**Analysis of extended realities - Fred Bancan**

**Outline**

“Extended realities” describe a feature of digital media which allow the user to interact and manipulate with a simulated physical environment which only has influences within the domain of the digital media and/or program.

Examples of Extended Realities:

* 2D and 3D spatial interactive videogames.
* 3D game asset modeling software
* 3D schematic design software
* Medical 3D scan result viewing software
* 3D art sculpting software
* 3D virtual reality video games
* Simulations for high-risk professional training such as military, medical, machinery operation and specialized vehicle piloting simulations
* Simulations for scientific research purposes

Virtual Reality outline

The term “Virtual reality” or “VR” is an extended form of “Extended reality” in which the user is given the ability to interact with the applications’ reality and space while simulating the absence of the barrier of human to digital interaction (e.g., keyboards, mice, monitors, speakers), allowing the user to interact with the Extended Reality naturally and seamlessly as if they physically existed in it.

Current VR user input technology is primarily composed of headsets and motion controls which are attached to the user. The user must operate these controls with their natural physical movements such as turning of the head and movement of the arms, hands and even fingers. These natural movements are detected and translated into the application in a way to simulate direct physical presence in the Extended Reality. Future VR user input technology may further improve the quality of user physical integration simulation, however the concept of VR and its many possibilities/uses/potentials are already well understood and researched.

Augmented Reality outline

The term “Augmented reality” or “AR” is an extended form of “Extended reality” in which the application’s Extended reality is based on, or is determined by, the users’ reality/physical environment. The user can observe this interaction and can interact with the Extended reality based on their natural environment which, similarly to VR, provides a seamless and natural experience for the user by creating the illusion that their reality, and the Extended reality, are merged.

**Extended Reality use cases in current digital media**

Since extended realities are based on the natural logic and properties of the (presumably) human users’ physical reality, they allow for natural, effective, intuitive, and immersive user input/feedback. If the application includes his quality of user interaction is highly difficult to achieve without the implementation of an Extended Reality environment.

Extended Reality use case examples:

* **PC games** – The PC platform provides the raw computational power and flexibility to allow for games to be developed with realistic and interactive real-time Extended Realities. This provides opportunity for game developers to create immersive and highly interactive environments for player enjoyment and storytelling. Both VR and AR are applicable to the PC platform for the same reasons and can be even more effective by improving the immersion of the environment and improving how intuitive the users’ input controls are. There is also a bonus of increasing the appeal of the game, especially over games which do not include VR or AR technology.
* **Mobile games** – While the mobile platform has the technical limitations of inferior computational power and user input flexibility (compared to the PC platforms and Console platforms), it has the advantage of portability and availability (due to most potential users having the mobile platform). Games created for mobile can still take advantage of Extended Realities in the same way PC games do, but it is limited by processing power and input options. Despite computational and input limitations, VR and AR can be implemented into the Mobile platform quite well due to the native presence of a camera, motion sensor, microphone, and high-resolution display. For example, VR Headsets are available which are designed for the use with a smart phone by attaching a wearable headset to the phone with goggles and speakers. The mobile platform does not usually support peripherals however, so extended reality games, including VR and AR games, must utilize the limited input controls of the mobile platform (volume and home buttons, touch screen, and motion sensor).
* **Simulation** – Extended Realities are especially useful for creating accurate and effective simulations for both training and researching purposes. Extended reality environments can be created with variables which resemble a real-life scenario which has not happened or can not be realistically replicated without the help of a digital media. This simulation can then be studied, and the results can help to prepare for such scenario if it were to occur in real life. Simulations utilizing Extended Realities can allow for interactive training applications in fields which see life-threatening or expensive situations which could not be reasonably replicated in a safe real-life training environment. VR and AR can be utilized to further simulate the real-life aspects of such situations, allowing the trainee to experience and physically adapt to the scenario without the risk of injury, expense, fatigue, and over-stimulation.
* **Medical** – Forms of Extended Reality can prove to be extremely useful for certain medical procedures where traditional direct techniques would prove very dangerous and expensive. AR especially comes forward with its ability to assist surgeons in making the correct decisions and precise actions in accordance with electronic surgery devices. AR can assist the surgeon in properly understanding the anatomy of a patient and interacting with digital surgery tools such as robotic devices for creating extremely small and precise incisions and implants. As well as small camera-mounted robotic devices for inspecting and probing vital organs and/or injuries.

**Physiological constraints of Extended realities**

Due to the nature of Extended Realities and user input, there are certain physiological constraints which commonly occur. Depending on the Extended Realities’ features (VR, 3D, First-Person perspective), and the peripherals used for user input, the physiological constraints experienced by the user may vary, as well as their intensities. This also depends on any pre-existing conditions or sensitivities the user may have, such as motion sickness or poor vision.

