ASSIGNMENT 1

SIT755

Abstract

Investigative report on technical and design aspect in virtual reality. Topics selected:
1. Virtual or Augmented reality hardware components
2. User experience in Virtual reality

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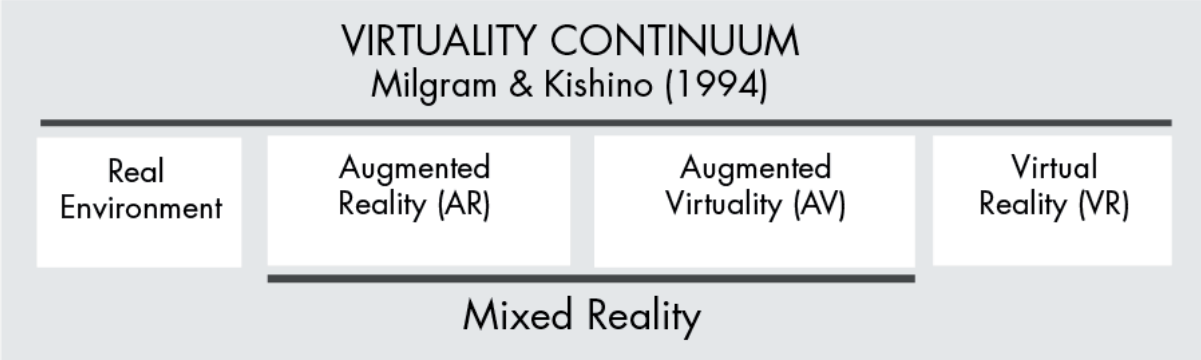
Introduction:

Virtual, augmented or mixed reality are part of the latest generation of ICT (Information and communications technology). Virtual reality (VR) is defined by the essence of being there/being present in a simulated environment. Augmented reality represents holograms which are placed in the real world, unlike virtual reality which is entirely based on the virtual world, augmented Reality has both real and virtual world co-exist.

The key to experience the virtual world involves immersion and interaction provided in the virtual environment. Virtuality continuum states that, in the process of interaction between users and virtual environments, different layers of reality and virtuality are involved (Tamayo, García and Barrio, 2018)



The virtuality continuum
Representation of the virtuality continuum (Tamayo, Garcia and Barrio 2018, fig.1, p.3).

The virtual world can be defined as the set of objects and predefined methods governing the object in imaginary space and virtual environment is part of this virtual world which is in the current view of the consumer of VR **(**Sherman and Craig 2018, p.6**).** The level of immersion is an important aspect of VR as user experience will certainly play an important role in keeping the consumers interested and how the user experience turns out decides whether the consumer would be interested in further consumption of the virtual reality (VR) space. To ensure the user's satisfaction and the user engagement in the VR world, a smooth experience is needed which is ensured through quick feedback on user actions or responsiveness of the system. To support virtual reality applications or functionality, we need to have a system of hardware components with minimum specifications to support the virtual environment, the Head-Mounted Displays (HMDs) (e.g. Oculus Rift, HTC Vive) and other sensors as required by the application (Geforce.co.uk, 2019)**.** According to Leap Motion, an advanced interaction website, until the recent developments in VR space, the digital world was experienced behind glass but with the VR, the digital world is now being connected to reality.

Contents:

Design of a virtual reality system involves the presentation of the virtual world to the user and perception level of the user to the environment, which is critical in terms of user

engagement in the virtual world. Thus, while designing user experience in virtual reality, it is important the understand perceptual capabilities of humans including working of perception and the consequence of the implementation of user experience on perception (illusions, induced emotions etc.) **(**Sherman and Craig 2018, p.109**).** We need to consider factors such as affordance, motion sickness (particularly with HMD), the interactions in virtual environments, the field of view (a virtual environment that can be viewed at a given time), usability etc.

To design user experience and supporting content for virtual reality, we need to have significant computational power which will power development and the processing of the VR applications (Unity, Unreal Engine etc).

