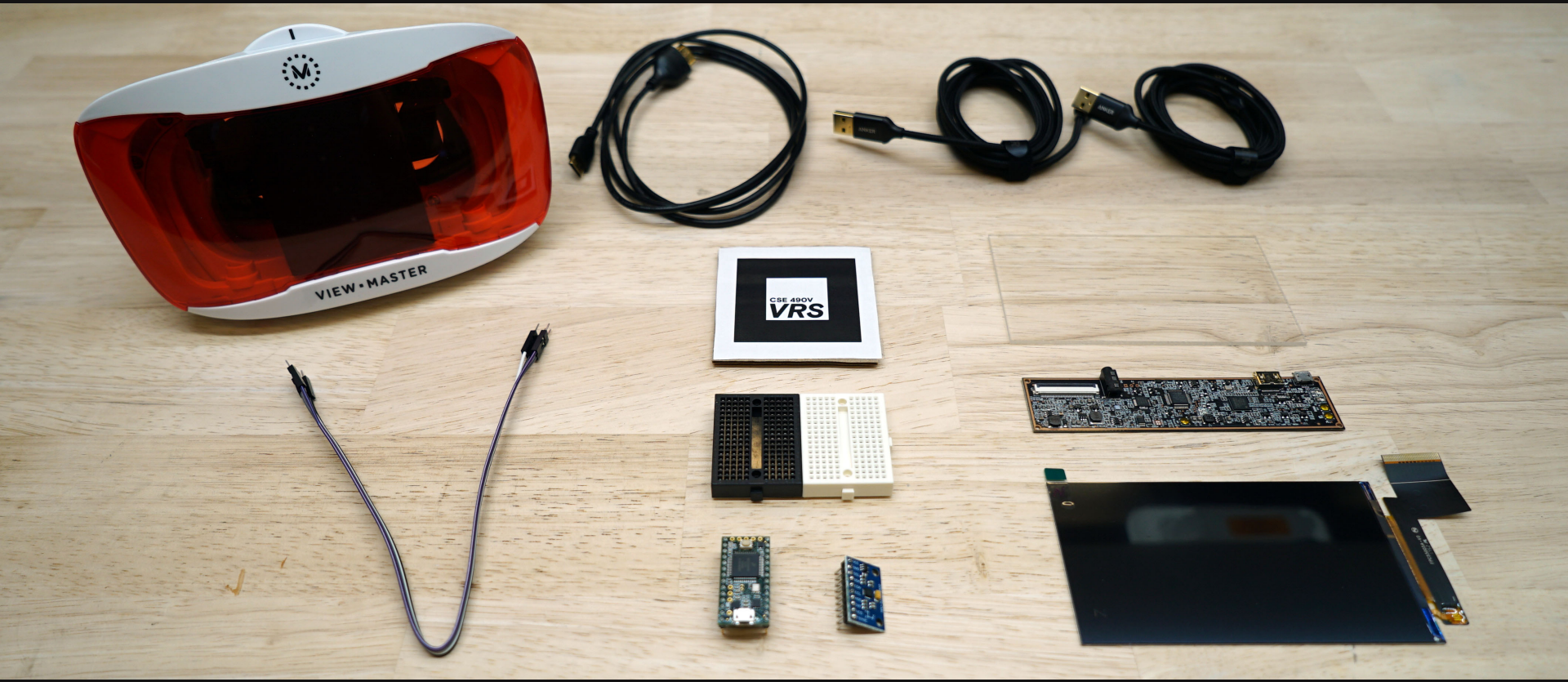


Final Project Presentations

VIRTUAL REALITY SYSTEMS

CSE 490V

OVERVIEW

Modern virtual reality systems draw on the latest advances in optical fabrication, embedded computing, motion tracking, and real-time rendering. In this hands-on course, students will foster similar cross-disciplinary knowledge to build a head-mounted display. This overarching project spans hardware (optics, displays, electronics, and microcontrollers) and software (JavaScript, WebGL, and GLSL). Each assignment builds toward this larger goal. For example, in one assignment, students will learn to use an inertial measurement unit (IMU) to track the orientation of the headset. In another assignment, students will apply real-time computer graphics to correct lens distortions. Lectures will complement these engineering projects, diving into the history of AR/VR and relevant topics in computer graphics, signal processing, and human perception. Guest speakers will participate from leading AR/VR companies, including by hosting field trips.

ACKNOWLEDGMENTS

This course is based on Stanford EE 267. We thank Gordon Wetzstein for sharing his course materials and supporting the development of CSE 490V. We also thank Brian Curless, David Kessler, Steve Seitz, Ira Kemelmacher-Shlizerman, and Adriana Schulz for their support.

