Exploration of Virtual Reality and Deferred Immediate Mode

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Goals

Our goal was to find a system that provides a modern, fast, and practical approach to virtual reality development. Specifically, we needed a framework which achieved the following goals:

Performant VR requires at least 90 frames per second to run smoothly. Low frame rates can cause users to experience headaches and nausea faster than when at high frame rates [1]. This requires VR programs to be highly optimized and multi-threadable.

Natural VR enables new user interfaces where components are organized within a 3D space. We wanted such components to be first class.

Flexible We need a general purpose user interface toolkit designed specifically for VR.

Modular We need a toolkit which does not include unnecessary features, but is extensible with modular components.

Deferred Immediate Mode

Over the course of many months, we explored several existing VR frameworks and application architectures. We determined that none of them accomplish our goals for VR development.

We decided to create our own framework which addresses the problems that we encountered while attempting to building complex VR applications in other frameworks.

When developing our system architecture, we ran into this problem:

There are some questions about the state of the system which cannot be answered until all system elements have "reported" their state.

To solve this problem, we created a revolutionary program architecture called **Deferred Immediate Mode (DIM)** which accomplishes all of our goals for VR development by adding a new aspect to immediate mode architecture called **deferability**.

Deferrability enabled us to solve this issue by resolving interdependencies after all elements have reported their state.

Flight

Flight is our implementation of a VR toolkit featuring high level abstractions for interacting with VR hardware, real-time rendering, asset loading tools, and UI elements. Flight is designed from the ground up to be performant, general, and modular.

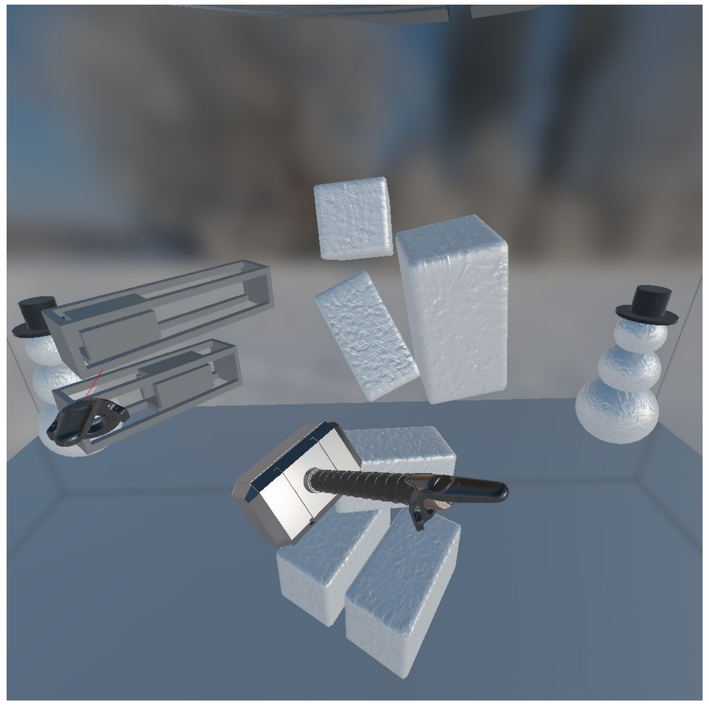


Figure: Our Final Project

References

[1] *The Importance of Frame Rates*. URL: https://help.irisvr.com/hc/en-us/articles/215884547-The-Importance-of-Frame-Rates.

More Information

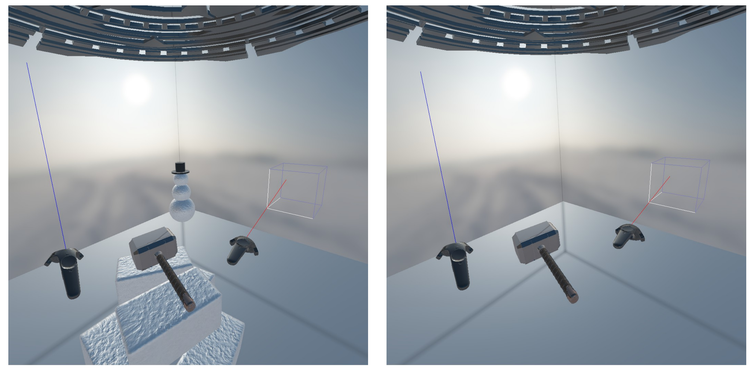
Project github.com/CSM-Dream-Team/final-project

Flight github.com/flight-rs/flight

Final Project

Our final project demonstrates the results of using DIM to implement a complex VR application. The environment currently provides these features:

Modularity: Each part of the application is its own isolated module that can be modified and even turned off without interfering with other modules.

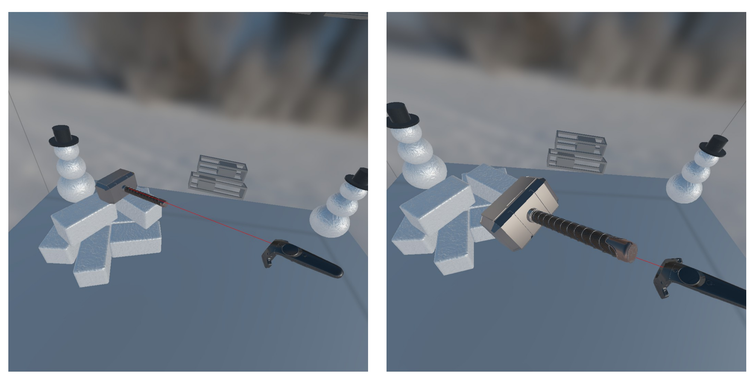


(a) Before (b) After

Figure: Application Toggles

Inter-Application Physics: Althogh each application is in a seprate module, DIM allows them to interact seemlessly. For example, Mjolnir can hit snowblocks.

Yanking, Grabbing, and Pointing: All elements which can be grabbed, yanked, or pointed at are manipulated using a common, intuitive user experience.



(a) Before (b) After

Figure: Yanking Mjolnir from a Distance