# VR Ice Hockey

Ruturaj Gole
*Computing Science, Multimedia*
*University of Alberta*
Edmonton, Canada
ruturaj@ualberta.ca

Davinderjit Kaur
*Computing Science, Multimedia*
*University of Alberta*
Edmomnton, Canada
dkaur@ualberta.ca

Asket Kaur
*Computing Science, Multimedia*
*University of Alberta*
Edmomnton, Canada
asket@ualberta.ca

Maryam Sedghi
*Computing Science, Multimedia*
*University of Alberta*
Edmomnton, Canada
msedghi@ualberta.ca

Hanming Li
*Computing Science, Multimedia*
*University of Alberta*
Edmomnton, Canada
hanming@ualberta.ca

***Abstract*—Virtual reality gaming is the application of a three-dimensional (3-D) artificial environment to computer games. Prior to the development of compact technology, VR gaming used projector rooms or multiple screens. VR gaming control may involve a tracker and head mountain display, game controllers or motion capture methods.This project creates a Virtual Reality (VR) simulator that uses proxy haptic technology to simulate the game of hockey. Trackers are mounted on a real hockey stick. The virtual environment will serve as a practice field for the player, and the system will track the trajectory of the ball or the puck in order to suggest changes in the player's gameplay. In this project, we simulate the hockey playing with HTC VIVE VR devices(Tracker, Controller and headset).**

***Index Terms*—Game, HTC VIVE, Simulation ,Virtual reality, Hockey**

## I. Introduction

During the past two decades, the virtual reality community has based its development on a synthesis of earlier work in interactive 3D graphics, user interfaces, and visual simulation. The video game community has pushed into spaces previously the domain of the VR community. Clearly, the VR field is transitioning into work influenced by video games and thus now influences that industry as well. Because much of the research and development being conducted in the games community parallels the VR community's efforts, it has the potential to affect a greater audience. Given these trends, VR researchers who want their work to remain relevant must realign to focus on game research and development. Research in the games arena affects not just the entertainment industry but also the government and corporate organizations that could benefit from the training, simulation, and education opportunities that serious games provide. Unity VR targets virtual reality devices directly from Unity,without any external plug-ins in projects.Virtual Reality(VR)is the use of computer technology to create a simulated environment .

In this project, we simulate a Ice Hockey game. This game is played in Virtual world where headset places the user inside an experience .Instead of viewing a screen in front of the them, players are immersed and able to interact with the 3D environment.

This game helps the people who cannot access the field of real hockey just with VR device and enjoy playing Hockey as well. Moreover, this kind of hockey is able to help hockey teams to keep their player in shape mentally and physically. Making this game needs several steps. Following section explains it more deeply and specifically.

## II. Related work

There have been numerous applications done in VR in several fields, such as Architecture and urban design, Digital marketing, Education and training, Engineering and robotics, Entertainment, Healthcare, Social science and Psychology. In this section, we focus on some application.

### A. VR and Pain Management

At the beginning of the 21st century, VR was introduced to the field of pain management . The first application of VR in clinical pain was a video game in which adolescent and adult burnt patients experienced less pain while they were playing [3]. Later, Hoffman and colleagues conducted an fMRI brain scan study in which they found that VR greatly and significantly reduced pain in five brain regions of interest related to pain in healthy subjects exposed to thermal stimulation [3]. Some years later, a second fMRI study demonstrated that the pain reduction experienced by using VR was comparable to the analgesic effect of a moderate dose of hydromorphone pain medication . Up to this point, the analgesic properties of VR had been mostly attributed to its powerful distractive capacity. However, its effectiveness has been demonstrated in the management of mild and severe pain states [2]. In addition, the positive pain-relieving effects of VR may also be mediated through a reduction in anxiety and through the user experiencing positive emotions such as a sense of fun [1].

### B. Flight Simulation

Often operational equipment is considered to be the most effective and valid training equipment. However, this is not true in every instance. In fact, sometimes it may be undesirable to use real equipment for training if suitable simulators are available. For example, the use of operational equipment has several disadvantages which include (1) high costs, (2) limitation on practice of varied aspects of tasks, and (3) safety hazards. Practical decisions in the use of training devices depend upon compromises between economic and training objectives. A trainer need not duplicate operational equipment to have training value.

