

Is This Real Life?

Investigating the Immersive Capabilities of VR Control Systems

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ABSTRACT

An in-depth look at the controls of current VR systems, to see which provides the most immersive experience. In order to make the project as successful as possible, telepresence is a key feature to get the user invested in the simulated world. While VR headsets all work in similar ways to display the world around the user, these systems have varied controls which could be the key to truly immersing the user. Multiple factors are looked at; however, telepresence is the most important in order to weigh up which system is the most proficient at immersing the user.

Keywords

Virtual Reality, Control Systems, Immersion, Facebook Oculus Rift, HTC Vive, Sony PlayStation, Telepresence, Valve Knuckles

1. INTRODUCTION

Over the past decade, virtual reality has risen from relative obscurity to the next core market in games and interactive technology. With the strong progress of this market, companies need to ensure they provide something different to stand out and obtain dominance over the competition. This paper will look at the different control systems of three of the major VR headset products available, in order to determine which is the most immersive for the user. The key factor is whether the controls cause the user to experience telepresence or whether they restrict the user from reaching such a state. The three products to be investigated are: Facebook Oculus Rift, Steam/HTC Vive and Sony PlayStation VR. In order to choose the best control system, multiple factors of each product will be compared, with the key feature being how much the user feels they are actually in the world they're experiencing. While this is difficult to analyse directly, looking at the overall efficiency of each system, and seeing how many ways they could impact the immersion, will be an accurate guide. Finding out which system provides the most immersive user experience will affect the path the project team may take in delivering the best experience.

2. FIELD

Virtual Reality is a constantly growing field in the current market and therefore the choice of product and services is becoming more widespread every day. This report will focus solely on VR technology, meaning AR (Augmented Reality) systems will not be investigated. This is down to AR allowing the user to see the world around them already leading to a heightened level of immersion compared to VR, which would result in an unfair comparison and isn't what the end project is focused on.

3. KEYPLAYERS

This paper will look into three current major products in the field of Virtual Reality systems. The first of which being the Oculus Rift, originally developed by 'Oculus VR' which was later bought by Facebook. The second is the HTC Vive, developed in partnership between HTC and Valve. Finally there is the PlayStation VR, created by Sony for use with the PlayStation 4. There are many more companies and products available to choose from, however since these three are the biggest and most widely used in the field, the summaries of their control systems will give the best insight into modern day VR controls. From this research it can be determined how controls define how much a user becomes invested into the game world around them. This analysis will then be used to consider the best controls system to use for the team project.

3.1 Oculus Rift

The Oculus [1] was the first 'Modern' VR system to be created, i.e. the first mobile VR headset that resulted in the current boom of VR research and development. Initially the Oculus was sold with an Xbox One controller due to a partnership with Microsoft, which brought Microsoft into the world of VR and eventually led to development of their 'Mixed Reality' [2]. The problem with using a non-VR controller is that the user needs to already know where the different buttons are prior to using it, since they obviously can't see the buttons during play. This problem was solved shortly after thanks to development of the 'Oculus Touch' [3] controllers.



Figure 1: Oculus Touch Controllers

While the controls still have a few differently labelled buttons, the layout of them is what makes it more intuitive than the Xbox controllers they're copied from. The higher up buttons (Y & B) are for 'back' type interactions and the lower buttons (X & A) are for 'select' type commands. These buttons and the dual analogue sticks are used with the thumb while on the back of the controller there is a trigger for the index finger. On the inside of each controller there is another trigger which lies where the user's middle finger sits. There is also a small touch sensor next

to the two buttons on top that can be used to produce a variety of gestures in certain games. All of these inputs are contoured and fitted to be easy for the user to interact with and are straight forward to use, meaning they shouldn't distract the user from whatever they're doing. One issue however is the way the motion capture works, with both cameras sitting in front of the play area, meaning that turning around can block both controllers with the user's body and hence ruin the in-game immersion when they disappear [4].

3.2 HTC Vive

As of writing, the Vive only has one type of controller but Valve have announced the 'Knuckles' [5] controller is in the works. Therefore this section will be broken into reviewing the current controller as well as looking into what has currently been released about the Knuckles.

3.2.1 Current Controllers



Figure 2: Currently Available Vive Controllers

The current HTC Vive controller has only 5 interactive parts. On the face are three things, all operated with the thumb. The first are two small circular buttons: the top one is for in game use whilst the lower button is for the system being used (typically Steam) and connecting the controllers. The second is a large trackpad that traditionally is used for movement or as a makeshift d-pad. On the reverse is a trigger to be pulled with the index finger and two grip buttons designed to be pressed simultaneously with the remaining fingers and palm.

Whilst the headset is on, the controllers show up as a rendered 3D model so you don't need to know their exact position to find them whilst in-game. Having these models and seeing them move in real time heavily improves the feeling of immersion a user has as it directly joins their real world movements will in game actions. The sensors for the Vive are placed on opposite sides of the play area which causes their vision to overlap and hence allow play in a 360° scope [6].

