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Driven-Walking for Visually Impaired/Blind People through WiMAX

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Abstract
Aim: It is known that people who are blind/visually impaired find it difficult to move, especially in unknown places. Usually the only help they have is their walking stick (white cane), a guide dog and sometimes special warning sounds or road signals at specific positions. *Material and Method*: In this paper we are trying to find a solution on how to build an appropriate navigating system for blind people. *Results*: Based on benefits of powerful properties of mobile WiMAX standard we suggest an important navigate application which can translate a digital visual environment properly for blind/visually impaired users through a plethora of combinations such as voice, brain or tongue signals. *Conclusions*: We believe that such an idea will be an initial point for a plethora of applications which will eliminate walking disabilities of blind/visually people.

Keywords: Blind; Visually impaired; WiMAX; Wireless network; Medical equipment.

Introduction

The World Health Organization estimates that in 2002 more than 161 million people (about 2.6% of the world population) were visually impaired from which 37 million (about 0.6%) were blind [1]. Since 90% of blind people live in developing countries [1] then equipment which can make movement within city easier it is necessary as there are various complex directions. Except for some organized urban areas where there are special warnings like sounds at specific positions usually close to traffic lights, most areas are not properly designed for blind people. In the rural areas things may be easier because blind people can easily use a guide dog to assist them in mobility. However, in both cases blind people have to cope with how they can move safely.

It is known that most blind people usually use the white cane as a basic equipment to move because it helps them to identify and avoid obstacles. Technical improvements of the white cane have been made for indoor movement [2-4]. However, even if they use a white cane, they cannot walk independently in an unknown area. Useful suggestions for outdoor movement have been made using Global Position System (GPS) navigating system [5, 6]. Generally, most ideas remain may be only at research stage due to the high cost of equipment or insufficient ergonomic use. Nevertheless, the critical point is that most of the suggested equipment cannot identify dynamic obstacles, causing in that way delays or confusing blind people when real-time obstacles appear. Until now no significant improvement has been recorded yet which can help them walk safely.

Moreover, the number of blind/visually impaired people is growing especially in the developed countries due to the growing number of people over 70 years of age. One challenge is how to develop a proper guidance system to an increasing number of people using limited financial and human resources. To overcome such a challenge the basic way is to exploit the forthcoming technology, specifically wireless technology. Today wireless technology seems to be an inseparable part for healthcare [7]. Especially novel based wireless standard like WiMAX seems to be quite indispensable in healthcare application instead of the known wireless technologies [8-13]. Low cost and high performance are some of the basic properties of mobile WiMAX standard which make it quite a promising component of the future healthcare applications. This finding acted as a stimulus for us to make an intensive research on finding solutions which can lead blind people to have an easy and independent walking. Here we are trying not only to suggest an inexpensive way to improve blind people walking but we are demonstrating a plethora of combinations on translating the digital visual environment to a user specification.

The central concept of our suggestions is to give to the blind person a dynamic view of his/her roundabouts. A body-device will be always in touch with a control center through a network based on mobile WiMAX standard. The body device will submit the current view around the person while s/he is moving and will receive properly moving instructions based on the person's instructions/desires. Also the body device can receive from the control center several other data like: the best safer guide road to reach a place, audio books, music, on-line lessons or other future suggested information. The blind person can have the choice over what kind of signals s/he would prefer to receive the information from the guidance center: voice, brain, tongue signals or a mix of them. We believe that mobile WiMAX standard is the best choice for communicating because it can provide portability, mobility, high-speed, broadband connection and interoperability. Last but not least, the most important feature is that building a network based on WiMAX standard has a low implementation cost.