## III. Proposed Game

This proposal has developed a VR Ice Hockey experience designed to improve player's hockey awareness skill and on-ice intelligence also entertain and make pleasure time for hockey fans to participate and experience hockey playing anywhere even in home. We followed the following steps to develop the game.

### A. Step1: Connect hardware devices

To simulate hockey game we use HTC VIVE which is a virtual reality headset developed by HTC and Valve. The headset uses "room scale" tracking technology, allowing the user to move in 3D space and use motion-tracked handheld controllers to interact with the environment. also we install tracker to hockey stick to track the movement of it; all the devices are updated latest released version.In brief description, these procedure should be followed:

1. Need to make sure that computer has the required minimum specs.

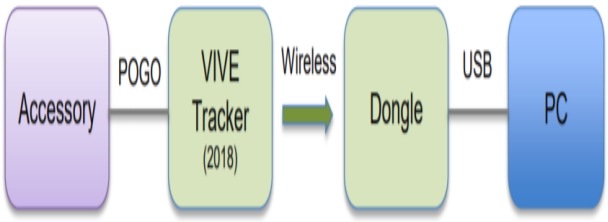


Fig. 1. how to connect hardware.

2. After installing all devised to the computer, download and install Steam VR. Fig. 2
3. In Steam, head to the Library, right click on Steam VR, and press Properties. Select the Betas tab, then, using the drop-down menu, press "Steam VR Beta Update" and wait for it to update.
4. Once Steam VR launches,the state of system will be appeared. Green means that everything is working properly. Flashing green means the devices can't see the base stations. Grey means the devices is off.
After connecting all devices, they are ready to use.
5. For our project we connect the tracker to the stick, after the calculate the math as below Fig. 2.

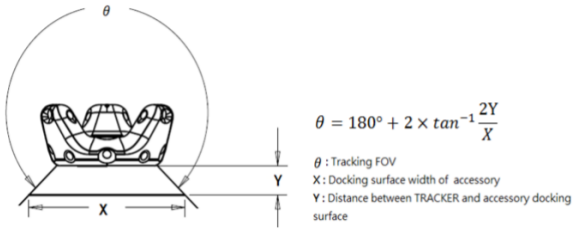


Fig. 2. How to calculate the position of tracker.

### B. Step2: Create game scene

Playing the game in real-time is extremely important to the player since every split second in our game is important. Currently, all games suffer from latency to some degree, either it's because of the hardware or the software pipeline. In our case, we didn't try to render a very life-like scene since that would increase latency, but instead we chose to design a scene more focused on simpler parts, such as real size of player, hockey etc. Many games don't have haptic experience, and this does not provide a realistic experience. We added hardware that supports haptic feedback.Fig. 3.


Fig. 3. How to calculate the position of tracker.

- The land should be icy and slippery so we use the texture of ice for our land also for environment, we prefer to locate our game on place where is covered by mountain and surrounded by amazing land giving a player have pleasure time while playing our game.
- This Game is First person gaming so only the hockey stick ad goal keeper are in scene.we use almost real size of hockey stick and using the goal keeper asset to make our game more real.the pock is also look like pock in real game.However, we add trajectory to moving pock to be traced more easily.
- for the the lighting scene we use Directional lights which are very useful for creating effects such as sunlight in scenes. Behaving in many ways like the sun, directional lights can be thought of as distant light sources which exist infinitely far away. The distance of the light from

the target object is not defined and so the light does not diminish.
- we only have one camera which is child of the "camera rig" which is connected to headset devices.

### C. Step3: Apply physics

One of the most challenging parts of our game was the physics. In this part, we should consider the action, reaction of puck with respect to the surrounding objects. First, we should make the floor ice-like by changing its Rigidbody properties and adding material to it such that the simulated friction, both static and dynamic are akin to that in real life. Static friction is the friction in concern when an object is stationary, whereas dynamic friction comes into play when an object is moving. In Unity, the dynamic and static friction of the floor must be reduced to zero in order to simulate ice. When it comes to static friction, it can be calculated as follows:

$$F_s max = \mu_s mg \tag{1}$$

where $F_s max$ is the force of static friction
$\mu_s$is the coefficient of static friction,
m and g are the mass and gravitational coefficients of the object

Dynamic friction, also known as kinetic friction, on the other hand, has to be calculated as,

$$F_k = \mu_k mg \tag{2}$$

where $F_k$ is the force of dynamic friction,
$\mu_k$is the coefficient of dynamic friction,
m and g are the mass and gravitational coefficients of the object.