3.2.2 Knuckles Controllers

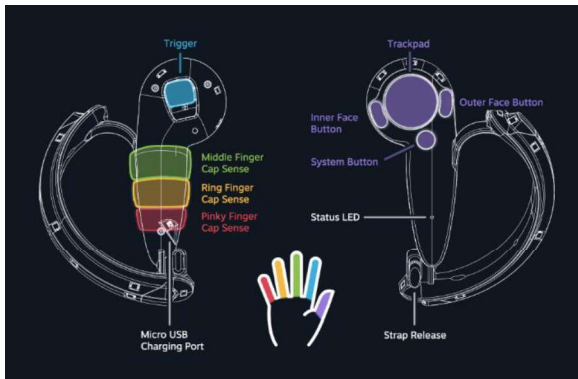


Figure 3: Valve's Upcoming Knuckles Controller

Valve's upcoming Knuckles controllers finally offer the chance for exact finger placement recognition in VR, something that the Oculus touch originally announced before down-playing the mechanic to a few simple finger poses [7]. The handset has an adjustable band to fit around the user's hand which is tightened so that the controller doesn't drop when the hand is open. In setup, the user calibrates where their fingers lie on the controller which is saved for the purpose of grip controls in game. Other than this new grip system, the remaining controls are very similar to the original Vive controller. On the back is a trigger which appears to be standard for VR controllers by today's standards. On the top of the controller is the track pad and system button, but this time there are two new buttons that will likely provide more interactive options in-game [8].

The innovation of being able to motion grabbing in real life and having the in-game avatar respond with the same action is a huge break-through in terms of improving immersion for the user. The adjustable straps also remove the possibility of dropping the controllers which could ruin a player's immersion, as doing so would result in the user stopping play to find them.

3.3 PlayStation VR

While the PlayStation VR differs from the other VR systems in this paper, due to being console based as opposed to PC based, the need to include it was felt. The reasoning behind this is that, if the PlayStation VR Move system proved to be the most immersive, research into adapting the controls for PC could always be considered. During research, the PlayStation Aim controller was discovered, [9] but due to the limitation of being focused on shooting games, it will not be covered in this paper.



Figure 4: PlayStation VR Move Controllers

Due to them being for a console, the PlayStation Move controllers replicate the key parts of the actual console controller. This means there are 4 buttons on the face to copy the square, circle, triangle and X buttons that are so iconic with the PlayStation series. On the top there is also a PS home button and another action button, with the reverse side displaying the typical trigger button [10]. By copying across the buttons from the traditional controllers, users who have a prior knowledge of the PlayStation systems will already know the properties of each button and their layout. However, to new users it may be difficult remembering and pressing the correct button while their vision is obscured by the VR headset, which could have an adverse effect on their opinion of the product using these controls.

In terms of how detectable the controls are, there is only a single camera that the user places in front of their play area, which means if they turn around then the camera cannot pick up the sensors on-top of the controls [11]. This causes the controllers to cease responding in game, which would instantly ruin the player's immersion and force them to stop play in order to re-centre themselves. This function of having one centred

camera also means that the options for room scale games are hindered if not completely implausible due to the limited movement space the camera can capture.

Another issue that arose from research involved the way the camera tracks the controllers and headset. It uses lights on the equipment to track their movement, so if the surrounding environment also contains bright lights, then these can confuse the camera to cause inaccurate aiming and movement in-game [12].

3.4 Summary

Table 1: Comparisons of controller data

<u>Category\</u> <u>Name</u>	<u>Oculus</u> <u>Touch</u>	<u>HTC</u> <u>Vive</u>	<u>Knuckles</u>	<u>PS VR</u> <u>Move</u>
<i>Intuitive Controls</i>	Specific button issues	Yes	Yes, probably most	Specific button issues
<i>No. Interactive points</i>	7	5	5	7
<i>Room Scale Issues</i>	Must face forward	None	None	Must face forward
<i>Cost (for 2)</i>	£110	£230	N/A	£60

The first step of truly immersing a user is making sure they can use the control system without having to stop and think about it or getting confused with the buttons. The Oculus Touch and PS Move both have the potential to fail here due to both being an extension of a current console controller. The specifically labelled buttons could throw a new user and cause them to either randomly press buttons or even remove the headset the view the controller. Both controllers for the Vive seem to avoid this pitfall by being brand new and yet still intuitive to use. They both contain a track pad and trigger which the user's fingers will naturally fall on, with the Knuckles even using actual hand movements to perform in-game actions, meaning the user doesn't even have to learn new controls to do this.