REQUIREMENTS

This course is designed for senior undergraduates and early MS/PhD students. No prior experience with hardware is required. Students are expected to have completed Linear Algebra (MATH 308) and Systems Programming (CSE

Douglas Lanman

Instructor

Kirit Narain

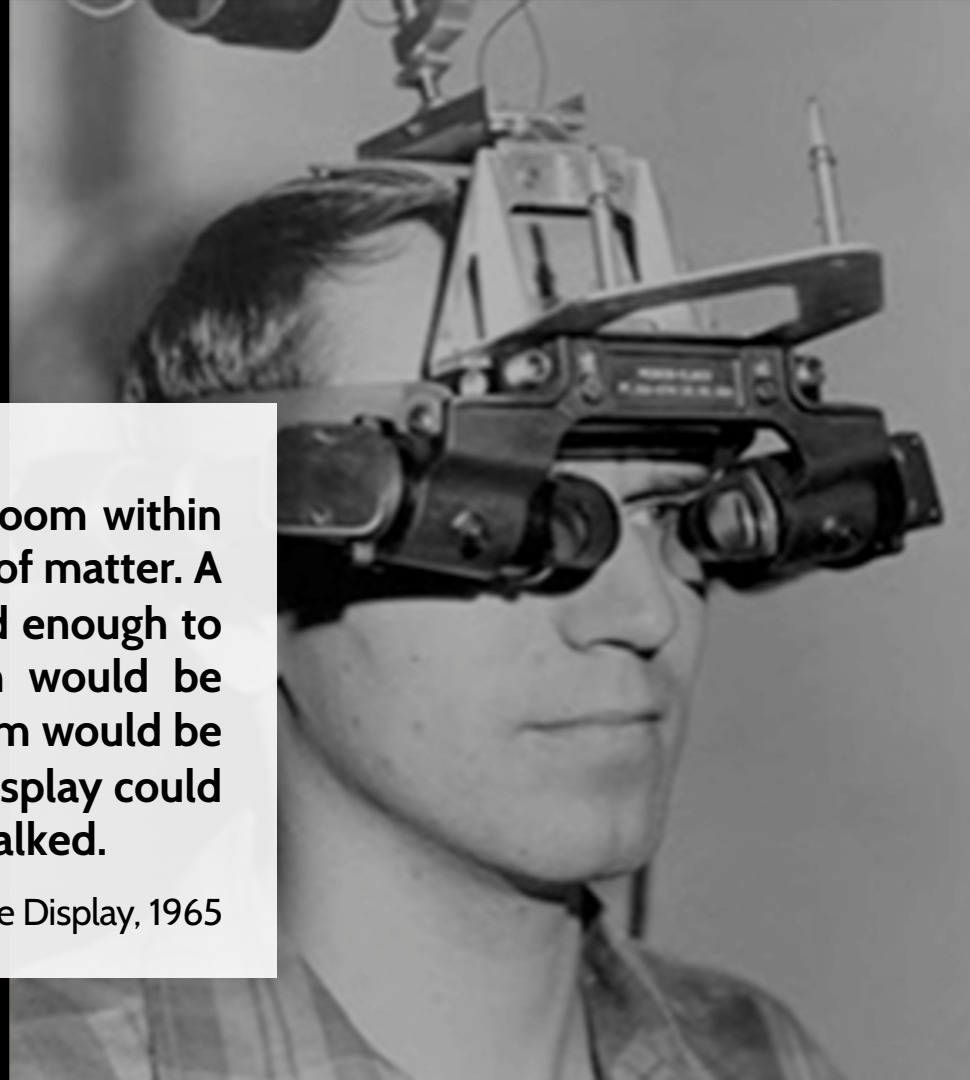
TA

Ethan Gordon

TA

The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked.

