MechVR: Interactive VR Motion Simulation of "Mech" Biped Robot

Saurabh Hindlekar* Victor B Zordan† Emerson E Smith III‡ John C Welter§ William Garrett Mckay¶

Clemson University

Abstract

MechVR is an interactive VR/Motion simulator that offers an experience of driving a 3D simulated robot in a custom training world. From the user's perspective, they "enter" the cockpit of a giant motorized biped, and experience an immersive, interactive virtual reality *training* ride as they drive the simulated robotic machine themselves. The idea is not unlike a flight simulator, but for an imaginary, giant walking, running, and flying robot machine. Under the hood is a custom software base that drives state-of-the-art motion simulation equipment based on a custom user interface. Our research questions include the control and physical fidelity of the virtual robot, and the transfer of the experience into an interactive real-world simulation (hardware) as well as the design of the user experience for this and similar applications, e.g. prototyping amusement park rides, and/or novel arcade-style motion experiences.

Keywords: Virtual reality, Motion simulation in the real world and virtual

Concepts: •**Human-centered computing** → **Virtual reality; Virtual reality; Interaction devices;**

1 Introduction

A "Mech Warrior" is an imaginary, giant-sized humanoid robotic war machine that is piloted by a person sitting inside the device. Shooting, stomping, and flying in these huge machines are among the many actions that have arisen from the lore of anime and since entered into a plethora of games and movies. Our interactive project takes a new spin on this idea by providing a first-person venue for an individual to enter the cockpit of such a robot, and to drive it through a virtual training mission, complete with target practice and careful navigation tasks.

Thus we introduce the MechVR project, Figure 1 and Figure 2, an interactive immersive physical motion simulation offering a first-person experience of driving a large legged "Mech" robotic machine (henceforth Mech). Specifically, the user will enter and sit recumbent in a fake cockpit (about the size of a standard golf cart, footprint) that mimics the experience of being inside the Mech through an actuated motion simulator. Next, state of the art peripherals transport the rider to a virtual training site where they drive the robot to perform synthetic 'field' practice.

*email:shindle@clemson.edu
†email:vbz@g.clemson.edu
‡jes8@g.clemson.edu
§email:jcwelte@g.clemson.edu
¶email:wmckay@g.clemson.edu

SIGGRAPH '16, July 24-28, 2016, Anaheim, CA,
ISBN: 978-1-4503-4377-0/16/07
DOI: http://dx.doi.org/10.1145/2929490.2932422

Figure 1: *MechVR: Riding a virtual robot*

2 Approach

Our base foundation is a unique third-party hardware "craft" [SimCraft 2016] that is a 3-Degree of Freedom (roll, pitch, yaw) motion simulator, see Figure 3. The real-world physical device is controlled through a simulation of the robot which is in turn controlled by the player/rider through two physical joysticks located inside the custom "cockpit". The user wears a stereo headset (Oculus) [Oculus 2016] that offers added immersion through look control and stereovision. With this custom hardware set-up, we design a user experience that transports the player from the venue, to a virtual training platform for testing the driver's Mech control skills.

To accomplish our goal, we have implemented a software system to drive the actuators of the motion device and an analogous 3D world. Namely, our system is written in Unity 3D [Unity3D 2016] and takes advantage of physical model of the robot to infer plausible accelerations for the craft. To accomplish the perception of the virtual Mech robot in software, we mimic the hybrid system described in [Nguyen et al. 2012] in which the robot (hull) which acts to house the player virtually is simulated as a simple abstract model with a balance control that maintains its orientation. Next, we model footsteps as force generating "disturbances" that topple the robot virtually. These disturbances create accelerations in the simulated version of the Mech which in turn lead to orientation differences in its cockpit that are interpreted and piped into the motion simulator hardware, leading to the resulting real-world/physical movement of the player. Two joysticks intuitively control the speed and turning angle of the virtual mech by each controlling the relative speed left and right. Figure 3 shows both the mech and the first person shot of its virtual scene.

A key to immersion is the consistent combination of visual and movement cues that communicate in aggregate what is happening in the virtual world. In addition, a believable premise for the interactive experience is key to draw people in and remove their disbelief. We do this through the careful design of a deliberate user experience. We describe the design of this user experience in the next section.

Figure 2: *View of the immersive VR experience from within the MechVR system*

3 Designing a game-like user experience

Following the notion of an amusement park ride, the MechVR project is designed to remove doubt and build excitement from the queue to the ride. The premise of the design is that this is not a "fake" robot ride or game, but a simulation environment, like an airplane flight trainer, that is (supposed to be) a surrogate for a real-world system. Thus, the fantasy is built and supported that players are being challenged to do well in this "synthetic" training, in order to graduate to riding a "true" Mech.

From the player's experience, they will be given the opportunity to enter a training simulation for the custom designed Mech. They will be able to run their Mech through a virtual training course complete with targets and obstacles. They will be scored based on accuracy and speed, making it a gamelike experience that is bound to transport participants to a new environment where they feel they are riding in the head of an actual legged robotic machine.

Audience members will watch the experience (e.g. in the queue for the ride itself) as the motion simulator moves the current rider. They can witness the experience through display monitors that will include the audience in the player's fateful ride to become the next viable recruit as a "Bot Jockey".

To make the experience more engaging and fun, we add select gamelike elements to MechVR. The experience inside the MechVR is built to increase in challenge and difficulty, from basic navigation to enemy evasion and more complicated maneuvering. Also, the setting, forced time challenges, and leaderboards offer rewards for the best jockey. Further, MechVR is placed within a imaginary science fictional space hangar to add intrigue and appeal to the final experience, see Figure 2.

4 Conclusion

MechVR is an experimental, entertainment-based immersive VR experience that mimics a prototype amusement park ride of a similar topic. The platform supports a wide variety of applications beyond the training Mech obstacle course we have generated to date.

In future work, we will continue to refine our software world and the driving accelerations that move the device based on the physics engine of the Mech. We also have our focus set on AI-like enemies and a network, dual person version in which head-to-head and pairwise interaction will offer a more interactive and social VR experience.

Figure 3: *Motion simulator hardware with 3-axis motor actuators.*

References

NGUYEN, N., ARISTA, R., LIU, K. C., AND ZORDAN, V. 2012. Adaptive dynamics with hybrid response. *Siggraph Asia (Technical Brief)*.

OCULUS, 2016. https://www.oculus.com/en-us/.

SIMCRAFT, 2016. http://www.simcraft.com/.

UNITY3D, 2016. http://www.unity3d.com/.