CSE 190: Virtual Reality Technologies

Announcements

Project 2 late deadline this Sunday, May 17th at 11:59pm

Project 2 clarifications by Friday

Project 3 due Sunday, May 31st at 11:59pm

Today's VR app presentations:
- Zi Wang: InMind VR 2
- Yiran Chen: Superhot
- William Lui: Inception VR

Mitigating Rendering Latency

Rendering an image in stereo takes about 10 milliseconds.

Problem:
◦ By the time rendering is done, the user may have moved their head.

Pose Prediction

Predict what head pose is when images are displayed by extrapolating current head motion.

Two options:

Constant rate: Assume the currently measured angular velocity will remain constant over the latency interval.

Constant acceleration: Estimate angular acceleration and adjust angular velocity accordingly over the latency interval.

Time Warp

The idea of Timewarp has been around in VR research for decades, but the specific feature was added to the Oculus software in April 2014 by John Carmack.

Standard Timewarp in itself does not help with framerate. It was made to lower the perceived latency of VR.

Timewarp reprojects an already rendered frame just before sending it to the headset to account for the change in head rotation.

That is, it warps the image geometrically in the direction you rotated your head between the time the frame started and finished rendering. Since this takes a fraction of the time that re-rendering would and the frame is sent to the headset immediately after, the perceived latency is lower since the result is closer to what you should be seeing.

Asynchronous Time Warp (ATW)

Asynchronous Timewarp takes the same concept of geometric warping and uses it to compensate for dropped frames.

If the current frame doesn't finish rendering in time, ATW reprojects the previous frame with the latest tracking data instead.

It is called "asynchronous" because it occurs in parallel to rendering rather than after it. The synthetic frame is ready before it's known whether or not the real frame will finish rendering on time.
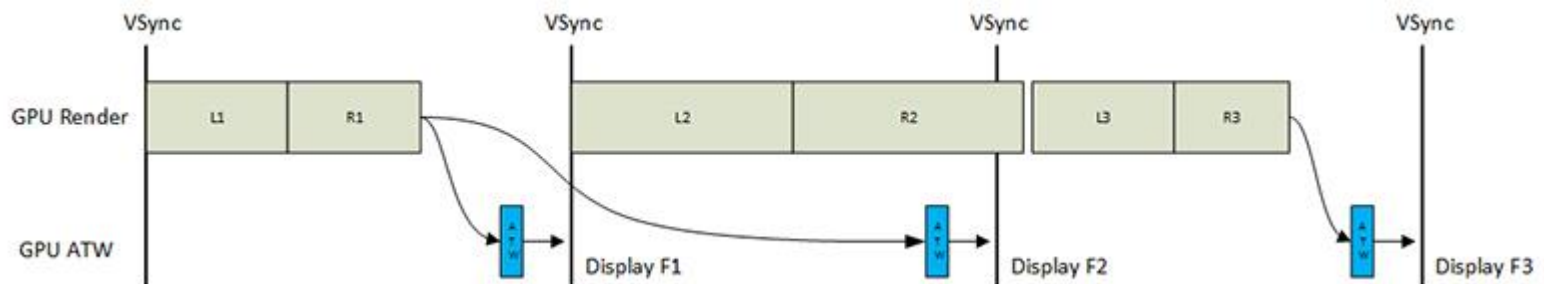
Asynchronous Space Warp (ASW)