–Ivan Sutherland, The Ultimate Display, 1965



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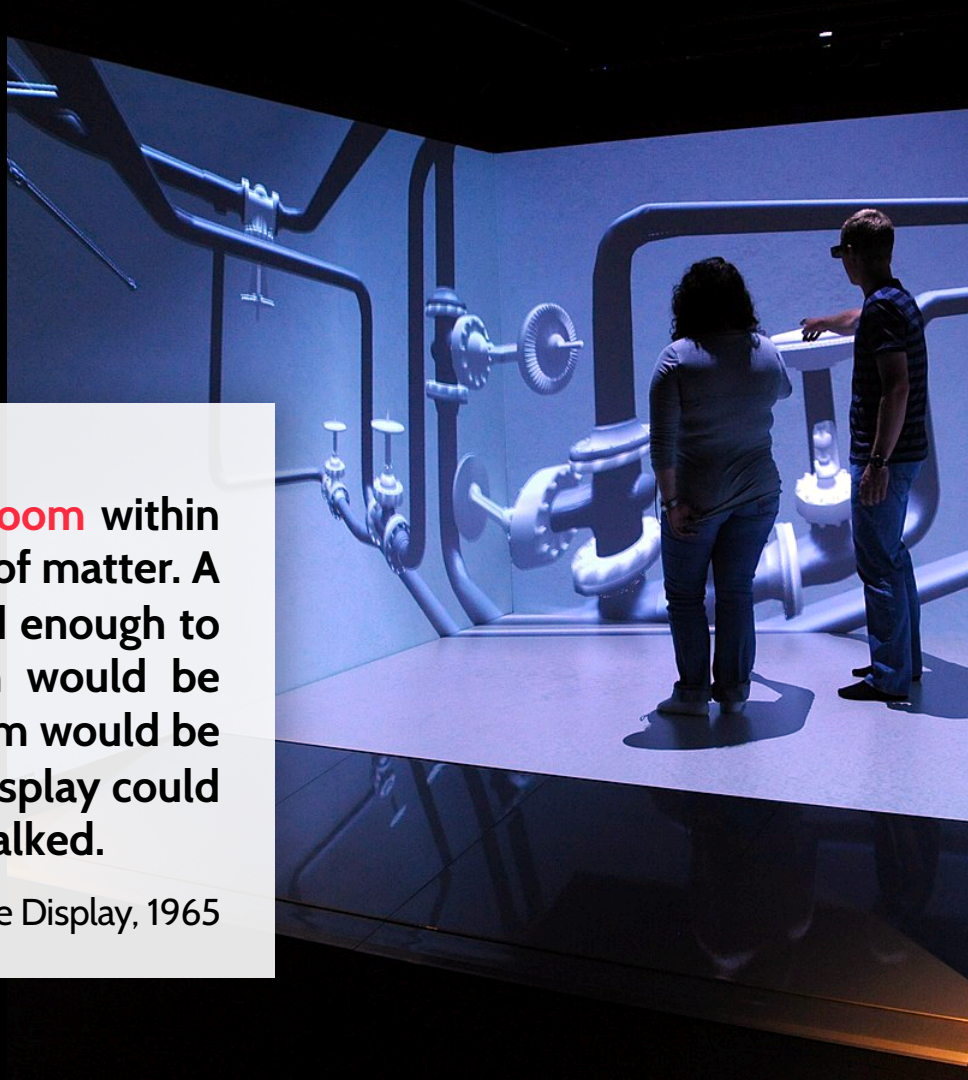


