Chapter 36
New Electro-Optic and Display Technology for Visually Disabled People

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ABSTRACT

The aim of the chapter is to review the most recent advances in electro-optical technologies applied to visually disabled people. The World Health Organization (WHO) estimates that the number of people in the world with some kind of visual impairment is 285 million, with 246 million of these persons in a partially sighted or Low Vision (LV) condition. The top three causes of visual impairment are uncorrected refractive errors, cataracts and glaucoma, followed by age-related macular degeneration. On the other hand, Head Mounted Displays or electro-optical materials used in liquid crystal or electrochromic devices can be used in technical aids for LV. In this chapter, the authors review how disabled people receive real world information using these new technologies, how the recently developed electro-optical technical aids can improve visual perception, and how these LV aids do work, from a technological point of view.

INTRODUCTION

The application of new techniques in assistive technologies is increasing in the last decade. In the context of vision, electro-optical materials and displays are giving a boost to visual impaired people aids. Besides the Design for All created software for user applications in tablet computers and e-book readers, or in mobile phones (see any of the IEEE International Workshop on Mobile Vision, conferences from 2010 on), which allow blind people the access to knowledge or mobil-

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ity, there is a breadth of encouraging research in the joint application of electronics and optics for developing technical aids.

The chapter will review the research contributions in the field of electro-optic technical aids for LV people in the last two decades. It is not intended to discuss their effectiveness as a clinical point of view, as many of these approaches are still under clinical test or even unfortunately they have never reached that step. The goal is to show, as an engineering point of view and technological approach, the solutions given in these years by the electronic and optics researches to the problem of improving the vision of LV people.

The structure of the chapter will be as follows:

- An introductory part of background showing the problem and possible technological solutions, divided into:
  - A background and statement of the problem: the goal is to understand how the people with these disabilities perceive the world, in order to understand how we as engineers can send the information that is lost.
  - A review of some image processing advances will be made, bearing in mind that any algorithm used in this kind of technique needs to be not only as robust as to be implemented in normal operation, but also as fast and simple as to be used on real time applications.
  - A summary of what electro-optic materials can help to physically develop the task concerning the previous point: liquid crystal devices, electrochromic materials specially stressed.
  - A review of some electronic devices that have been developed maybe for other tasks but can be used in this area, such as head mounted displays, special glasses with projection systems towards the eye, etc.
- A second part with an account of the specialized engineering research applied to LV people, stressing the points related with:
  - The use of head mounted displays and the implementation of algorithms in them.
  - The technique of multiplexing information in the patient field of view, superimposing the real world to the processed images.
  - The use of electronic prosthetic devices for artificial vision.
  - The use of special electrochromic filters.
- A final discussion on the points to be considered in the near future to develop more successful devices, taking into account the problems that are usually found in the exposed ones.

BACKGROUND: THE PROBLEM, ELECTRONIC DEVICES, AND IMAGE PROCESSING APPLIED TO VISION

Statement of the Problem: How a Low Vision Person can be helped by Electro-Optical Technologies.

The most up to date study of WHO (World Health Organization, 2010) estimates that the number of people in the world with some kind of visual impairment is 285 million, with 246 million of these in a partially sighted or LV condition (See Figure 1). Giving that 65% of them aged over 50 years, it is also a problem of a great concern, particularly in most Western countries, where the life expectancy is higher. In this work, we are focusing in persons with LV because the electro-optical aids aim at enhancing their remaining vision.

The top three causes of visual impairment are uncorrected refractive errors, cataracts and glaucoma, followed by age-related macular degeneration. Nevertheless, a decreased prevalence of