Lightweight Navigation in the Hospital with Portable Devices

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Abstract

We present an easy-to-deploy lightweight mobile system for indoor navigation in the hospital. We describe a pilot study that helped us select the map layout and we outline the system implementation.

1. Introduction

Outpatients often need to execute examinations, tests, and therapies that take place in various wards of a hospital. Mobile navigation systems can help them easily and effectively reach the locations of their activities. We consider a navigation scenario supported by smartphones or tablets and present a lightweight navigation system that does not adopt complex positioning technologies that are still expensive, complicated to deploy, and not fully reliable in indoor environments [3, 1, 5]. Our system gathers the position of the patient from her clinical schedule (e.g., patient P has finished blood sample taking in lab L and has to go to room R for the medical examination) and does not perform automated position discovery. Therefore, the indoor maps must be precise and must effectively guide the patient to destination without errors. In particular, they must let the patient to localize herself based on environmental landmarks shown in the map.

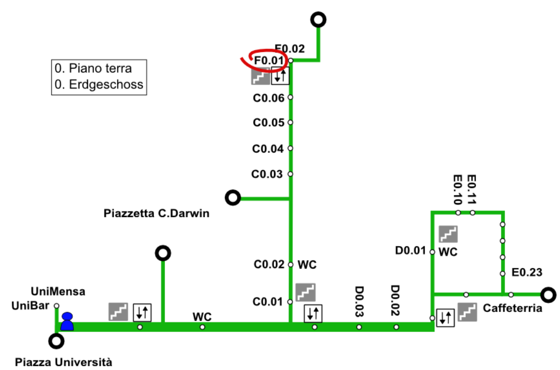

Figure 1. Tube-like map.

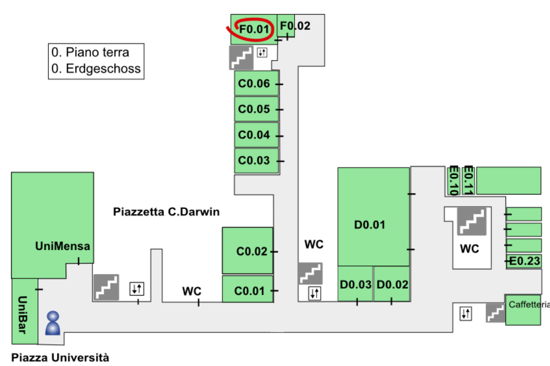

Figure 2. Traditional map.

2. Selection of Map Layout

We compared a new tube-looking map layout [6] (Figure 1) with a traditional-looking, landmark enriched simplified layout (Figure 2). We tested the tube-like layout because it was conjectured to be easier to use allowing the user to better assess the structure of the building, and suitable for large indoor environments such as hospitals or universities [6]. The pilot study involved 7 subjects (4 males, 3 females, average age 24 years) and was conducted at the University of Bozen-Bolzano. We aimed at clarifying: *(1) if the layout of the map influences the time needed to complete the navigation task*; and *(2) what type of layout is preferred by the users*. The subjects did not know the premises of the university and their goal was to reach **Room F0.01** (circled in red in both maps) starting from the main entrance. The users were given an A5 paper map, whose size was chosen to resemble the dimensions of a tablet. The initial position of the user was indicated with a human-shaped icon (in Figures 1 and 2 it is shown on lower left corner). The task simulates a patient, starting from a location (e.g., the lab L) and requested to reach another place (e.g., the room R) for the execution of a clinical activity. Five users (3 males, 2 females) performed the navigation task using the tube-like map, 2 users (1 male, 1 female) used the traditional map. We assigned more users to the tube-like map because this type of layout is new and need a more accurate evaluation.

The experimenter measured the time for reaching **Room F0.01**. We observed that some users of the tube-like map made navigation mistakes that had a negative impact on the task completion time. In particular, these users were not able to correctly turn left and enter the small corridor just before the elevator at the middle of the hallway depicted in the lower part of the maps. We also asked the subjects to evaluate the usability of the two map layouts by expressing their agreement (on a Likert scale from 1 to 5) with the following statements: *(1) It was simple to reach my destination using the map*; *(2) It was simple to understand the map*; and *(3) I liked the layout of the map*. The users of the traditional map expressed a very positive evaluation: all of them fully agreed with the three statements apart one of them, whose agreement with the third statement was 4. The answers of the users who evaluated the tube-like map were more diverse. The average agreement with statement 1 was 4.6, with statement 2 was 4.4, and with statement 3 was 3.8, with 2 people whose evaluation was less or equal than 3.

To our knowledge, our study is the first evaluation of the tube-like layout. Our results, even though based on a limited number of tested subjects, give an indication that using traditional maps users make less navigation mistakes, and that traditional maps are preferred, hence contradicting the conjunctures presented in [6].

3. Implementation

Figure 3 shows the rendering of the map on an iPad, one of the mobile devices that we use for the actual navigation in the hospital. Starting from the fire escape maps of the hospital, we designed a simplified landmark enriched map, with the goal of reducing ambiguities, decreasing the complexity of the map, improving readability, and assuring navigation performance [4]. Elevators, stairs, toilets and other landmarks were replaced with standard icons. The important areas (reception, waiting room, therapy rooms, and doctors' room) were shown in green and clearly labeled using the same numbering and colors used in the hospital. Irrelevant areas were colored in grey, to speed up the interpretation of the map [7]. In order to clearly highlight the navigation

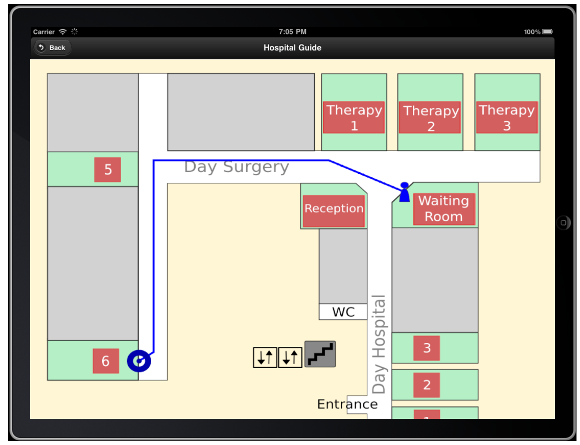

Figure 3. Hospital navigation with an iPad.

path, we adopted a graph-like representation of the space. The nodes of the graph are the destinations (green areas in the map) and the junction points between corridors, the edges represent segments of the walking paths. Routes are shortest path in the graph and are shown with blue lines.

We have embedded this navigation component in *Ospedale Amico*, a multi-functional mobile information system for hospital assistance [2] and we are evaluating it on the field in the oncological day hospital of Meran-Merano (South Tyrol, Italy).

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