BUILD YOUR OWN VR HEADSET

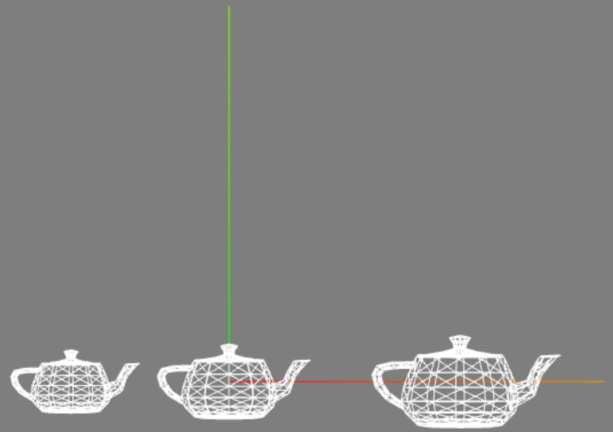

VIEW•MASTER
CSE 490V
VRS

HOMEWORK 1: TRANSFORMATIONS IN WEBGL

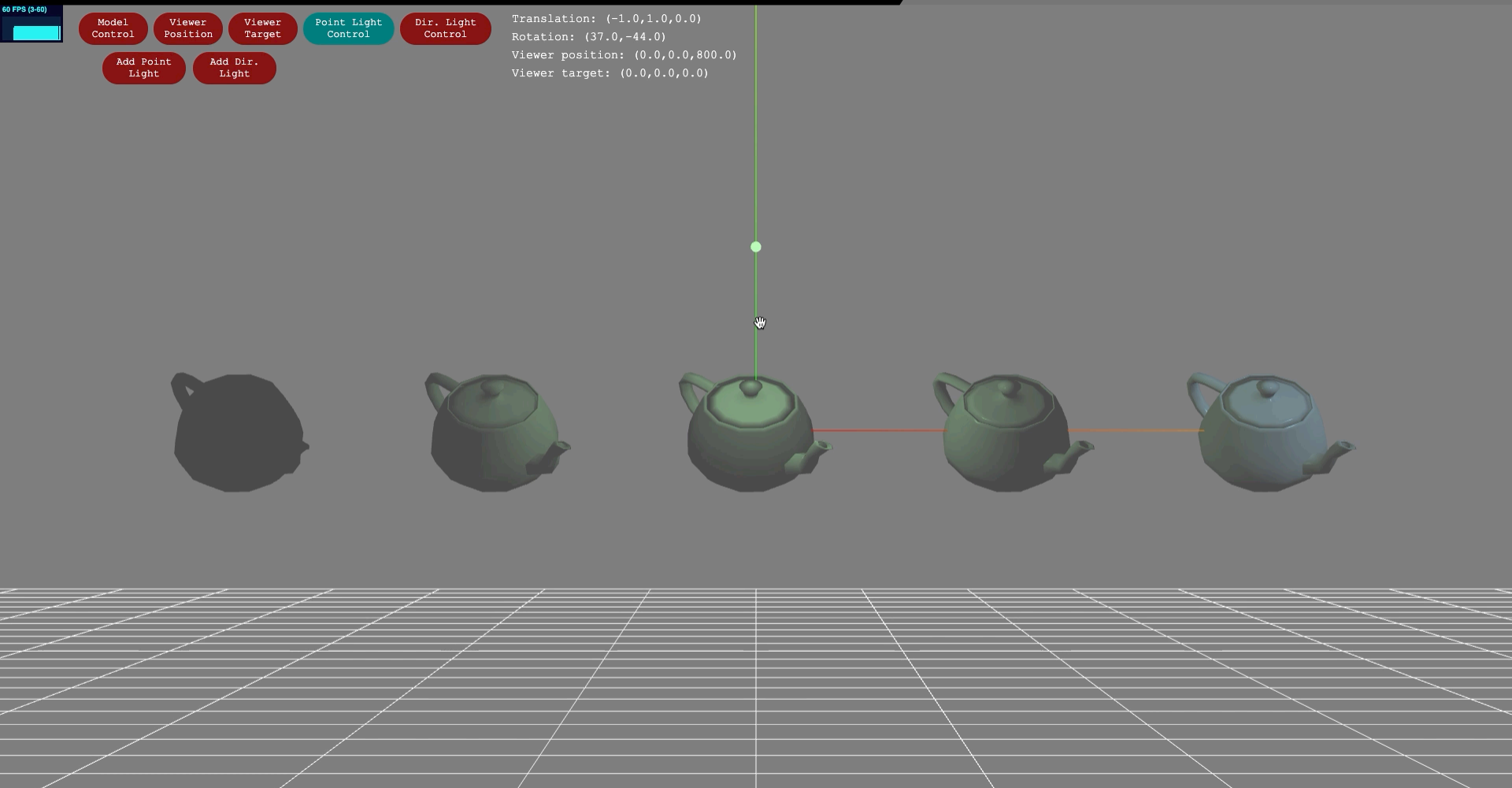
51 FPS (5-60)

