Chapter 5
Innovative Smart Sensing Solutions for the Visually Impaired

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ABSTRACT

Although several aids have been developed to help people with visual impairment in the accomplishment of daily activities, indoor and outdoor navigation remains a critical task when considered both as a technological and a social issue. The development of new technological approaches (such as the use of smart multi-sensor architecture) allowing for the perception of the neighboring environment and providing the user with an optimized form and degree of information are activities focused by researchers working on the field. In the chapter some systems currently being developed at the D.I.E.E.S. in Catania are briefly discussed, highlighting the efforts dedicated to develop smart methodologies for the optimization of the information the user is provided with. In particular, the attention will be focused on the PYRUS system, which adopts a multi-sensor architecture and quite complex smart post-processing to provide the user with information useful to perform urban mobility tasks, and orientation and mobility aid based on a multi-sensor network of ultrasound transducers to localize the user in the environment and to guide him/her in a safe way through the environment.

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INTRODUCTION

Since the sixties, with the rapid growth in electronic and sensing technology, a new research area dealing with the healthcare and the development of innovative and intelligent products supporting older and impaired people has appeared, progressively earning interest from universities, research centers and industries and creating a thriving market. In the last decade the research aimed to enhance the quality of life of older and impaired people has increased at an unprecedented rate. The ferment in this area has affected not only healthcare research centers and universities (just as the large number of scientific papers shows) but industries and politics too. In confirmation of this, the European Community is financing many research activities dealing with Ambient Assisted Living (AAL) with the objective to enhance the quality of life of older people through the use of Information and Communication Technologies, ICT (The AAL Joint Program web site).

Substantial interest has always been attracted by the challenge of developing effective devices or systems able to support visually impaired people performing daily activities. Several methodologies and electronic aids have been proposed over the years, a useful classification of them can be conducted on the basis of the task performed, from specific tasks (color sensing, light sensing, temperature sensing, etc) to complex tasks (clear path indicators, orientation and mobility etc.) or on the basis of the employed approach (Committee on Vision, 1986): sensory enhancement, sensory supplementation, sensory substitution. In particular, sensory enhancement aims to partially recover the functionality of depressed receptors, while the use of devices giving supplementary information for the accomplishment of a particular task is known as sensory supplementation. As an example, magnifiers are common devices performing a vision enhancement task for low-vision disabilities, while the use of smart image processing techniques represents a valuable solution for image enhancement (Peli, Goldstein, Young, Trempe and Buzney, 1991; Peli, Lee, Trempe, and Buzney, 1994). Advanced methodologies such as Stochastic Resonance (SR) are intriguing solutions to improve the sensitivity of depressed receptors (Moss, Ward and Sannita, 2004). Sensory substitution, in general, means replacement of one sensory input (vision, hearing, touch, taste or smell) by another. Research in this area aims at providing some equivalent of vision via hearing or touch etc. or vice versa (Meijer, 1992).

Although several aids have been developed to help people with visual impairments in the accomplishment of daily activities to the purpose of developing more effective aids a deeper understanding of needs and abilities of the visually impaired must be gained. Disability is one of the most relevant causes of social marginalization and blindness is the worst disability in the world. Actually, there are about 330 million people with some form of impairment in the world; among them about 160 million people are visually impaired (The World Health Organization web site). For such people the possibility to autonomously access public sites and available information is a fundamental need. Anyway, structural and technological barriers often limit the site accessibility thus causing marginalization and precluding blind people from the possibility to share environments and available informative stimuli with other people. This limitation creates serious discouragement in visually impaired people and can dramatically compromise their possibility to gain adequate cultural stimuli and skills for suitable social inclusion. Rather than asking a visually impaired to live in already structured environments it should be desirable to create environments-for-all, including visually impaired or other people with disabilities. In this sense, the idea of enriching environments with adequate sensing solutions (e.g. networked sensors) could be a convenient way to boost site accessibility for people with disability.

In particular, indoor and outdoor navigation remains a critical task when considered both as a