The main hardware components for virtual reality are:

- Computation devices (including and not limited to computers, processors, consoles etc):
    - Virtual reality systems demand higher powers than what is needed for regular gaming systems as it involves heavy rendering that is used for creating sensory system contents such as visual, haptic, auditory etc for virtual environments.
    - We need combined computation power of CPU (central processing unit) and GPU (graphics processing unit) with the minimum specification for designing the content and supporting the application graphics and 3D rendering. The minimum specification for supporting VR is dependent on HMD we will be using.
    - For HTC Vive, minimum specifications needed are as following:
        - GPU: Nvidia GeForce GTX1060 or above/AMD Radeon RX 480 or better
        - CPU: Intel i5 4590 or Higher/AMD FX 8350 or better
        - RAM: 4 GB or more

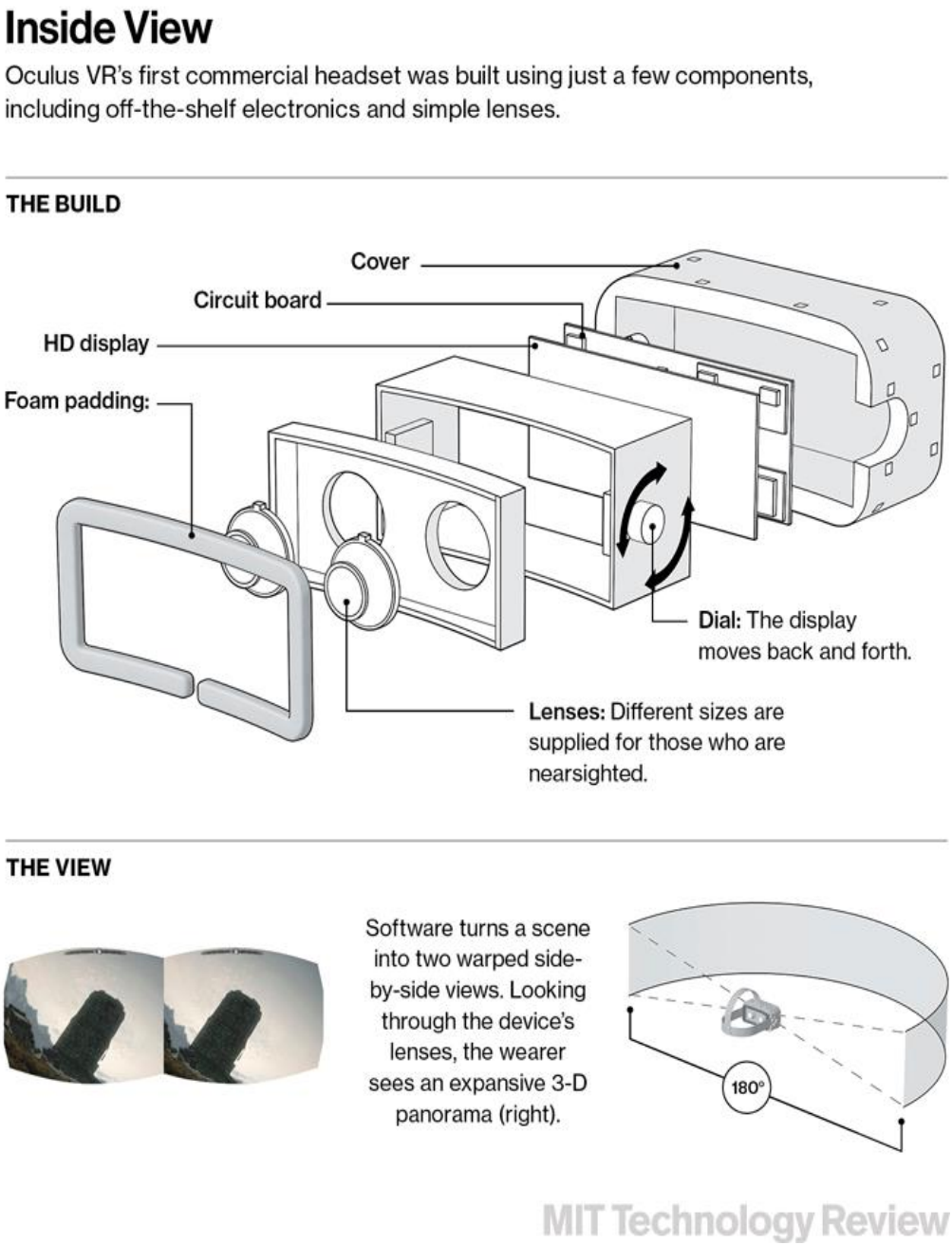
        (Vive.com, 2019)

