Psychology Documentation

- HOME > MOTION

MOTION

Contents [hide]

Introduction

Our ability to detect motion serves a critical role in our understanding of the worlds we interact with in virtual reality.

Careful manipulations of motion properties can have a huge influence on the emotional context we attribute to our surroundings. It can also directly change the emotional impact of an experience. This is relevant to both simplistic single object movements and large scale motionscape patterns made up of hundreds if not thousands of elements.

Core functions of motion detection

Spatial awareness and physical judgement

The ability to perceive and predict object trajectory such as a vehicle or football allows us to avoid or intercept these objects accordingly. In the VR game Audioshield our ability to predict the end point of moving orange and blue balls means we can intercept with the appropriate shield (most of the time).

Audioshield first look, VR mixed-reality

Motion detection in Audiosheild

Animacy

We also gain an understanding of an objects’ animacy and behavioural characteristics from motion. In virtual environments a ball can move either because it has been forced to or it can move of its own accord. A ball which moves simply because it has been hit is perceived as a normal, lifeless object. In contrast a ball which moves by itself is able to embody a sentient presence with personality traits and values.

Heider and Simmel (1944) were the first to demonstrate that animations of simple geometric shapes interacting with one another can elicit the perception of animacy, as well as more complex social behaviours such as chasing, cowering and protecting.

Heider & Simmel animation 1944 SD

Heider & Simmel animation (1944)

Further investigations have found that shape motions are capable of portraying behaviours such as intentionality (Gergely, Nadasdy, Csibra, & Biro, 1995), and helping or hindering (Kuhlmeier, Wynn, & Bloom, 2003).

Basic motion properties convey emotion

As with behaviours, basic geometric shapes have been shown to convey specific emotions during various simple motion pathways. Emotions such as kindness and fearfulness (Rime et al., 1985), aggressiveness and anxiety (Lethbridge & Ware, 1989), and relaxed, determined and alert (Tagiuri, 1960) have all been demonstrated in this way.

The emotions which we associate with motion depends primarily on speed, direction and pathway.

Speed

Fast moving objects are associated with intense emotions such as angry, excited, strong and happy (Pollick et al., 2001). In comparison, slow motions can be associated with calm, relaxed sad or bored.

The motion speed of objects also provides an immediate indication of their weight, size and the force exerted on them (Bacigalupi, 1998; Lassiter, 1987).

Pathway/trajectory

Motion pathway is another important indicator of an objects’ emotional properties. Traguiri (1960) was first to compare the emotional associations we have to certain trajectories.

Straight, arched, angular and meandering motion pathways studied by Traguiri (1960)

Straight motions were perceived as determined, alert, aggressive, and purposeful while arch-like paths were perceived as unhurried, unsure, happy, and relaxed. Meandering paths were perceived as immature, confused, upset, and curious.

The author found that angular motion pathways conveyed emotional content depending on the direction of the angles, either towards or away from a goal. Pathways with just approach angles are considered direct or purposeful whereas those consisting of both approach and avoidance angles portray approach with caution or hesitation.

Direction

Nakatini (2009) foudn that upward motions tend to be rated as more pleasant, whereas downwards motions are considered more negative. In part, the author attributes this to the common phrases “feeling down” or “feeling low”.

Direction also plays a vital role in drawing our attention and portraying approach and avoidance behaviours.

In 2D environments, movement towards the right is perceived to have forward momentum while movement to the left implies a reversal of time or feeling of losing ground (Bacigalupi, 1998). Whilst unlikely to be reflective of 3D environments in virtual reality, this awaits further validation.

Motionscapes – evoking emotions through motion

A motionscape is a visual phenomenon composed of a large amount of coordinated objects with shared motion properties. Examples can be seen in nature, such as birds that fly in a flock or fish that swim in a school. We can see similar movement patterns when snowflakes or leaves are blown in the wind.

Motion-emotion research has naturally evolved over time. Advancing on evidence using 2D object motions (Bartram & Nakatani, 2010 & Mancini et al, 2007), motion has been investigated in the context of motionscapes, suggesting that exposure to large scale motion patterns in virtual environments can have a significant impact on our emotions.

Both 3D simulations (Feng, Bartram, & Riecke, 2014) and virtual reality environments (Feng, 2014) have been used to study such effects. The end result is a range of key motion properties, expanding on the properties of speed, direction and pathway to include shape and view point.

Shape

The shape of motionscapes can be *linear* or *non-linear*. Linear motionscapes involve objects moving almost parrallel and in unison, towards the same direction. Non-linear motionscapes revolve around a centre or axis point, following a multitude of different trajectories.

Linear

linear motionscapes are generally less intense, threatening and create less urgency compared to non-linear motionscapes. They are used most effectively to produce calming, relaxing and reassuring effects through ambience.

Consider however the dramatic change in effect which can occur in linear motionscapes through simple changes in speed and direction.

Non-linear

Non-linear motionscapes include spherical, circular and radial motion patterns. These are commonly associated with greater intensity, urgency and threats. The art installation 'Submergence' provides a great example of this at 4:04 in the video.

Spherical motionscapes are found to be the most exciting. They are often used as a method to indicate highly intense experience and emergency. Circular motionscapes are an effective way to guide user attention to specific locations.

Spherical

Circular

Radial

Point of view

When considering the use of different motionscapes within VR, the view point of the user is critical to the resulting emotional response. Motionscapes can be viewed either from outside or from within.