Common Physiological constraints:

* **Disorientation** – Users, especially ones who have not previously acclimated to Extended Reality based applications, will typically experience disorientation. This is because the user will perceive the Extended Reality naturally as they do with real life (primarily if it is first person and 3D), however they will not be able to naturally interface with the application as seamlessly as moving their eyes, body, and head as they do in real life, causing the user to become disorientated within the virtual environment. This will differ depending on the set-up and quality of the peripherals used for the application. For example, a high-quality VR headset and motion controls will allow nearly any user to seamlessly interact with the virtual environment.
* **Physical/Spatial Restriction** – As Extended Realities are simulated spatial environments within digital media, there will typically be limits on how much freedom the user has in terms of movement. For example, in games where the user moves a virtual character/avatar using either standard peripherals (controllers, keyboard, mouse), or VR controls (motion tracking and headset), there will usually be restrictions in where the character/avatar can move or what they are allowed to physically do. The most common restriction is virtual environments which are contained within a set area of which the user can not explore further, but “Open World” games and “Procedurally Generated” games can remedy this to an extent. For VR, the biggest physical/spatial constriction is for the user in the real world. This is because VR uses real-life motion of the user for control input, which means they are limited by the size of the room they are in, the range of the wireless connection of their peripherals, any cables connected to their peripherals, and any real-world geometry which may impede their movement.

Differing Physiological constraints of VR platforms:

With VR platforms being supplied by different brands/companies, there will be differing Physiological constraints for the user. Some examples of current popular platforms, and their constraints, include:

* **Oculus** **(Oculus Quest)** – Despite being a modern platform with high-quality motion sensing controls on the headset and hand-held controls, the Oculus Quest is restricted in flexibility and computational power due to it being a mobile-based VR platform. This can result in performance issues while being used, which can further disorientate the user, or cause delays in user input. The Oculus Quest also has an ergonomic restriction due to it being a rather heavy peripheral which must be controlled by the users’ head movements.
* **Steam VR / Valve Index** – The Valve Index is a high-end, pc-based VR platform with very seamless input for the user, implementing motion controls based on the users’ head, body, hands, and finger movements. The Valve Index is a very flexible and performant platform due to its use of the pc platforms’ raw computational power. The main constraint of the Valve Index is the use of cables attached to the users’ headset which can lead to physical/spatial restriction.

**HUD and UI design for Virtual Reality based games**

Unlike traditional HUD and UI design which could be interfaced with a mouse cursor and/or keyboard input, VR based games require designs which use motions of the users’ head and/or hands to interface with the UI and HUD. The HUD and UI must also be designed around to accommodate for the nature of VR games, specifically the user having their entire field of view taken up by the display of the game.

UIs in VR based games require special considerations when designing user input and layout. With the absence of a mouse cursor, it may be difficult for a user to precisely click on buttons or adjust dials. At the same time, UIs which require the user to make many head movements to aim a crosshair/cursor can lead to fatigue or disorientation. UIs which utilize hand movements are therefore more ergonomic in comparison, however, not all VR platforms support motion detection of the users’ hands. The UI must be designed around both the application and the platform available to the user to provide an intuitive and ergonomic experience.

HUDs in VR based games may not require interaction from the user, however the layout and visual design of the HUD is very important for user readability and comfort. A HUD which is difficult to see may prove confusing or distracting for the user, however a HUD which occludes large areas of the users’ field of view, or contains harsh/bright colors in its elements, can be even more distracting. A balance must be met where relevant information is displayed to the user in an accessible fashion, but without distracting from the visual experience.

**Haptic Feedback and Extended Realities**

Haptic Feedback describes the use of physical/touch sensory feedback to the user. Haptic feedback can be used for almost everything in Extended Reality based applications, however selective use can improve how intuitive the experience is for any user. Depending on the platform used for the application, there may be differing levels of variation in the Haptic Feedback available for the developer. For example, modern smart-phone platforms have very precise and flexible Haptic-Feedback hardware built into them. These can be used to provide different intensities of vibration to the user, and even differing patters in the vibration. The smart-phone platform has the bonus of always being in contact with the fingertips of the user, allowing Haptic Feedback to always be received by the user as intended. Certain console platforms may include Haptic Feedback hardware in their hand-held controllers, allowing for games on these platforms to utilize said hardware. This also means Haptic Feedback hardware is not available on all platforms, which is the determining factor when deciding its use.

Haptic Feedback is most effective when it is designed around intuitive real-world sensory experiences. For example, pressing a button on a real-world appliance typically results in the feeling of a ‘click’ as the button is properly actuated, which communicates to the user that the button was indeed properly pressed. Simulating this phenomenon within an Extended Reality based application with the use of Haptic Feedback gives the user an intuitive and effective response when interacting with elements such as buttons in a UI. This same principle can be applied to environmental events, such as explosions or powerful vehicle engines. Added Haptic Feedback to these events provides an additional level of sensory immersion for the user.