Enhanced player interaction using motion controllers for VR FPS

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***Abstract*—Goal of virtual reality (VR) is to increase the realism and user experience. In order to achieve these goals, we analyze the existing solutions and propose a new method of user interaction for a first person shooting (FPS) game prototype. In our FPS prototype, wearing a head mounted display together with two motion controllers, we design the player interaction using both hands to operate in-game firearms and mimicking shooting action in real-world. Additionally, we make use of one of the trending and free game engines in order to develop a run-able game prototype.**

I. Introduction

Recently, virtual reality related technologies expand rapidly, create new trends and cause changes in the industry. Technologies such as HMD, motion controllers, motion tracking devices are now available on a consumer level bringing VR experiences to users for a fairly low cost. These changes revolutionize the whole gaming industry allowing developers to create high-end contents. These market trends and new consumer level technologies focus on developing even more advanced devices and technologies to provide immersive user experiences. Therefore, the main key challenges which developers and researchers face are creating believable interaction, sensory illusion and realistic haptic experience.

II. Previous Works

A lot of research has been done in the field of virtual-reality and VR games. Ryan P. McMahan et al. [1] has evaluated and proven that still there is a lot to be learned about the effects of increasing a system's fidelity to the real world. The results of their study show that the levels of interaction and display fidelity can be significant factors which determine performance, presence, engagement, and usability. Another study presented by Jefry Tedjokusumo et al. [2] study shows that FPS-VR is the most preferred game mode due to the fact that virtual-reality environments are more immersive, allow the users to enter a totally different word where visual effects can be exaggerated and add more value to the environment. In order to increase players' behavior and enhance player motivation Tzu-Chi Chen et al. [3] has developed a FPS-VR edutainment system allowing players to perform various tasks under a specified time limit. However, to the best of our knowledge, previous methods do not focus on providing both hand experience where users not only can feel that they are present in the virtual world but also that they can interact with objects in a more advanced way. FPS-VR developers tend to copy the standard logics and mechanisms of FPS games directly into VR and just map specific interactions to a button interface on game pads or motion controllers. Therefore, we propose an enhanced interaction that use both hands, create interaction logics for VR FPS exploiting HMD and controllers, and introduce haptic feedbacks in a more finesse way for believable interaction and VR experience.

III. System Overview

The system that we propose in our paper consists of several elements including wearable devices (HMD, motion controllers), game system, tracking devices and a player (Fig.1). Since we do not focus on developing new hardware, we make use of the recent consumer version of set of HMD device that comes along with two motion controllers and a tracking system made of two sensors. In the system, a player with use of the HMD and motion controllers provides all the input data required:

- HMD position and orientation,
- Motion controller position and orientation
- Motion controller 8 buttons' press and events (trigger, shoulder, grip, face 1-5 buttons),

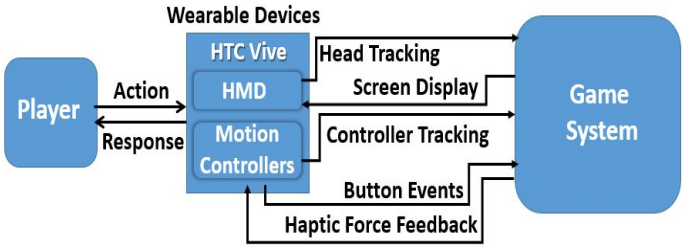

Fig. 1. The player with use of wearable devices creates actions which our system can process and our system responds by haptic force feedback of motion controller, by providing new graphics, or by changing agent's actions.

IV. Interface Design

We have designed two kinds of guns which become the direct interfaces between the player and actions performed in FPS (Fig.2). Both of them have a similar fire trigger button and both require a special reloading interaction. The first one is similar to a small pistol, it fires a single shot and, after the users uses all the ammunition, it has to be reloaded by pulling its upper part. The second gun is similar to a big automatic machine-gun, it fires multi shots and has to be reloaded by pulling the lever on the side. Additionally, special ammunition can be attached to the big gun in order to shoot a boosted type of projectiles. Such a novel approach avoids using old-fashioned standards where the interface of all actions is usually a mouse and a keyboard and allows to create more realism and can make the user feel more present in virtual world.