Feelings of intensity, urgency and threats become amplified when motionscapes are viewed from within.

The view point is also a critical factor when considering the direction of moving objects.

Outside viewpoint (Feng, Bartram, & Gromola, 2017)

Inside viewpoint (Feng, Bartram, & Gromola, 2017)

Speed

Above all other components, speed most consistently predicts the calming/energising effects of motion. This includes the average movement speed of objects, the rate of acceleration and the amount of accelerations which take place.

Faster speeds tend to be more exciting, negative, urgent and threatening. Whereas slower motions produce greater feelings of calm, relaxation, sadness and boredom.

Direction

Up/down

The general findings indicate that downward motions tend to be more calming and upward motions tend to be more exciting. These findings are attributed to references of nature, for instance with the universal effects of gravity predicting a normal movement pattern falling downwards towards the ground. As opposed to upwards movement patterns which are strikingly abnormal and considered exciting as a result.

In/out

The direction of motion has a different affect depending on the user's point of view. When a user is placed within a motionscape, particles moving inwards towards the viewer can be perceived as threatening. If a user is viewing a motionscape from outside the motionscape and the motionscape is directed towards a centre, it can be used to guide the user's attention.

Spherical motionscapes moving outwards towards the viewer can give an intense and exciting impression of moving forward. This sensation of moving forwards is utilised in Starfield, yet by using a linear motionscape with slower motion speeds, the experience has a more calming effect.

Pathway/trajectory

Straight motion patterns are typically perceived as more calming, compared to wavy or angular motion pathways. However, wavy patterns representing natural features, such as wind or snow, can also be perceived as calming.

(Lockyer & Bartram, 2012)

(Feng, Bartram, & Gromola, 2017)

Motionscape examples – art installations

Motionscapes have been incorporated within art installations for their affective qualities.

Submergence

Submergence is an interactive installation by Squidsoup which combines motion, colour and light to provide a compelling emotional experience. Users are taken on a journey through four different sections, with progressive changes in tension and curiosity.

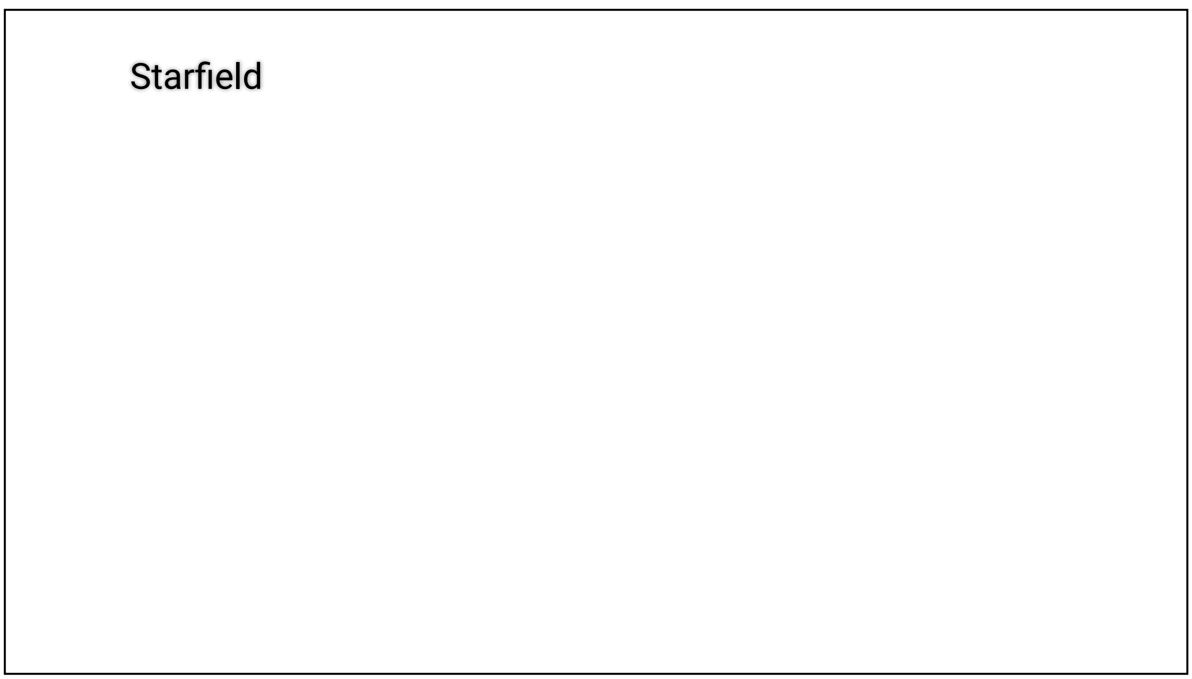
The installation builds up towards a final climax beginning at 4:04 in the clip below. The intensity of this sections is evident through fast, spherical motion pathways, bright pulsating lights and a euphoric yet uplifting electronic feel to the music.

Motionscapes are utilised through the transition of coloured lighting across 3 dimensions allowed by suspended light structures. With the use of Kinect sensors, light and motion responds to the movement of the user.

Submergence installation by Squidsoup, Oslo (2013)

Starfield

Starfield is an interactive installation by Lab 212 designed to create a calming environment. The linear motionscape (stars) moves toward the user at an incremental rate in response to swinging forwards. The end result is a surreal yet relaxing sensation of moving forwards in space.



Starfield installation by Lab 212

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