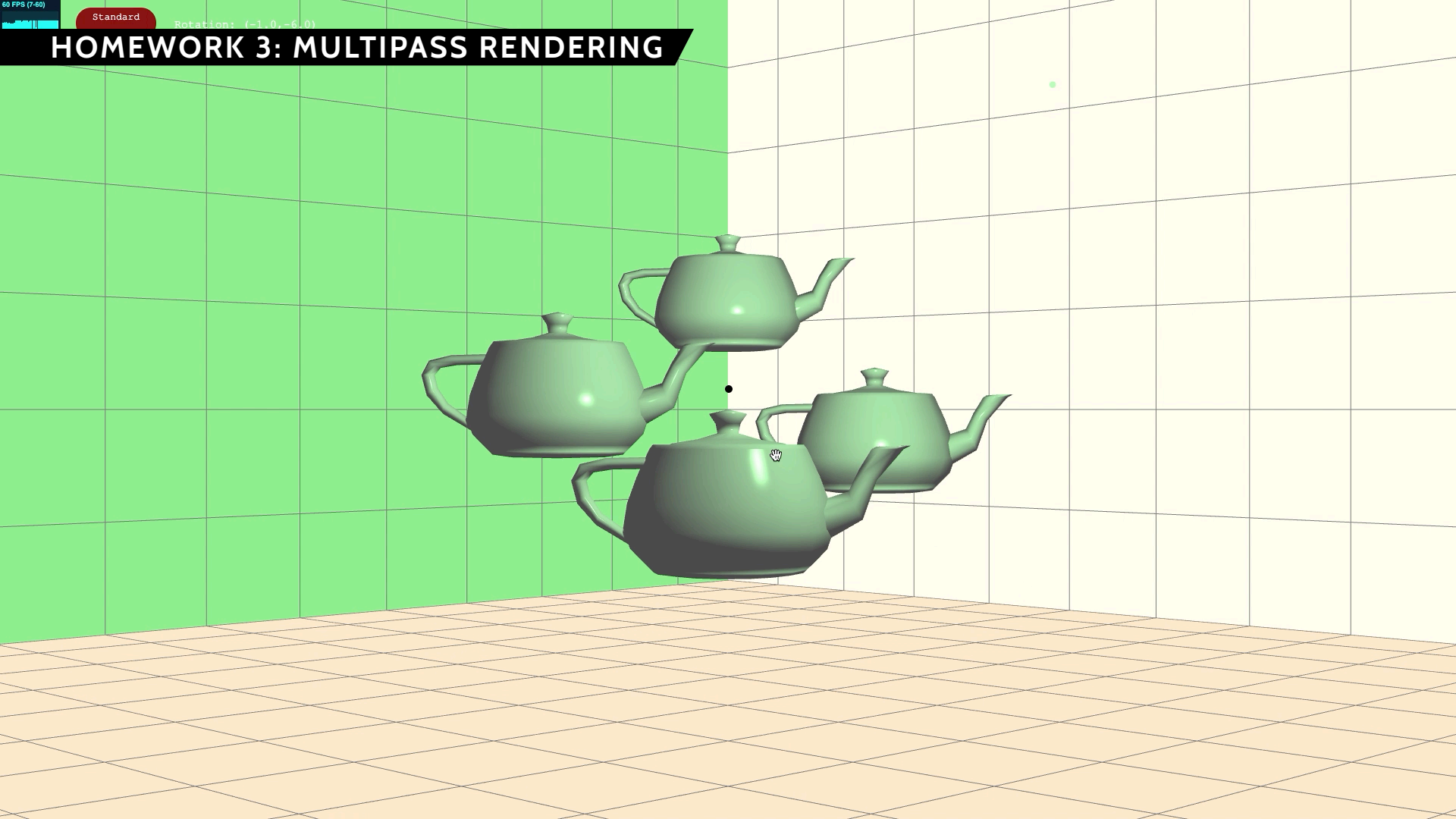
Model Control | Viewer Position | Viewer Target | Near Clipping | Perspective Matrix