    - For Oculus Rift, minimum specifications are as following:
        - GPU: Nvidia GTX 1050Ti/ AMD Radeon RX 470 or better
        - CPU: Intel i3 6100/ AMD Ryzen 3 1200, FX 4350 or better
        - RAM: 8 GB or More

      (Oculus.com, 2019)

- Head-Mounted Displays or HMDs:
    - The head-mounted display is providing the VR content view to users covering the field of view of the user. These displays are giving immersion into the VR world to the user as they give a first-person view or Point of view (POV) of the content to users.

- Popular HMDs are HTC Vive, Oculus Rift, Google Daydream, Samsung Gear VR etc. HMDs like Google daydream/Samsung Gear VR utilize smartphone displays.
- The head-mounted display has a set of sensors, lenses, individual eye display and display screen(s). Headphones are usually attached to the HMDs for providing audio simulations. Magnetometers, accelerometers and gyroscopes are most common sensors used in HMDs and they combine by calculations user's motion and direction in space to achieve all degrees of motion an object can move in space freely.
- The Oculus Rift and HTC Vive offer a similar resolution of 1080 x 1200 for each eye and with a refresh rate of 90 Hz, final resolution comes out to be 2160x1200, which helps in preventing motion sickness issue and gives a smooth experience to users. Both Oculus Rift and Vive offer 110 degrees Field of View (FOV). While HTC Vive comes with Vive Controllers, Oculus Rift is packaged with Oculus touch which is used for motion tracking. (Digital Trends, 2019)
- The following image will help understand insights of an HMD, the example given is for Oculus Rift documented by Parkin (2019)



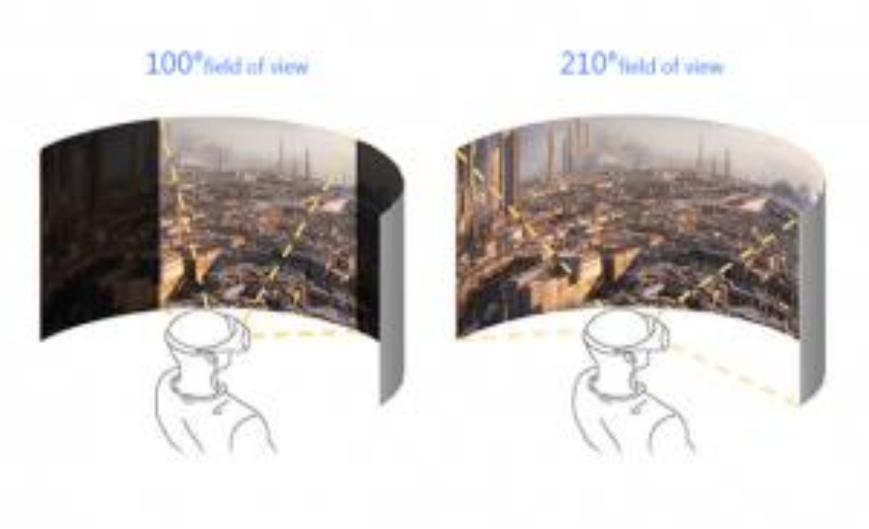
- Input devices
    - For the human brain to accept the virtual world as real, it does not have to look only real, but it should also feel real. Input devices are helping us to track the user actions and movements which helps in achieving the presence in the virtual world.
    - These devices along with head-mounted displays are used to provide a higher level of immersion for the user. The boost in user experience is provided by input devices which convinces the user's brain to view the virtual environment as real and interact with the different objects in the virtual world.