When an application fails to render frames at 90Hz, the Rift driver drops the application down to 45Hz with ASW providing each intermediate frame.
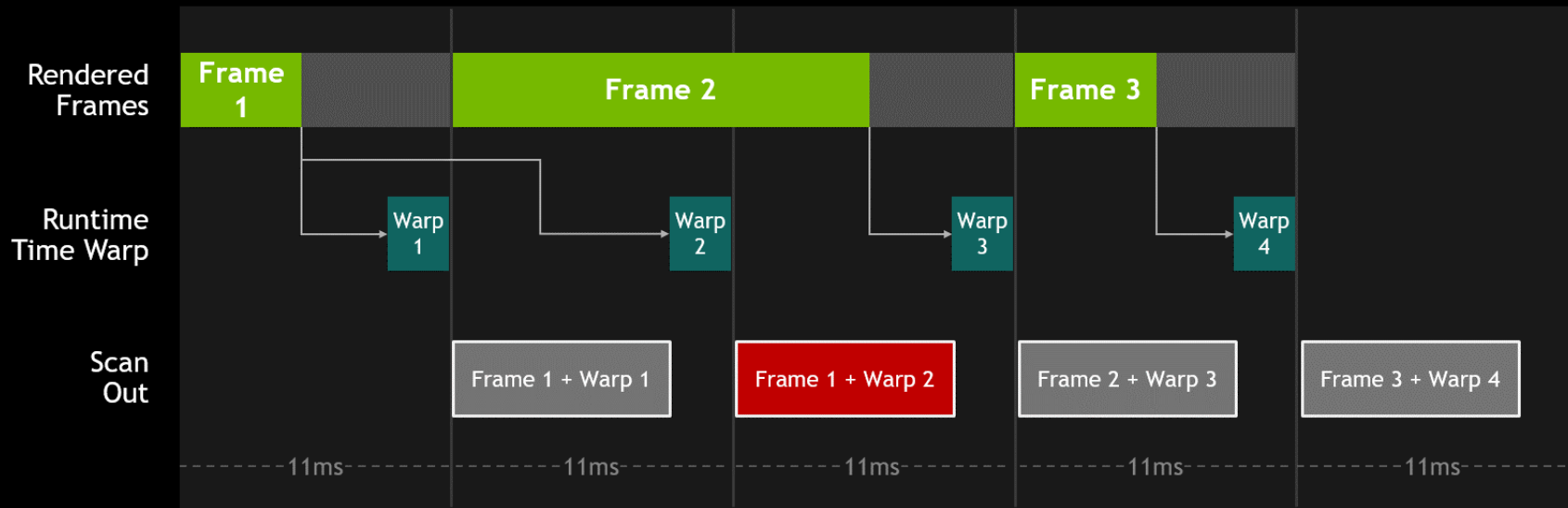
ASW works in tandem with ATW to cover all visual motion within the virtual reality experience.