Of these, when we talk about reducing both the frictions to zero, we're decreasing their coefficients of friction. The default gravitational acceleration in Unity is already set to the gravitational acceleration of the Earth in reality, so that we needn't not bother ourselves with.

Consequently, we must consider these factors when thinking about the puck as well. The mass of the puck should be high enough to prevent it from triggering a kinematic reaction too excessive, but low enough to make it movable. Other than those, we have factors such as linear and angular drag. Drag is paramount to stop the puck from sliding forever. The puck object has its own static and dynamic friction. Whenever the puck interacts with the floor, we have many choices of how the motion should proceed. In order to make the puck slide, we should gradually decrease the friction, as simultaneously the drag of the puck stops it from moving. This can be done by either averaging the frictions, multiplying the frictions, or taking the minimum or maximum between the two frictions.

For making the objects interact, may they be the floor and the puck, the hockey stick and the puck, the goalpost and the puck, we need another colliders attached to the objects. The choice of the colliders is important because the shape of the hockey stick is irregular, and we cannot use box or cylindrical colliders for it. Therefore, the appropriate choice of collider is necessary.

For making the puck move, we take in account the velocity of the hockey stick to apply force to the puck. We define a speed constant that we can alter to make the puck go faster or slower.

The Vector3 velocity object that we get from the hockey's Rigidbody has the information about its velocity in all three axes. However, depending upon the direction of the hockey stick's movement in one plane, velocity of that axis can be negative. Normalization of the values therefore is necessary to get just the magnitude of the vector in that axis. Unity makes these calculations beforehand. Moreover, we do not want the puck to move in the Y axis, so we make it zero.

$$F_{px} = F_{hx}.speed \tag{3}$$

$$F_{py} = 0 \tag{4}$$

$$F_{pz} = F_{hz}.speed \tag{5}$$

where,
$F_p$ is the force applied to the puck in an axis,
$F_h$ is the force of the hockey in an axis,
speed is our speed constant we can change.

Torque is calculated in a similar fashion, where we consider the movement of the hockey stick in all three axes to add torque to the puck.

Unity provides functionality to do all this in single instructions with methods such as AddForce() and AddTorque().

### D. Step4:Player interface

This part was the most time consuming. We should have the start, pause and game over menu which can be handled by player while wearing the headset as the player won't have access to the keyboard or mouse during the gameplay. Unlike most VR games, it would be inconvenient in our case to make the player hold the controller along with the hockey stick to select the options. Therefore, To make it convenient for the player to select the items from menu, we track the sight of player and whenever their sight is on an option for more than a few seconds, we select it. Whether an item is being selected is known visually through a loading circle that empties radially with as the countdown expires. The sight is really a raycast that originates from the camera. The raycast is turned off once the menu is done with. For the main menu, we have the option to start or quit the game. The pause menu can be brought up by looking at the pause icon that appears in the corner of the game.

The pause menu has the functionality to restart, resume or quit the game. After three tries, the game is over, and the game over menu is displayed. If the player gets a score of at least 2 out of 3, the players gets a win, and a loss otherwise. The appropriate message is displayed on the menu as such. The score is constantly displayed in the game except when a menu is displayed. Fig. 4.

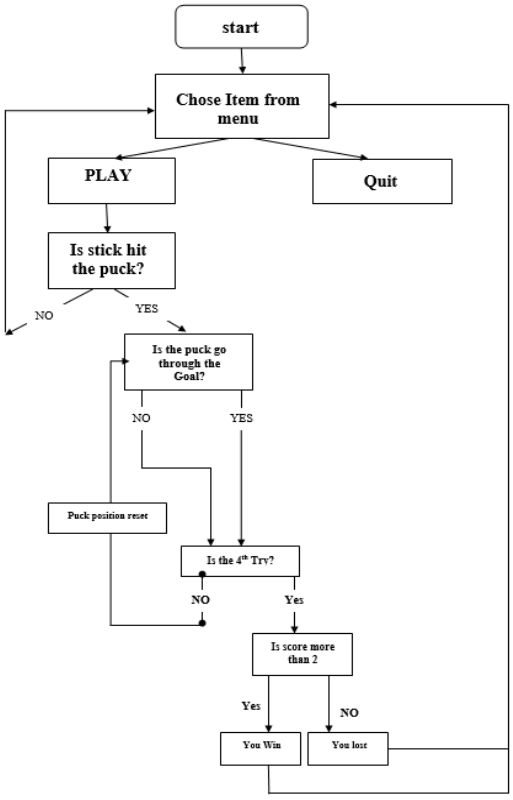


Fig. 4. Diagram of the VR Interface Functionality.

