Exploration of Virtual Reality Using 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 (DIM)

Immediate Mode is an architecture in which the entire UI is defined procedurally every frame. However, there is a problem with immediate mode:

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 incomplete information problem, we added a new aspect to immediate mode: **deferability**. This provides a number of benefits.

Procedural UI Generation: like immediate mode, DIM allows for easy procedural definition of UIs.

Prevents Stale State and Cross Mutation: stale state occurs when the UI continues to display old data even after an update to the data. Cross mutation occurs when one UI element can modify the state of another element. Since the entire UI is recalculated every frame, there is no possibility for these problems.

Interdependency Resolution: interdependencies are resolved after all elements have reported their state.

Flight

Flight is our implementation of a VR UI library and the DIM architecture. Flight is designed from the ground up to be performant, general, and modular.
Flight provides high level abstractions for interacting with VR hardware, rendering objects in VR, and resolving interdependencies between elements.

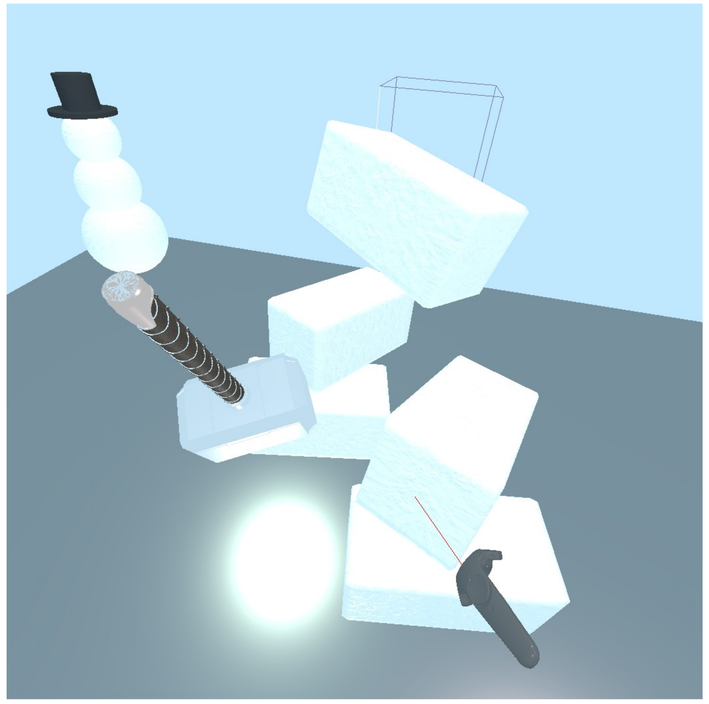
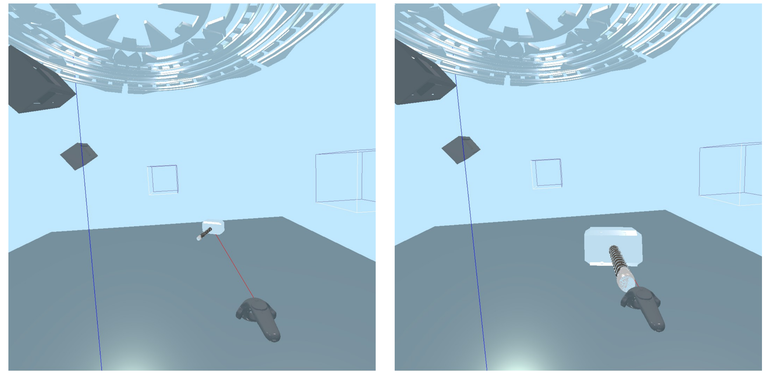


Figure: Our Final Project

Final Project



(a) Before (b) After

Figure: Yanking Mjolnir from a Distance

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