Material and Method: Mobile WiMAX Standard

Mobile worldwide interoperability for microwave access WiMAX standard, IEEE 802.16e [14], can offer a powerful wireless communication for providing high data rate communication in broadband access for metropolitan area networks. WiMAX is based on the IEEE 802.16 [15] BWA (Broadband Wireless Access) standards family which was first published in 2001 and in 2005 IEEE 802.16e was approved as the official standard for mobile applications. WiMAX forum [16] was established in 2001 as a non-profit cooperation to promote and certify broadband wireless products. Most of the powerful features can be easily configured from the following properties since mobile WiMAX can provide [17-20]:

- a very high capacity and wide coverage over metropolitan-size areas, so there will be no need for hot spots for a wide area. It can cover up to 30 miles supporting up to 75 Mb/s data rate (single channel).
- interoperability, thus making it easier for end-users to transport and use their device at different locations with different service providers.
- mobility, enabling subscribers to maintain their connection as they move across areas covered by different base stations.
- low in cost network architecture since it is designed to be cost-effective because it is flexible, easy and economical to deploy instead of 3G which is limited to business users.
- different quality of service (QoS) for each user with a guarantee of a reserved bandwidth and short end-to-end latency. Therefore, it will enable more efficient communication that can support seamless voice and video conference, such as voice over IP (VoIP), video conferencing, streaming media and other useful multimedia applications.
- security by adopting the most known security technique available today.

Mobile WiMAX seems to have powerful properties instead of the known wireless technologies 3G, 4G and Wi-Fi networks since it can take advantage of very high bandwidths to offer a unique mix of performance, QoS and throughput. Therefore based on those features mobile WiMAX can be a powerful tool not only for medical applications but also for multimedia, education, business, army and other kind of applications.

Results: Application for Visually Impaired/Blind People

In this part we will describe applications with a plethora of combinations which will hopefully help in making the life of visually impaired/blind people easier. Applications have several features which can be flexible based on user needs and adapted to outdoor or indoor movement.

Safe Dynamic Move

The application will consist of two major parts body device and guidance center which will be connected together through a wireless network based on mobile WiMAX (Figure 1).

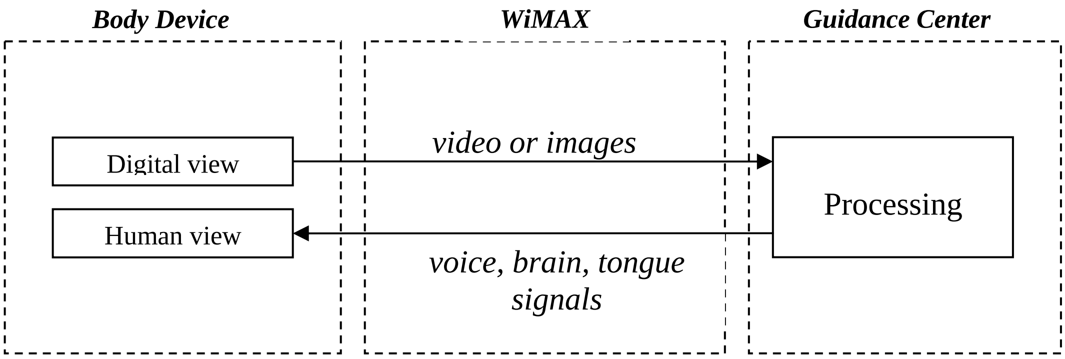

Figure 1. Safe dynamic move

Body Device

To have a dynamic model we should have an on-line view of the surrounding place of a visually impaired/blind person, therefore there will be a camera at body device. It is not necessary for the camera to be always open and the user or the guidance center can decide when it is better to be used. There will be various ways of the digital visual data that the user will receive from the guidance center like: voice, brain or tongue signals. Moreover, the camera is necessary when the user wants to read a notice, news or books. Except for the camera, sometimes sensors may be necessary to identify the appearance of very close and sudden obstacles.

The body device can receive from the guidance center the more appropriate short route for outdoor movement based on the start and the end of the route after the user's request. The route will be dynamically adjusted during the user's movement avoiding crossing places which are not currently proper for visually impaired/blind person movement. Such places can be for example streets/pavements where there is human traffic or which do not have the appropriate guide signals for visually impaired/blind people or which are currently busy with maintenance workplaces.