### E. Step5: Music

We add proper music in scene when the game is started the audio of out door will play.when the player hit the ball , the hitting puck and stick voice will be play and when the puck move through the goal the buzz will be played to inform player that shout has score. all music works with trigger of puck with object.

## IV. Usability Study

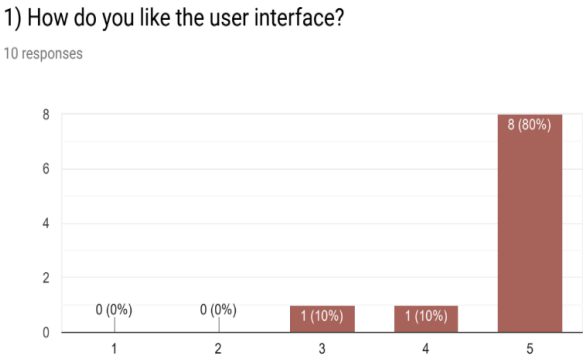


Fig. 5. User Interface Likeability

We conducted usability study on 10 subjects aged between 20 to 30 years of age. We made them play the game demo and then answer 10 questions detailing various aspects of the game such as interface, efficiency and user friendliness of the game. Our project has the aspect that is realism that we need to consider. We recorded the gameplay of the subjects to study them.

We asked subjects whether they liked the interface and made them rank their experience of the interface on a scale from 1 to 5, with 1 being worst and 5 being best. 80 percent of the subjects straightaway gave the highest scores for liking the interface. The average score was 4.7. Fig. 5

For the physics, we asked the subjects how difficult it was for them to hit the puck. The scale ranges once again from 1 to 5, with 1 meaning that it was very difficult to 5 with not difficult at all. The score averaged at 4 meaning that the puck was not difficult to hit, but it wasn't completely easy. Fig. 6

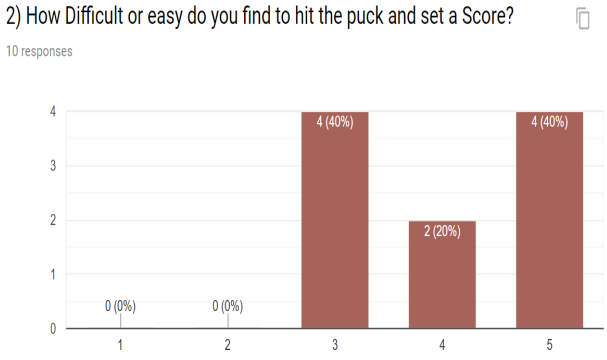


Fig. 6. How difficult or easy do you find to hit the puck and get a score?

## Conclusion and Future Work

In this paper, we addressed steps to implement ice hockey game in virtual world. One of our main contributions in this project is to implement it in virtual world. We also added virtual physics related to puck and hockey.

We can enhance this project by adding multiplayer option to the game in order to make it interesting. Along with it, to make it more fascinating we can work on adding audience to cheer the players. This will make the game more realistic and enjoyable.

Also, we can work on physics of wind resistance. There are many other features that can be added in order to make the game more interesting and captivating. Following is the figure of suggestions for future work given by students during usability test related to further improvement.

## References

[1] Guendalina Graffigna et al. "Enabling eHealth as a pathway for patient engagement: a toolkit for medical practice". In: *Stud Health Technol Inform* 199 (2014), pp. 13–21.

[2] Hunter G Hoffman et al. "The effectiveness of virtual reality for dental pain control: a case study". In: *CyberPsychology & Behavior* 4.4 (2001), pp. 527–535.


Fig. 7.

[3] Shahnaz Shahrbanian et al. “Use of virtual reality (immersive vs. non immersive) for pain management in children and adults: A systematic review of evidence from randomized controlled trials”. In: *European Journal of Experimental Biology* 2.5 (2012), pp. 1408–1422.