ABSTRACT

Vision is the prime sensory modality among the human senses to gain knowledge about the surrounding world. It provides a feedback mechanism for balanced interaction with the environment, and plays a vital role in sensory integration. Vision loss brings a major challenge for living a normal daily life. It can adversely affect one's quality of life in terms of social, psychological, physical and independent performance. According to World Health Organization (WHO), there are 285 million visually impaired people worldwide of whom 39 millions are blind. Most visually impaired people prefer a long white cane or guide dog as an assistive tool to attend their daily-life mobility activities. However, both white cane and guide dog provide short range information, and cannot detect overhanging obstructions. The advent of technology has contributed many electronic travel aids (ETAs) for assisting mobility difficulties of visually impaired people. These ETAs provide spatial feedback to the subject via non-visual senses, primarily hearing and touch. However, a very few ETAs have succeeded to attract potential users. This does not mean that visually impaired people are not interested in technology aids; rather it highlights the need of research to improve their usability and acceptability. Usable functions, information overload, complex user interface and poor aesthetics are major concerns for majority of ETAs.

This thesis presents need assessment driven development of three novel assistive systems for augmenting mobility of visually impaired people. The first system is a multisensory *electronic mobility cane* (EMC) that is able to (i) construct a logical map of the surrounding environment, and (ii) interpret, categorize and prioritize situation specific details of the environment. The second mobility aid is implemented in the form of an *electronic bracelet* and *vision enabled waist-belt* (EBVB). This system detects the possible path and obstacle distribution on the path. The third system, *the Path Sarathi* (PS), exploits a *vision based smart clothing* approach and provides reliable assistance for mobility as well as orientation. These above mentioned prototype systems provide a simplified representation of the surrounding environment without causing information overload to the subject. The overall design of these assistive systems underlines the inclusiveness of anthropometry, physical and psychological aspects of potential users.

The three assistive systems proposed in this thesis were subjected to series of clinical evaluations in order to verify their design and to assess their ability to assist the subjects in their daily-life mobility. Clinical evaluations were performed with totally blind and low vision subjects. All subjects walked in controlled and the real-world test environments with the proposed aids and the traditional white cane. The evaluation results and significant scores of subjective measurements have shown the usefulness of the proposed aids in vision rehabilitation services.

Keywords: *Electronic travel aid, assistive technology, vision rehabilitation, visually impaired.*