Guidance Center

The guidance center will receive images or video of the user's surroundings taken from the camera of the user body device and will convert them to appropriate voice guidance, brain or tongue signals. There will of course be a powerful work station running the appropriate software applications which can make an on-line object recognition from a video and images. Further process of those data is necessary for recognizing the obstacles and the appropriate ways of the user's movement. Continuously the user will receive in real time the guidance information in voice, brain or tongue signals format or perhaps a mixture of those signals. The conversion format can be based on the user's choice or the guidance center can decide based on digital visual properties. However, we want to add one more important suggestion, that the conversion from a digital surrounding view to the user's format can be based on the personal characteristics of the individual user. The guidance center can learn automatically after the initial use of the whole application the appropriate individual user's conversion features.

The digital visual information will be submitted in a wide variety of ways after object extracting to user device:

- Voice. Such translation can be based on already used techniques like Meijer [21] or others [22]. Furthermore, we suggest automatic voice guidance as if the user is in a labyrinth. That is feasible because the guidance center knows the position of the user through the wireless network coordinates and the user's environment through the digital object extraction from the visual data. Therefore, being in the on-line touch with the user the guidance center can give the right directions avoiding dynamic obstacles.
- Brain. The guidance center will convert the environment information in appropriate format for an array of electrodes placed in direct contact with the visual cortex of the user [24, 25]. Such a technique has a long history and was originally started at 1968 [23]. For more information there is an extensive review of electrical stimulation [26].
- Tongue. In this case the user must wear a small chip device on his tongue to receive the environment information in tongue signals. Such a way is successfully used by Bach-y-Rita and Kaczmarek [27, 28]. However, in our case the translation device is placed on guidance center and we suggest that the tongue chip receive wirelessly the data from user device. Such improvements make the application more ergonomic.

The above descriptions prove that our application is open since any idea can be fitted on it.

The software stored at guidance center about the conversion of surrounding user scene may be stored and run locally to the user's device. In that case we believe that the quality of the produced information will not be so good because of the lack of efficiency of the user's device. Also, the user's device will not be so ergonomic if extra hardware features are added. However, if such local equipment is available then the software will be updated with the latest features through the guidance center.

When the user wants to read information, s/he will inform properly the guidance center and voice messaging based on optical character recognition of the image will be submitted to the user. In case there is a difficult hand written and urgent message then a human assistant will be available.

The guidance center has stored current views and information about the roads to use it when receiving a request about the best shortcut from the user. Based on this info it can easily find the safest route for the impaired/blind person. While the user is walking the initial condition of street/pavement may changed, however, the guidance center will be able again to give the optimum path based on on-line view.

Why Mobile WiMAX is Necessary

Fist of all, in order for the communication between body device and guidance center to be feasible mobility is crucial. Mobility can be easily offered from several current wireless technologies. However, it will be quite complex and expensive to build a wireless network without the help of mobile WiMAX. High capacity, high bandwidth and a good quality of service (QoS) are some of the basic properties of the network to transfer video and image files in a real time from body device to guidance center. Also users want to feel safe about their private information therefore security over the network is necessary. Since WiMAX technology can cover a wide area with a good quality of a communication the number of guidance centers will be small, which will make the whole idea less expensive and complex. The wide area convergence can make the application practicable for rural or poor areas as well, where high technologies facilities are rarely available. Moreover, the low in cost of the network's construction can make it useful for poor countries.

Learning

Through the same application visually impaired/blind person can download from the guidance center books or online lessons. Of course those will be given through speech but in the case of lessons if needed some parts (for images) can be given in brain or tongue signals.

Conclusions

In our days wireless technology not only is rapidly spread out but has significantly improved which make it a useful tool to improve and develop several applications. Specifically, a novel technology like mobile WiMAX standard is designed to facilitate low cost implementation wireless network with high standards. We took the chance to fit such a technology in applications which will make the life of visually impaired/blind people easier and safer. In that way dynamic obstacles can be easily avoided especially during outdoor moving. One of the benefits of the application is that it is open-based since any idea of translation of digital visual environment can be easily fitted to it simply by updating only the guidance center.

Such an application is not available yet to the market but we hope that not only it will be available soon but it will also improve and be extended further. We believe that with this article we open a new door to new applications where computer technologies can contribute to medical care applications.

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