This research was supported by Basic Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Science, ICT & Future.

This work (NRF-2016R1A2B4016239) was supported by Mid-career Researcher Program through NRF grant funded by the MEST.

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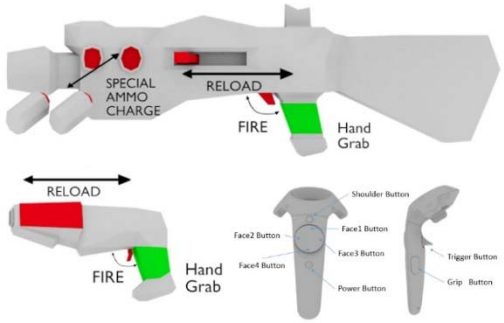

Fig. 2. Small and big gun prototypes with explanations presented next to a motion controller model which represents users hand when no gun is being held.

V. Interaction Design

We use our interface design and develop specific interactions which a user can perform with hands holding both motion controllers (Table.1). (1) Any gun can be picked up with use of any from the two motion controllers. As a player moves any of the controllers, a controller collides with the collision box of guns. If a player press the trigger button on the motion controller during colliding, the gun then will be attached to the respective motion controller. (2) In order to fire, the user has to press the trigger button on the motion controller with the gun attached to it. (3) Reloading is bit complicated since it requires the user to use the other free hand not holding the gun. Firstly, the free hand has to be placed in the range of the collision box related to the reloading mechanism. Secondly, the user has to press and drag the trigger button on the motion controller and move it in the proper direction in order to reload the virtual gun. (4) Any gun can be dropped simply by pressing the trigger button and shoulder button at the same time on the motion controller with the gun. (5) Additionally, we have added an extra interaction where the user can pick and place a special ammunition on the machine gun. Picking the ammunition is performed in the exact same way as picking the gun by simply pressing the trigger button on a controller which is colliding with the ammunition collision box. (6) In order to attach the ammunition onto the gun, the player has to move the controller into the desired area and then press again the trigger button in order to attach it to the gun. All actions including picking, dropping, shooting and reloading use appropriate feedbacks by vibrating the controllers either weakly or strongly for a certain period of time depending on the velocity and mass of players and objects.

VI. Results

We have developed a FPS prototype in VR under the Unreal Engine ver. 4.12 (Fig.3.), which fully supports any HMD devices along with motion controllers. In the prototype, the player can pick and drop weapons, and also reload each one of them with use of the other hand. While shooting or reloading, specific haptic force feedback, vibration, is being sent to the controller in order to increase the experience and create a believable interaction.

Fig. 3. Screen capture of Unreal Engine4 game scene holding the special ammunition in one hand and the big gun in the other one.

TABLE I
Interaction Table

Action Name	User Interaction	Haptic Feedback
Gun Pick / Drop	onPress trigger and shoulder button	Single light vibration on pickup and drop
Gun Fire	onPress trigger button	Strong single (small gun) or continuous (machine gun) vibration
Gun Reload	onPress trigger button and movement of motion controller along reload axis	10 single and light vibrations are mapped onto a short path on the reload axis
Special Ammunition Pick / Drop / Mount	onPress while hand collides with ammunition box collider / onRelease trigger button / onRelease while colliding with mount box collider	Single light vibration on pickup and drop, strong vibration on mount

VII. Conclusion

In this research we have developed a novel interaction for FPS in VR. We have improved user presence in VR by designing two hand interactions with guns, we mimic realistic behavior, provide vibrating feedbacks for certain actions and reduce the amount of keys required to be pressed in an old-fashioned first person shooters. We believe that with this research we can encourage developers to create more realistic believable interactions and interfaces for games and other interactive media in VR.

Examples of Reference Styles

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