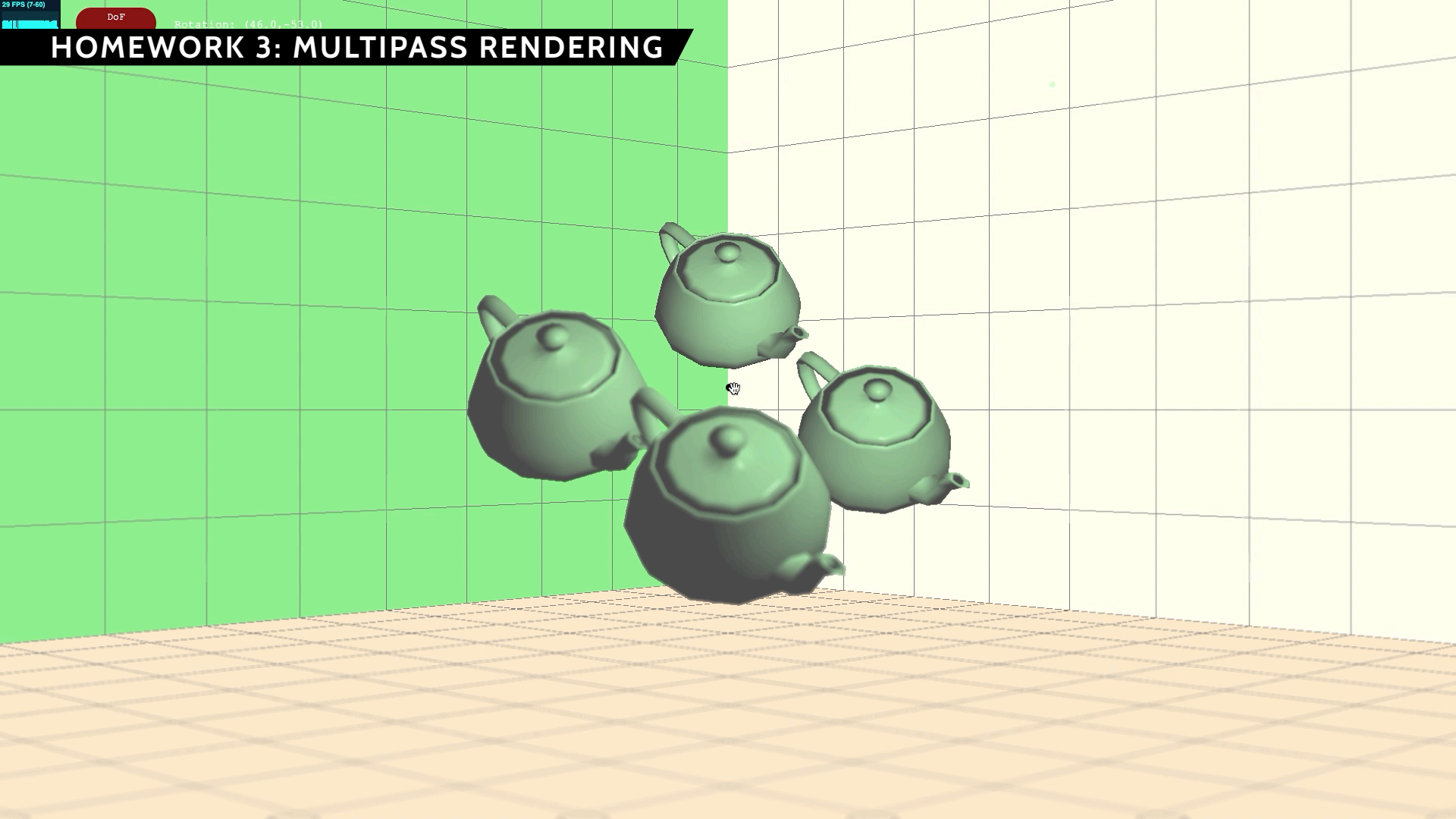
Translation: (0.0,0.0,0.0)
Rotation: (0.0,0.0)
Viewer position: (0.0,0.0,800.0)
Viewer target: (0.0,0.0,0.0)