The number of interactive points ties in with the intuitive use very well. The more buttons or triggers a controller has, the harder it is to remember what each one does while playing, especially to newcomers of VR. Again the Oculus Touch and PS Move are equally bad in this respect due to the ported console buttons. The PS Move uses all four buttons from the PS console controls whilst the Oculus splits the Xbox buttons with two on each hand but makes up for it with two triggers. Both Vive controllers then only have 5 interactive points so are more likely to be easy to remember and use, the Knuckles more so since it claims to allow actual hand motions as actions in-game.

Room scale play will always provide the chance to make more immersive games/interactions as the user can actively move around in world space while simultaneously moving in game space. Therefore grading the capabilities of each controller's ability to work in room scale situations seemed like a valid point and this time there is differentiation between the Oculus Touch and PS Move. The PS Move can only be detected in a particular window that the camera can see, so while this allows some degree of room space VR, it's very restricted and turning around will block the controllers, ruining immersion. The Oculus touch can be moved around a much larger space but only if the user stays facing the direction of the two sensors, for the same reason that otherwise the controllers are blocked and stop working. For the third time, the Vive controllers are superior to the others by using a camera setup that allows full 360° play. The user can mark out the play area and then walk around it facing any direction, making them feel as if they're really in the game,

especially when coupled with the knuckles realistic grabbing mechanic. This is of course going under the assumption that Knuckles will run in the same way as current Vive controls, therefore maintaining room scale functionality.

Finally, and possibly the least important, is the cost of two controllers. This factor takes a step back from the investigation into immersion and looks more at the most viable to use for the project if money was an issue. Looking at the other three summary points, the Vive controllers have far more benefits than the other two, which is shown by the price. The cheapest and overall most limited are the PS Move controllers followed by the Oculus Touch, which can do more than the PS Move but still less than the more expensive Vive controllers. The cost of the Knuckles has yet to be released, however due to the current Vive controllers being the most expensive and with the knuckles being newer and more powerful, it is a safe guess that the price for a pair will be greater than £230.

3.5 USP

From the first mentions of VR development, the concept caught the attention of many through its innovation. But even in a new market, competitors need to stand out by bringing something different to the table or at the very least out do the previous product in some way. Oculus grabbed everybody's attention from its initial announcement in 2012 [13] where it gained ten times the requested funding on Kickstarter and won 'Best of E3'. Upon release, the Oculus was received well but lack of any motion controllers was disappointing for many; an opportunity that HTC and Valve took with both hands and provided a solution in the form of the Vive, with its wireless motion controllers. Coupling this innovation with Valve's addition of 'Steam VR', meant the Vive had one up on the Oculus as well as appealing to the enormous Steam user base.

Meanwhile, the consoles didn't have any focused VR technology. By the end of 2010, PlayStation had just the PS Move controllers which Microsoft matched soon after with the release of Xbox Kinect, but neither of these were VR based, just motion controllers. While Microsoft had a partnership with Oculus back in 2015 [14], and hence Xbox One controllers were shipped with Oculus Rifts, Microsoft never developed VR for the Xbox. Sony took advantage of this market gap and went on to produce PS VR, the first console VR headset, which coupled with the Move controllers.

Now, after VR has become a reality, focus shifts onto improving the formula and expanding into further detail/immersion. Valve have taken a step towards this by announcing the Knuckles, which is starting to bridge the gap between whole hand gestures and movements being recreated in VR. This took advantage of Oculus' far simpler attempt at hand gesture recognition (see 3.2.2) and went on to offer something far superior that people have always wanted. In the future, technology will likely keep improving to provide a more realistic and immersive experience for users.

As for the personal project, a USP cannot be achieved in a similar way to the key players as the product is a game instead of new technology. However, the project can use the best control system concluded in this paper and go on to utilize its advantages to provide a unique game. The USP of the project will most likely be achieved through the gameplay and use of the control system, something that is outside the scope of this paper.

3.6 Technologies/Approach

After summarising all data gathered during market research, by far the best control system is the Knuckles controller for the HTC Vive. The only issue with this is that the Knuckles are currently still in development with no release date in sight. This could mean that upon release the Knuckles fail to live up to the

promises Valve have made thus far, but if that is the case then the recommendation would still fall to the second best control system: current HTC Vive controllers. This isn't too surprising given that the best choice is the improvement to the current controllers, with both out-performing the Oculus Touch and PS Move controllers.

4. CONCLUSIONS

In terms of how immersive each controller can be, the 360° functionality provided by both Vive controllers is practically essential to ensuring the user experiences telepresence in the game, hence why they are prime choice for use in the project. The controls on each are simple and intuitive to keep the user from distancing themselves once playing and the longer the user goes without remembering they're just in a game, the more immersed they become with the product. Use of the other two controllers would subtract this feeling and hence ruin the immersion the user experiences.

There is definitely a further field of research into how headsets could improve to provide more immersion, possibly by going wireless. Investigations into in-game immersion techniques would also be highly beneficial if paired with this report, since both papers would together cover the software and hardware immersion issues produced by VR.

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