Ultra Low Latency Dataflow Renderer

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Motivation for Ultra Low Latency in Virtual Reality

Latency is the delay between a user’s input, and a computer’s response to this input.
- Virtual Reality (VR) is conditioned by latency.
- Virtual Environments (VEs) emulate physical systems.
- Users of VEs expect them to respond accordingly.
- When a VE’s reactions are delayed:
  - The illusion is destroyed.
  - User behaviour deteriorates.

Computer systems have unavoidable latencies that must be compensated for:
- Graphics Processing Units (GPUs) provide high throughput, but their architecture suits only small subset of rendering techniques.
- Dataflow Computing provides new opportunities for low latency algorithms designed for VR.

Latin to miterable counters:
- The stronger the reaction, the more believable the environment.
- Our real-time ray caster can be seen on Demo Night, Wednesday 2nd

Ultra Low Latency Dataflow Renderer

We constructed a Dataflow Engine (DFE) based renderer with ultra low latency:
- Pixel values are computed atomically just in time that results in:
  - 1 ms for the renderer.
  - 6 ms for the entire apparatus (predominantly the scan-out time of the display).

We achieve one of the lowest latency systems reported:
- Comparable systems, e.g., Jota et al., typically use novel display technologies such as DMDs with a tight coupling between the renderer and the display.
- Our renderer took the place of a typical GPU and directly drove a full HD display.
- DFEs integrate well into the host system allowing maximal reuse of existing libraries and components.

The Effects of Low Latency on Pointing and Steering Tasks

We conducted a study: The Effects of Low Latency on Pointing and Steering Tasks.
In this study users completed simple tasks requiring high dexterity on a typical LCD.

Latency had a non-linear effect on the human motor system. This has significant implications for researchers conducting user performance tests.

Future Work

The Effects of Low Latency on Presence in Virtual Reality

A real-time ray casting renderer is already implemented:
- It can render a 3D virtual environment within a head mounted display without approximations.
- Users will be put in a stressful virtual environment while physiological cues are measured.
- The stronger the reaction, the more believable the environment.

Light Field Rendering

We will extend our ray caster to render from light fields:
- Light fields take a long time to synthesise.
- But sampling is a straightforward, highly localised operation.
- This will enable the ultimate combination of low latency and high fidelity.
- Hardware light field renderers have been built before:
  - But were limited by memory technology.

We aim for a system capable of displaying a large, highly detailed virtual environment.