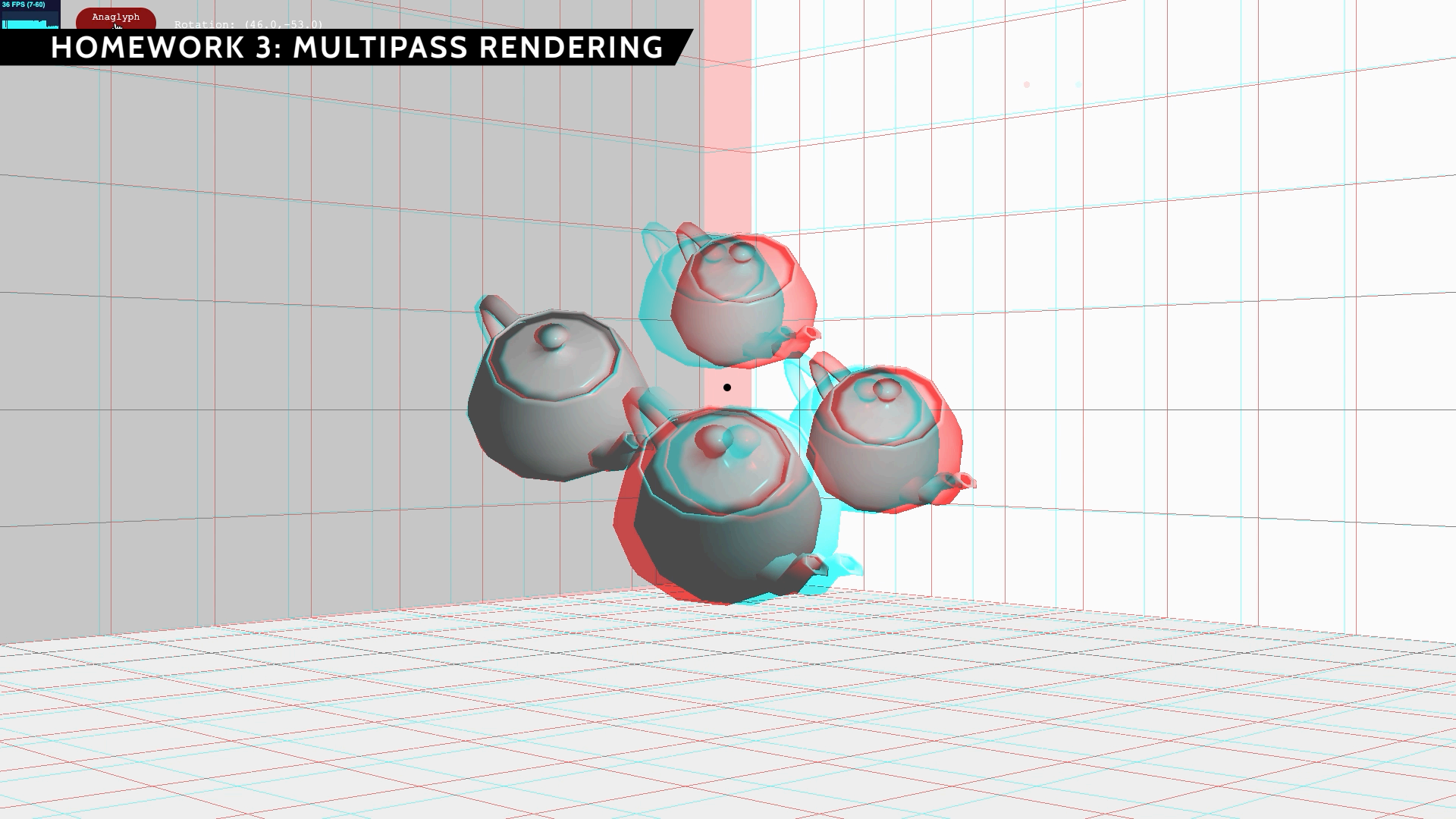


HOMEWORK 2: LIGHTING AND SHADING WITH GLSL



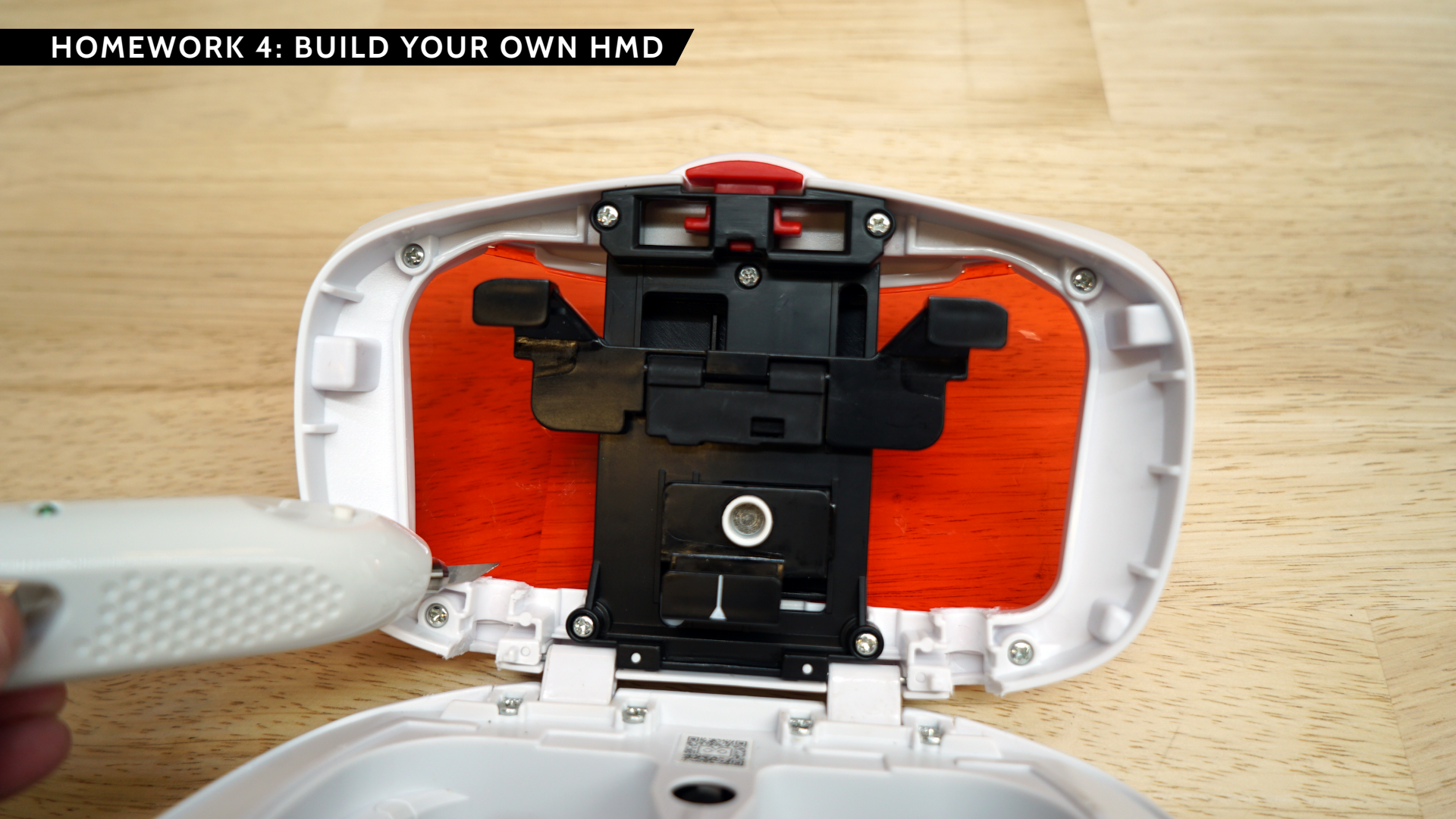

60 FPS (7-60)
Standard
Rotation: (-1.0,-6.0)
HOMEWORK 3: MULTIPASS RENDERING


29 FPS (7-60)
DoF
Rotation: (46.0,-53.0)
HOMEWORK 3: MULTIPASS RENDERING

