P1 / **MOBILE COLLABORATION**
The app synchronized his contributions with everyone else's

P2 / **NANOSTRUCTURED CARBON COMPOSITES**
New techniques to nanostructure carbon fibres for novel composites

P3 / **SCREENLESS DISPLAY**
Holographic colour video display with the resolution of a standard TV.

P4 / **THE REAL 4G**
Such breakthroughs could give networks some 30 times as much capacity as LTE-Advanced.

NEW HORIZON COLLEGE OF ENGINEERING

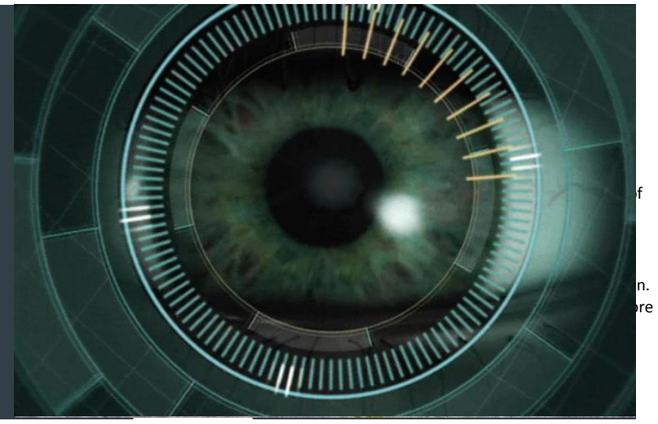
USABILITY & HUMAN COMPUTER INTERACTION

EMERGING TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

UHCI / Q4 / JUNE 2016

Eye Tracking and Eye-Based Human Computer Interaction



The first generation of eye tracking devices was highly invasive and uncomfortable. A breakthrough in eye tracking technology was the development of the first "non-invasive" eye tracking apparatus in the early 1900s (Wade and Tatler 2005), based on photography and light reflected from the cornea. It can be considered as the first ancestor of the current widely used video-based, corneal reflection eye tracking systems. The development of unobtrusive camera-based systems (Morimoto and Mimica 2005) and the increase of computing power enabled gathering of eye tracking data in real time, enabling the use of gaze as a control method for people with disabilities (Ten Kate et al. 1979; Friedman et al. 1982). Since then, eye tracking has been used in a wide range of application areas, some of which are reviewed later in this chapter. Using the eye as as input method has benefits but also some considerable challenges. These challenges originate from eye physiology and from its perceptive nature.

Eye Physiology and Types of Eye Movement

To see an object in the real world, we have to fixate our gaze at it long enough for the brain's visual system to perceive it. Fixations are often defined as pauses of at least 100 ms, typically between 200 and 600 ms. During any one fixation, we only see a fairly narrow area of the visual scene with high acuity. To perceive the visual scene accurately, we need to constantly scan it with rapid eye movement, so-called saccades. Saccades are quick, ballistic jumps of 2° or longer that take about 30-120 ms each (Jacob 1995).

Eye tracking has a long history in medical and psychological research as a tool for recording and studying human visual behavior. Real-time gaze-based text entry can also be a powerful means of communication and control for people with physical disabilities. Following recent technological advances and the advent of affordable eye trackers, there is a growing interest in pervasive attention-aware systems and interfaces that have the potential to revolutionize mainstream human-technology interaction. We dicuss challenges involved in using a perceptual organ, the eye, as an input modality. Examples of real life applications are reviewed, together with design solutions derived from research results. We also discuss how to match the user requirements and key features of different eye tracking systems to find the best system for each task and application.

The eye has a lot of communicative power. Eye contact and gaze direction are central and very important cues in human communication, for example, in regulating interaction and turn taking, establishing socio-emotional connection, or indicating the target of our visual interest (Kleinke 1986). The eye has also been said to be a mirror to the soul or window into the brain (Brigham et a1.2001; Ellis et al. 1998). Gaze behavior reflects cognitive processes and can give hints of our thinking and intentions. We often look at things before acting on them (Land and Furneaux 1997).