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# Model of guidance for visually impaired persons in the traffic network

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ABSTRACT

The movement of the blind and visually impaired persons in the traffic network is today based exclusively on the application of aids (white cane) and methods that the users learn during the training of orientation and movement. In present paper authors investigate accessibility of information and communication technologies and services with the purpose of increasing the mobility level of the blind and visually impaired persons when moving in the traffic network of the City of Zagreb. The traffic intersections were analysed from the viewpoint of difficult-to-master for independent movement by using the basic methods of crossing a traffic intersection which the users acquire at the training of orientation and movement. The method of survey and interviews with a target group of users was used to evaluate all the relevant parameters of guidance and navigation resulting from the mentioned analyses and by performing training of orientation and movement in the duration of six months. Based on the carried out research and the used scientific methods the dynamic model has been defined and it is based on relevant parameters of guidance and navigation, and on the application of the information and communication technologies and services. The information provided to the user, by the system, is defined according to the currently available technologies. The model was efficiency tested on a real system of the traffic network of the City of Zagreb.



## 1. Introduction

The City of Zagreb covers an area of 641.35 km$^2$ which makes 1.13% of the area covered by the Republic of Croatia. The location of the City of Zagreb in regional – Central European space denotes the interrelation of three biggest cities connected by the past, the present and the future – the Zagreb – Vienna – Budapest triangle, lower level of the connection is Zagreb – Graz – Trieste with Ljubljana in the centre, and in Croatia it is the triangle of Rijeka – Split – Osijek with Zagreb in the centre. According to statistical data there are currently 792.875 people living in the City of Zagreb, while there are 91,261 disabled persons which is 13.2% out of the total number of citizens. There are 1985 blind and visually impaired persons (users) in the area of the City of Zagreb and the data refer to all forms of visual impairments (Benjak, 2013).

Today's development of information and communication technology and services in this area may contribute to improving the quality of life for users. Apart from the standard audio signal, which is used for navigation through the traffic intersection, there is also the possibility of developing new solutions and services, which is reflected also in many scientific studies in this field (Manduchi & Coughlan, 2012). The mentioned system uses the mobile terminal device, camera installed on it and the

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application enables the transfer of information to the user. Current solutions are also based on the Global Navigation Satellite System (GNSS), Global System for Mobile Communications (GSM) and Radio-frequency Identification (RfID) technology (Baranski, Strumillo, Bujacz, & Materka, 2009; Bujacz, Baranski, Moranski, Strumillo, & Materka, 2008; Marukatat, Manaspaibool, Khaiprapay, & Plienjai, 2010). The basic function of these solutions is correct navigation of the users. Some of the solutions use also sensor technologies (João, Farrajota, Rodrigues, & Hans du Buf, 2011; Quoc, Kim, Lee, & Eom, 2010). Additional technologies are used because GPS technology still features errors in the locating procedure. The sensor technologies are used to enable better precision in locating the users. The project which is exclusively focused on the area of implementing new Information and Communication technologies (ICT) in the function of precise guidance is Crosswatch (Coughlan & Shen, 2013). The starting facts in setting the future solutions in this issue are considered through the mentioned project. The facts are directed to the issues of what kind of information has to be provided to the users, when (through real-time information) and where (by means of sensor technologies or the similar) (Coughlan & Shen, 2012; Periša, Peraković, & Šarić, 2014). The problem in orientation and moving has also been considered through the implementation of RfID technology thus enabling greater precision in moving (Nassih, Cherradi, Maghous, Ouriaghli, & Alj, 2012; Periša, Peraković, & Runjić, 2011; Zhang, Li, & Amin, 2010; Zou & Wang, 2010). In the mentioned studies the errors have been presented during the usage of the currently available technologies (GPS, DGPS, RfID, and combination of GPS and RfID technology).

The absence of the mentioned research is reflected in the identification of relevant traffic and technical parameters of guidance and navigation, and the education and rehabilitation parameters that define through synergy effect the basic requirements of the user moving in the traffic network. Based on the parameters the users' requirements are defined as well as the knowledge base of the users moving in the traffic network which forms the main elements of the dynamic model of guidance and navigation. The dynamic model makes it possible to obtain precise information about the location of movement and way finding thus increasing the safety level of entities moving in the traffic network.

## 2. Relevant parameters of guidance and navigation for visually impaired persons

The systemic approach and analysis have been used to define the areas of relevant parameters: the area of the traffic and transport technology, and the area of education and rehabilitation science. The parameters were analysed over a period of six months. Within this period the authors passed the training of orientation and moving. The training was performed with an authorized peripathologist at the following locations: *ZUK "Borongaj"* (internal polygon of the Faculty of Education and Rehabilitation Science and the pedestrian zone of the Scientific and Academic campus "Borongaj"), intersection of *Horvaćanska street* and *Petrovaradinska street* and the pedestrian zone of the street of *Hrvatski sokol*. The used aid for orientation and moving was the white cane, and a fold over the eyes served to present as clearly as possible the condition of the users. For the testing of the applications whose purpose is correct navigation and guidance the following was used: Loadstone, MobileGeo, Outdoor Navigation, Nokia maps, Intersection Explorer and WalkyTalky. From the mentioned applications the study considered the values whose function is defining of the precise information about the location, information about the environment and the adaptability and availability of applications to the users.

In this paper the research was carried out with target population (users) where the planned sample was 175 users. There were 144 users who responded to the survey, which is 82% of the planned figure. The research was carried out in the form of on-line survey and interview which was done with the users themselves. The representative sample was defined according to the data of the Croatian Association of the Blind and the Society of the Blind Zagreb about the number of the employed users (substantial visual impairment) in the area of the City of Zagreb, and there are 171 of them. The mentioned figure indicates the number of users who move every day independently along the traffic network of the City of Zagreb. There were 101 employed users participating in the study which makes the sample representative. The survey also included 29 students from the University of Zagreb which represents 100% of that population.

The mentioned research was used to grade the traffic, and education and rehabilitation parameters important for safe and independent movement of the users in the traffic network of the City of Zagreb. The importance of traffic parameters during movement along the traffic network is presented in Fig. 1. The definitions of parameters that are used in the questionnaire:

- speed – concept which defines the speed of the movement of the user along the desired route (depends on the route and time);
- time – concept which describes the duration of the user movement along the desired route;
- movement safety – undisturbed movement, for the user to gain confidence in the proposed solution and to get the feeling of safety;
- precise information – data that enhances the user's feeling of safety, because if the information is not correct the movement of the user may be endangered;
- landmark – information that may provide the user with the information in which direction to continue moving, information on the location;
- perception – recognition of the environment in which the user is positioned resulting in memorizing of the information;
- orientation – orientation in space (not equally expressed in all persons);
- independence – feeling that the model provided to the user allows movement with minimal assistance of another person;
- mobility – free movement of the user, i.e. capability of walking in a safe and coordinated way; and
- education of the users – education of the users about the method of using the system.