ASW applies <u>animation detection</u>, <u>camera translation</u>, and <u>head translation</u> to previous frames in order to predict and extrapolate the next frame.
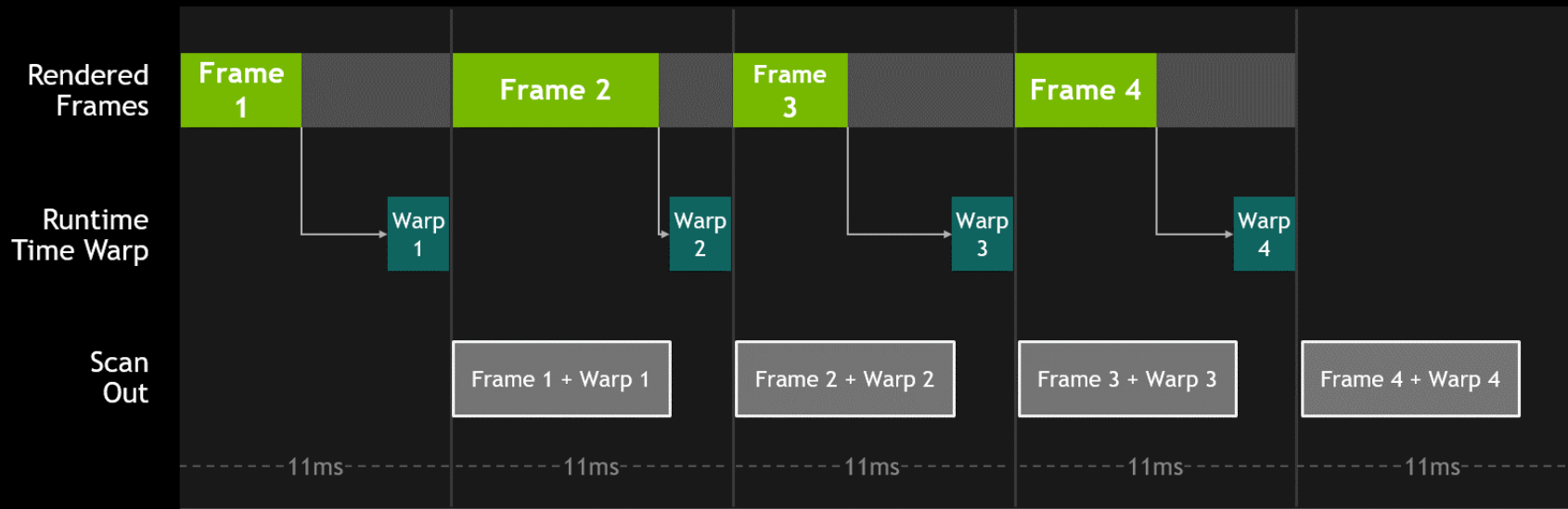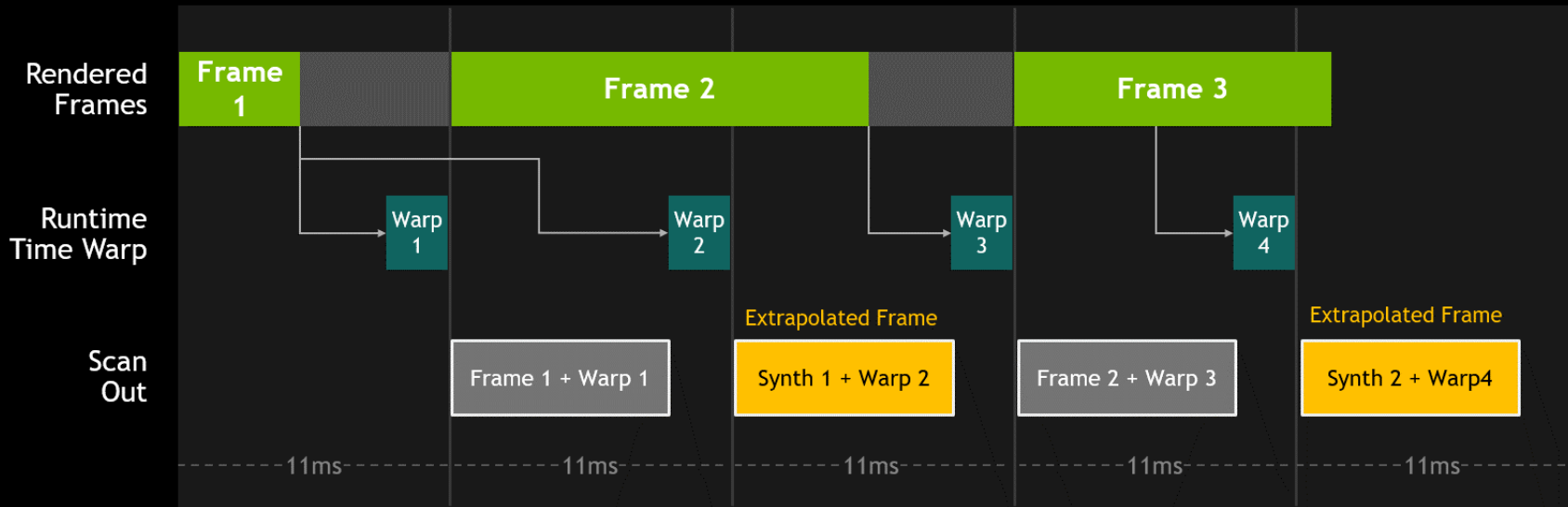
IDEAL VR PIPELINE

SYNTHESIZED FRAME

ASW – Results

As a result, motion is smoothed and applications can run on lower performance hardware:

◦ Nvidia 960 or greater (down from GTX 970 or greater)
◦ Intel i3-6100 / AMD FX4350 or greater (down from Intel i5-4590 equivalent or greater)

ASW tends to predict linear motion better than non-linear motion.

ASW – Visual Artifacts

ASW has problems with:
◦ Quick brightness changes
◦ Rapidly-moving repeating patterns in the environment
◦ Head-locked elements that move too fast to track properly

Spacewarp is a band-aid rather than a real performance optimization

Alternatives to ASW:
◦ Reduce rendering resolution
◦ Reduce polygon complexity
◦ Reduce texture detail
◦ Reduce time spent on non-rendering tasks

ASW 2.0

Asynchronous Spacewarp 2.0 is an update to ASW which enhances the quality of the technique by incorporating understanding of depth. When announcing the technique, Oculus showed the following scenario as an example of the visual artifacts the 2.0 update will eliminate:

https://www.youtube.com/watch?time_continue=4&v=I3LGq5TmMkw

Unlike the other techniques, ASW 2.0 won't work on just any app. The developer has to submit their depth buffer each frame, otherwise it will fall back to ASW 1.0.

Both Unity and Unreal Engine submit depth by default when using their Oculus integrations.