- The input device provides the user with a way to navigate in the virtual environments and give a natural feel of it which helps in better user experience in virtual reality.
- Some of the input devices are as following:
    - Joysticks
    - Tracking balls
    - Controller wands
    - Data Gloves
    - Trackpads
    - Treadmills
    - Motion trackers, platforms
    - Data Gloves

      (Reality Technologies 2019; Sherman and Craig 2018**).**

Interaction design in virtual reality deals with the user interfaces, object mapping and interactions, affordance, constraints etc. in a virtual environment. Affordance in virtual reality can be defined as the interaction between object/element and users, objects that user can interact with, the signifiers which will be used for notifying users with interactive objects. Signifiers or indicators may be auditory or visual or given through haptics. We need to consider the relationship between different elements in VR e.g. if the user can interact with a switch, there should feedback to that action. Ex. Light switches/switchboards etc. In virtual reality, the immersion is based on how real it can feel, so if we design in a way that it interconnects the physical and virtual world, it gives a realistic feel. For example, we should consider physical objects such as walls, rivers, rigid bodies etc. and the interactions should be as real-world ex. we cannot walk through walls or on water, collision effects should be considered (Sherman and Craig, 2018).

Immersion can be mental or physical. Presence (feeling of being present) in virtual reality is achieved through a combination of both the mental as well as physical immersion which is defining characteristic of VR. (Sherman and Craig 2018, p.10**).** Making users feel the presence in the virtual environment is critical to keep users engaged so that they behave as if they are in the real environment. To ensure this we need to consider the scaling of user screens, field of view and appropriate viewing angles, immediate feedbacks and right responses to various actions depending on hardware components we are using. While design user experience in VR, we need to ensure that users are focussed towards the target direction they are supposed to go, to achieve this we can use indicators to redirect users back to hot spots or the area where the action is taking place/will be taking place. Field of view provides users with a realistic perception of their environment, it should be wide as possible to give users a holistic view of the current scenario in the virtual world. Most of the high-end HMDs support viewing angle of 110 degrees which was found to be enough (Reality Technologies, 2019).



Latency in VR refers to the time taken for the image to be displayed on HMD screens against the head rotation of users. Very Low latency ensures that users are seeing the screens appropriately as they move their head in different directions but increase in latency may turn out to be bad user experience as the head movements and the display on the screen won't be in sync and hence disengagement might be the result of the higher latencies. This delay is caused due to hardware as well, hence it should be ensured that the minimum requirements are met for such applications.

Tracking the user movements and giving immediate feedback to it enhances user experience in VR. Motion tracking needs to be accurate and the system should be responsive to the motion of users (ex. Head movements, head movements, lateral movements of user bodies etc). Mismatch in visuals and physical activity may result in motion sickness in VR as compared Augmented reality because in VR, users have HMDs mounted but a mismatch in their actions and feedback from the system might make them feel dizzy as they are given point of view (POV) to a virtual environment, while there body being outside of the virtual space may feel the difference due to immersion. Here, another concept of the Frame rate is considered, which refer to the frequency at which screen refreshes. Usually, TV shows have 30 fps of the frame while console games may have 60 fps of frame rate but to ensure that human perception of the virtual world, we should aim for 90+ fps in the virtual world. Oculus Rift is known to provide a frame rate of 90 fps which make the experience more realistic for users. To avoid motion sickness issues, HMD manufacturers, such as Vive or Rift are providing options to teleport in the virtual world or using the joystick to control the movement of avatar (replication of user in a virtual environment) (Reality Technologies, 2019).

