CSC 406 Lecture Series (4), ABUAD

Human Input-Output Channels

Input Output channels

A person's interaction with the outside world occurs through information being received and sent: input and output. In an interaction with a computer the user receives information that is output by the computer, and responds by providing input to the computer – the user's output become the computer's input and vice versa. Consequently the use of the terms input and output may lead to confusion so we shall blur the distinction somewhat and concentrate on the channels involved. This blurring is appropriate since, although a particular channel may have a primary role as input or output in the interaction, it is more than likely that it is also used in the other role. For example, sight may be used primarily in receiving information from the computer, but it can also be used to provide information to the computer, for example by fixating on a particular screen point when using an eye gaze system.

Input in human is mainly though the senses and output through the motor control of the effectors.
There are five major senses:

• Sight
• Hearing
• Touch
• Taste
• Smell

Of these first three are the most important to HCI. Taste and smell do not currently play a significant role in HCI, and it is not clear whether they could be exploited at all in general computer systems, although they could have a role to play in more specialized systems or in augmented reality systems. However, vision hearing and touch are central.

Similarly there are a number of effectors:
• Limbs
• Fingers
• Eyes
• Head
• Vocal system.

In the interaction with computer, the fingers play the primary role, through typing or mouse control, with some use of voice, and eye, head and body position. Imagine using a personal computer with a mouse and a keyboard. The application you are using has a graphical interface, with menus, icons and windows. In your interaction with this system you receive information primarily by sight, from what appears on the screen. However, you may also receive information by ear: for example, the computer may 'beep' at you if you make a mistake or to draw attention to something, or there may be a voice commentary in a multimedia presentation. Touch plays a part too in that you will feel the keys moving (also hearing the 'click') or the orientation of the mouse, which provides vital feedback about what you have done. You yourself send information to the computer using your hands either by hitting keys or moving the mouse. Sight and hearing do not play a direct role in sending information in this example, although they may be used to receive information from a third source (e.g., a book or the words of another person) which is then transmitted to the computer.

Vision

Human vision is a highly complex activity with range of physical and perceptual limitations, yet it is the primary source of information for the average person. We can roughly divide visual perception into two stages:

• the physical reception of the stimulus from outside world, and

• The processing and interpretation of that stimulus.

On the one hand the physical properties of the eye and the visual system mean that there are certain things that cannot be seen by the human; on the other interpretative capabilities of visual processing allow images to be constructed from incomplete information. We need to understand both stages as both influence what can and cannot be perceived visually by a human being, which is turn directly affect the way that we design computer system. We will begin by looking at the eye as a physical receptor, and then go onto consider the processing involved in basic vision.

The human eye

Vision begins with light. The eye is a mechanism for receiving light and transforming it into electrical energy. Light is reflected from objects in the world and their image is focused upside down on the back of the eye. The receptors in the eye transform it into electrical signals, which are passed to brain. The eye has a number of important components. Let us take a deeper look. The cornea and lens at the front of eye focus the light into a sharp image on the back of the eye, the retina. The retina is light sensitive and contains two types of photoreceptor: rods and cones.

(1) Rods

Rods are highly sensitive to light and therefore allow us to see under a low level of illumination. However, they are unable to resolve fine detail and are subject to light saturation. This is the reason for the temporary blindness we get when moving from a darkened room into sunlight: the rods have been active and are saturated by the sudden light. The cones do not operate either as they are suppressed by the rods. We are therefore temporarily unable to see at all. There are approximately 120 million rods per eye, which are mainly situated towards the edges of the retina. Rods therefore dominate peripheral vision.

(2) Cones

Cones are the second type of receptor in the eye. They are less sensitive to light than the rods and can therefore tolerate more light. There are three types of cone, each sensitive to a different wavelength of light. This allows colour vision. The eye has approximately 6 million cones, mainly concentrated on the fovea.

(i) Fovea

Fovea is a small area of the retina on which images are fixated.

(ii) Blind spot

Blind spot is also situated at retina. Although the retina is mainly covered with photoreceptors there is one blind spot where the optic nerve enters the eye. The blind spot has no rods or cones, yet our visual system compensates for this so that in normal circumstances we are unaware of it.

(ii)Nerve cells

The retina also has specialized nerve cells called ganglion cells. There are two types:

X-cells

These are concentrated in the fovea and are responsible for the early detection of pattern.

Y-cells

These are more widely distributed in the retina and are responsible for the early detection of movement. The distribution of these cells means that, while we may not be able to detect changes in pattern in peripheral vision, we can perceive movement.

Visual perception

Understanding the basic construction of the eye goes some way to explaining the physical mechanism of vision but visual perception is more than this. The information received by the visual apparatus must be filtered and passed to processing elements which allow us to recognize coherent scenes, disambiguate relative distances and differentiate colour. How we perceive size and depth, brightness and colour is crucial to the design of effective visual interfaces.

