suited for use of elderly users.

In Japans Kanazawa Medical University Hospital there is deployed a navigation system based on 3D visualisation of routes [5]. It uses an OpenSimulator virtual world server to depict the hospital layout, connected to a touchscreen monitor. 3D visualisation of the route can be suitable for users experienced with good spatial orientation, but is not suitable for users with limited orientation and especially for for visually impaired people. This systems does not provide route optimisation for people with motor impairments.

Navigation systems based on GPS are not suitable for indoor usage because of missing GPS signal. Similarly indoor navigation systems based on Wi-Fi localisation are expensive to maintain. Neither of those systems provides navigation information, routing algorithms, and user interfaces suitable for people with special needs.

NaviTerier [2] project deals with design and implementation of a navigation system for visually im-


(a) (b)

Fig. 1: Accessibility problems found in current navigation system of the hospital. Main hospital information panel (a). Horizontal navigation line (b).

paired people inside buildings using a regular mobile phone. This system does not require any specialised technical equipment. It relies only on mobile phones with voice output, which visually impaired people already use. The navigation system works on a principle of sequential presentation of carefully prepared descriptions of the building segments to visually impaired user by means of mobile phone voice output.

Regarding user capabilities and preferences, most designers of current systems try to solve the problem of disabled users by means of introducing various assistive technologies. Better solution to this problem is Ability-based design [6]. It employs context-awareness to provide adaptations to user-specific abilities, instead of forcing users to use a specific assistive technology. In order to provide context-aware adaptations, there must be a context model. Context models typically consist of models of user, device, and environment. According to [6], the problem with currently used context models is that they leverage the users' disabilities rather than the users' abilities.

## 3 Field Study

We have conducted an expert evaluation of the current in-hospital navigation system used in University Hospital in Motol (see figures 1a and 1b). We found out that colored horizontal navigation lines are not raised above ground level thus they cannot be used by visually impaired people. In many cases these navigation lines continue through walls as an effect of recent reconstructions. Most elevators lack description of floor buttons in Braille code. Another source of orientation and navigation problems is a high axial symmetry of the hospital building.

Other findings emerged from the interview conducted with one of the doctors. The doctor mentioned that s/he has encountered a situation when elderly people lost their orientation in the hospital. Concurrently s/he said that if s/he has doubts

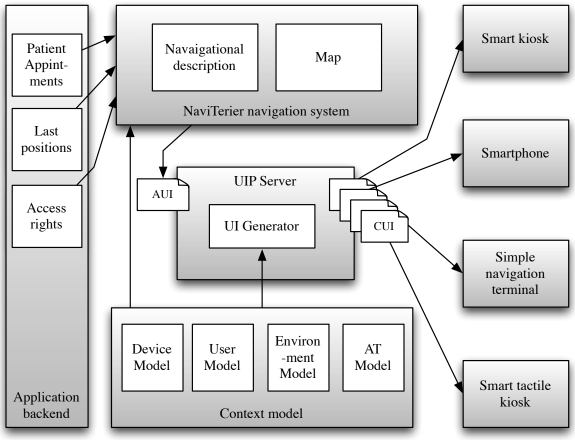


Fig. 2: NUIP architecture overview.

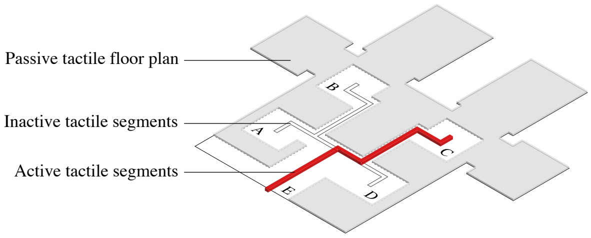


Fig. 3: Smart tactile kiosk.

whether patient can navigate safely s/he can manage patients escort by hospital attendant.

## 4 NUIP navigation system

Our navigation system combines several methods that provide personalised information for people with special needs. First, we developed a route planner, which supports customising of the route according to the user abilities and preferences. Second, we developed a navigation description generator, which creates description of the route with respect to the users limitations. Finally, our context-sensitive UI generator adapts the user interface according to navigation terminals and personal devices used during the navigation.

Figure 2 depicts architecture of the proposed NUIP in-hospital navigation system. The central component is the UIP Server, which is connected to a navigation planner that generates navigation plan according to users abilities and preferences. The UIP Server is also connected to the in-hospital information system (Application backend) to get information about patients planned appointments, access rights and last position of personnel from the security system.

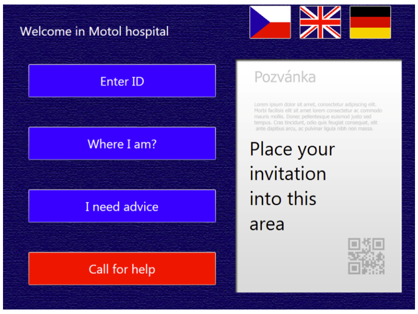


Fig. 4: Smart kiosk.

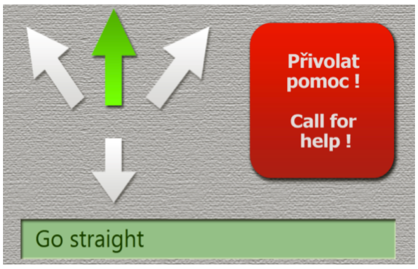


Fig. 5: Simplified navigation terminal.

## 5 Results

Individual components of our system have been implemented in the framework of the NaviTerier project [2] and in the framework of User Interface Platform (UIP) project [3]. User testing showed that NaviTerier navigation system provides efficient navigation of blind people in both outdoor and indoor environments. In the framework of the UIP project an in-hospital navigation system based on various terminals with adaptive UIs have been developed (see figure 2).

Figures 4 and 5 show an example of generated UI for Smart kiosk and Simplified navigation terminal. The Smart kiosk provides a simple generic UI that adapts to users abilities as soon as the user identifies himself/herself. Besides a traditional form-based log-in the identification is possible by scanning invitation letter directly through the kiosk surface. The Simplified terminal serves as interaction point at the corridor junctions. It provides simple directional instructions to the user. Any in-hospital terminal can be used for calling help in case of an emergency.

Figure 3 shows a Smart tactile kiosk. The Smart tactile kiosk compounds of a passive tactile map frequently used for passing navigation and environment information to visually impaired people [7], and active tactile segments which erect from the passive map to form a navigation route. The active tactile segments feature colored diodes to convey the information easily to sighted people.

## 6 Conclusion

In this paper we present a navigation system that addresses problems of navigation of people with limited navigation and orientation capabilities in the hospital environment. Route planning, its description as well as UIs are automatically generated with respect to user abilities and preferences. The system introduces four types of terminals with adaptive UIs that provides efficient navigation.

## Acknowledgements

This research has been supported by the project Design of special user interfaces funded by grant no. SGS13/213/OHK3/3T/13 (FIS 161 – 832130C000) and it has been supported by the Technology Agency of the Czech Republic under the research program TE01020415 (V3C – Visual Computing Competence Center).

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