It is important to consider user profile while design user experience in VR, we should consider the target audience, effect of different induced emotions on users (ex. Anxiety, fear etc). Virtual reality is still new for a big audience, we should consider providing enough (not overwhelming) instructions while exploring the virtual world. The HMDs which are being used are still evolving to user needs. They might be bulky at times or the fitting may not be correct which may result in physical pain for which we need to consider the physical

aspect of the human body. Exposure to virtual longer duration may result in fatigue and eyestrains hence we need to ensure that we are keeping the design simple.

Conclusion:

Virtual reality user experience design involves extensive study of human perceptual system and planning the design based on constraints which may be put by the capabilities of human perception of the virtual world, restriction on the computation power of system or HMD aesthetics. We need to have better feedback from the system to user actions to keep the user engaged and there should be enough instructions wherever applicable to keep user-focussed in the virtual world. Developers should be careful about what level of immersion they provide as it may not go for all users due to the induced emotion human brain feels while experiencing the virtual reality.

Virtual reality space has seen big developments recently and the funds being invested in this field has been on the rise. With big players such as Facebook, Microsoft etc. being involved in this space, it seems imminent that there will be more investments and research in this field. HMD manufactures are trying to enter a bigger consumer market by providing cheaper HMDs for consumers. We are seeing better HMDs with higher framerates, high power processors and graphic cards being manufactured, this will result in better user experience or rather a more lifelike experience of the virtual world.

Reference list:

Reality Technologies. (2019). *What is Virtual Reality (VR)? Ultimate Guide to Virtual Reality (VR) Technology*. [online] Available at: https://www.realitytechnologies.com/virtual-reality/ [Accessed 28 Mar. 2019].

Reality Technologies. (2019). *What is Augmented Reality (AR)? Ultimate Guide to Augmented Reality (AR) Technology*. [online] Available at: https://www.realitytechnologies.com/augmented-reality/ [Accessed 28 Mar. 2019].

Geforce.co.uk. (2019). *Virtual Reality | System Requirements | GeForce*. [online] Available at: https://www.geforce.co.uk/hardware/technology/vr/system-requirements [Accessed 28 Mar. 2019].

Purwar, S. (2019). *Designing User Experience for Virtual Reality (VR) applications*. [online] UX Planet. Available at: https://uxplanet.org/designing-user-experience-for-virtual-reality-vr-applications-fc8e4faadd96 [Accessed 28 Mar. 2019].

Sherman, WR & Craig, AB 2018, *Understanding virtual reality: Interface, application, and design*, 2nd edn, Morgan Kaufmann, Cambridge, MA, United States.

Vive.com. (2019). *VIVE™ Australia | Buy VIVE Hardware*. [online] Available at: https://www.vive.com/au/product/#vive-spec [Accessed 28 Mar. 2019].

Oculus.com. (2019). *Oculus Rift | Oculus*. [online] Available at: https://www.oculus.com/rift/#oui-csl-rift-games=star-trek [Accessed 28 Mar. 2019].

Parkin, S. (2019). *Oculus Rift and the Return of Virtual Reality*. [online] MIT Technology Review. Available at: https://www.technologyreview.com/s/526531/oculus-rift/ [Accessed 28 Mar. 2019].

Digital Trends. (2019). *Oculus Rift vs. HTC Vive: Prices drop, but our favorite stays the same*. [online] Available at: https://www.digitaltrends.com/virtual-reality/oculus-rift-vs-htc-vive/ [Accessed 28 Mar. 2019].

Tamayo, JR, Barrio, MG and García, FG 2018, *User experience and interaction design in creative processes and educational sciences with virtual and augmented reality technologies. A research with quantitative and qualitative methods*, Enseñanza & Teaching, 36(1), pp.63-79.