Perceiving size and depth
Imagine you are standing on a hilltop. Beside you on the summit you can see rocks, sheep and a small tree. On the hillside is a farmhouse with outbuilding and farm vehicles. Someone is on the track, walking toward the summit.

Perceiving brightness
A second step of visual perception is the perception of brightness. Brightness is in fact a subjective reaction to level of light. It is affected by luminance, which is the amount of light emitted by an object. The luminance of an object is dependent on the amount of light falling on the object's surface and its reflective prosperities. Contrast is related to luminance: it is a function of the luminance of an object and the luminance of its background.

Although brightness is a subjective response, it can be described in terms of the amount of luminance that gives a just noticeable difference in brightness. However, the visual system itself also compensates for changes in brightness. In dim lighting, the rods predominate vision. Since there are fewer rods on the fovea, object in low lighting can be seen easily when fixated upon, and are more visible in peripheral vision. In normal lighting, the cones take over.

Perceiving colour
A third factor that we need to consider is perception of colour. Colour is usually regarded as being made up of three components:

- hue
- intensity
- saturation

Hue
Hue is determined by the spectral wavelength of the light. Blues have short wavelength, greens medium and reds long. Approximately 150 different hues can be discriminated by the average person.
Intensity
Intensity is the brightness of the colour.
Saturation
Saturation is the amount of whiteness in the colours. The eye perceives colour because the cones are sensitive to light of different wavelengths.

Colour Theory
Colour theory encompasses a multitude of definitions, concepts and design applications. All the information would fill several encyclopedias. As an introduction, here are a few basic concepts.

Primary Colours
In traditional colour theory, these are the 3 pigment colours that cannot be mixed or formed by any combination of other colours. All other colours are derived from these 3 hues: Red, yellow and blue
Secondary Colours
These are the colours formed by mixing the primary colours: Green, orange and purple
Tertiary colours
These are the colours formed by mixing one primary and one secondary colour.
Yellow-orange, red-orange, red-purple, blue-purple, blue-green and yellow-green.

Colour Harmony
Harmony can be defined as a pleasing arrangement of parts, whether it be music, poetry or colour. In visual experiences, harmony is something that is pleasing to the eye. It engages the viewer and it creates an inner sense of order, a balance in the visual experience. When something is not harmonious, it's either boring or chaotic. The human brain rejects what it cannot organize, what it cannot

understand? The visual task requires that we present a logical structure. Colour harmony delivers visual interest and a sense of order.

Some Formulas for Colour Harmony
There are many theories for harmony. The following illustrations and descriptions present some basic formulas.

Analogous colours
Analogous colours are any three colours, which are side by side on a 12 part colour wheel, such as yellow-green, yellow, and yellow-orange. Usually one of the three colour predominates.

Complementary colours
Complementary colours are any two colours, which are directly opposite each other, such as red and green and red-purple and yellow-green. In the illustration above, there are several variations of yellow-green in the leaves and several variations of red-purple in the orchid. These opposing colours create maximum contrast and maximum stability.

Natural harmony
Nature provides a perfect departure point for colour harmony. In the illustration above, red yellow and green create a harmonious design, regardless of whether this combination fits into a technical formula for colour harmony.

Colour Context
How colour behaves in relation to other colours and shapes is a complex area of colour theory.

Red appears more brilliant against a black background and somewhat duller against the white background. In contrast with orange, the red appears lifeless; in contrast with bluegreen, it exhibits brilliance.

As we age, the colour of lens in eye changes. It becomes yellow and absorbs shorter wavelengths so the colours with shorter wavelength will not be visible as we aged. So, do not use blue for text or small objects. As we age, the fluid between lens and retina absorbs more light due to which eye perceive lower level of brightness. Therefore older people need brighter colours.

Different wavelengths of light focused at different distances behind eye’s lens this require constant refocusing which causes fatigue. So, be careful about colour combinations. Pure (saturated) colours require more focusing then less pure. Therefore do not use saturated colours in User interface unless you really need something to stand out (danger sign).

Guidelines
- Opponent colours go well together (red & green) or (yellow & blue)
- Pick non-adjacent colours on the hue circle
- Size of detectable changes in colour varies. For example, it is hard to detect changes in reds, purples, & greens and easier to detect changes in yellows & bluegreens
- Older users need higher brightness levels to distinguish colours
- Hard to focus on edges created by colour alone, therefore, use both brightness & colour differences
- Avoid red & green in the periphery due to lack of RG cones there, as yellows & blues work in periphery
- Avoid pure blue for text, lines, & small shapes.
- Blue makes a fine background colour
- Avoid adjacent colours that differ only in blue
- Avoid single-color distinctions but mixtures of colours should differ in 2 or 3 colours., 2 colours shouldn’t differ only by amount of red