2 Perception, the Eye and Assistive Technology Issues

Learning Objectives

The sense of sight results from the detection and processing of visual information in the eye, and the visual areas of the brain to which it is transmitted in the form of electrical signals by the optic nerve. One of the distinctive aspects of the sense of sight is the ability to use it to obtain an overview of a situation or scene. This involves the processing of very complex information and the formation of visual maps in the brain. Other features of the sense of sight include the ability to understand and interpret both moving and still images and to perceive both two and three-dimensional objects. Unfortunately the mechanisms of visual processing in the brain and the detailed functions of its different visual areas are still not fully understood.

The chapter comprises five sections, followed by a chapter summary and projects. The opening section, Section 2.1, introduces an overview of perception and seeks to place the sense of sight in this context. A description of the physiology of the visual system then follows in the next section. After the presentation of the main structures of the eye, the focus turns to the retina and the subsequent processing by the nervous system and the brain. Section 2.4, entitled Vision in Action, discusses how the eye accomplishes operations such as image formation, accommodation to focus on objects at different distances and colour vision. Section 2.5 discusses visual impairment and assistive technology design, including the demographics of visual impairment, the main different types of visual impairments and the use of corrective lenses.

The main aim of the chapter is to give an understanding of the main components and functions of the visual system, as well as some of the different types of visual impairments. Specific learning objectives include the following:

- Understanding the context of vision in human perception.
- Knowledge of the main structures of the eye and their functions.
- A basic overview of the visual processing system in the brain.
- Understanding of the activities carried out by the visual system, including spatial form processing, binocular vision, motion detection and colour vision.
• Knowledge of some of the different types of visual impairments and the use of corrective lenses for the common impairments in focussing, such as myopia, hyperopia and astigmatism.

2.1 Perception

2.1.1 Introduction

Perception is the process of obtaining, selecting, interpreting and organising sensory information. In addition to its other functions, this sensory information can be used to support motor activity. Perception can be divided into the following two categories:

• Exteroception or the perception of information from external stimuli.
• Interoception or the perception of information from stimuli within the body. This includes proprioception or awareness of changes in body position and movement of the body and the vestibular system that detects movement and changes in the position of the head.

It is mainly the exteroceptive and proprioceptive systems that are relevant to assistive technology, although there may be a role for the vestibular system. Thus, interoceptive systems are not discussed further here.

The exteroceptive systems can be categorised as:

• Distant senses: vision, hearing and olfaction (smell).
• Contact (or near) senses: tactile system and gustation (taste).

The distinction between distant and contact senses is very important in the context of both sensory processing and assistive technology. It affects the search strategies that can be used to obtain environmental information and the type and extent of information that can be obtained. In addition the distant senses are, in principle, able to obtain an overview of a scene, whereas the contact senses can only obtain information from the part of the scene with which contact can be made. Gustation is probably inappropriate for use in assistive devices, due to the social unacceptability of investigating objects by sticking out the tongue and the possibility of damage to it or unfortunate reactions if objects are brought into the mouth. The strength of olfaction and the ability to use it to identify objects are very variable between different people and olfaction is currently not used in any assistive devices. This leaves hearing and touch as the main senses that blind people can use to obtain external sensory information to complement their sense of sight.

Both hearing and sight are able to process complex information obtained from a wide spatial area and process several items of information simultaneously. However, there are also significant differences. In particular, auditory information is generally sequential, whereas visual information can be either sequential or simultaneous. The ability of the visual system to process simultaneously a large quantity