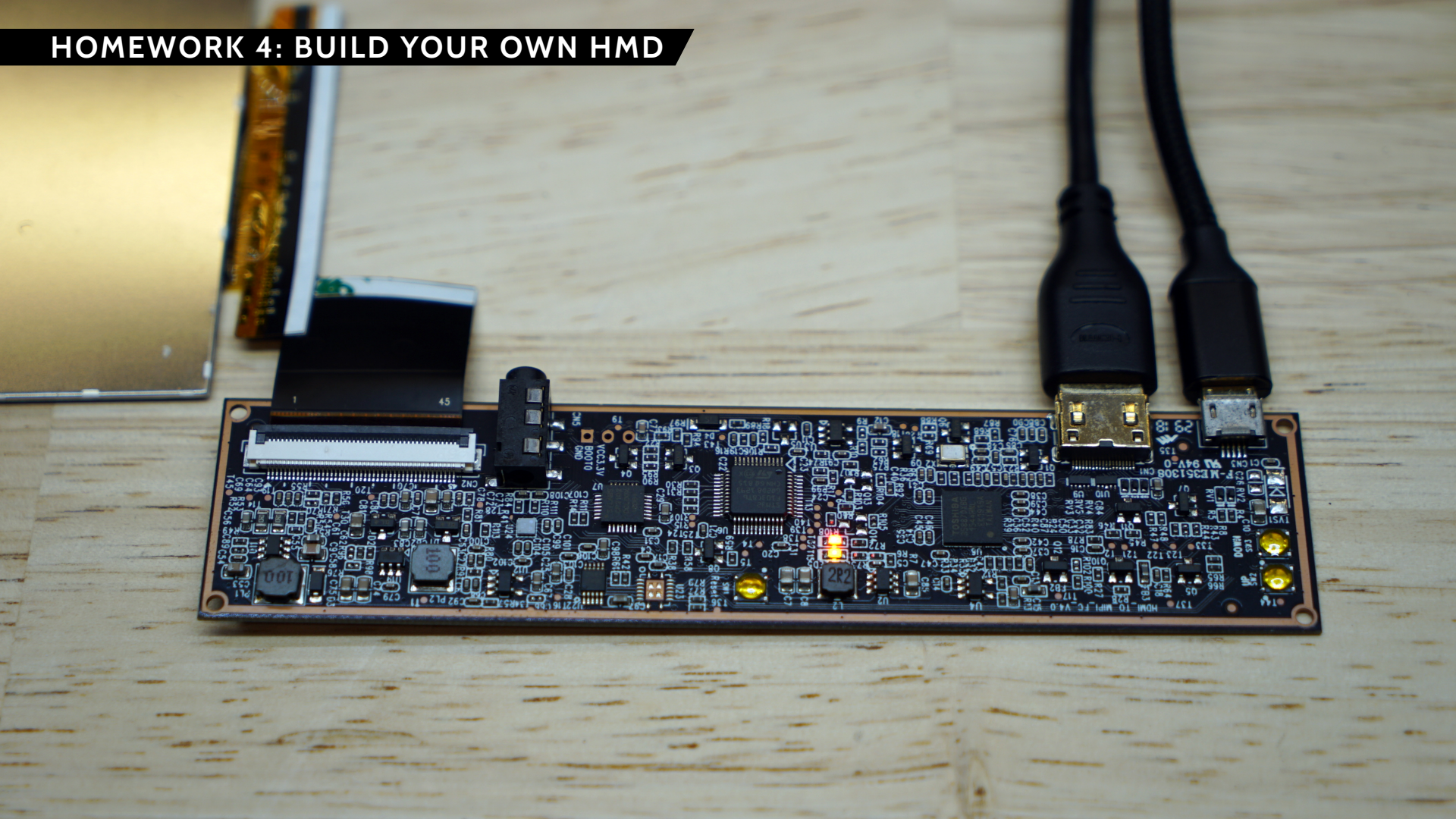

36 FPS (7-60)
Anaglyph
Rotation: (46.0,-53.0)
HOMEWORK 3: MULTIPASS RENDERING

HOMEWORK 4: BUILD YOUR OWN HMD

HOMEWORK 4: BUILD YOUR OWN HMD



HOMEWORK 4: BUILD YOUR OWN HMD



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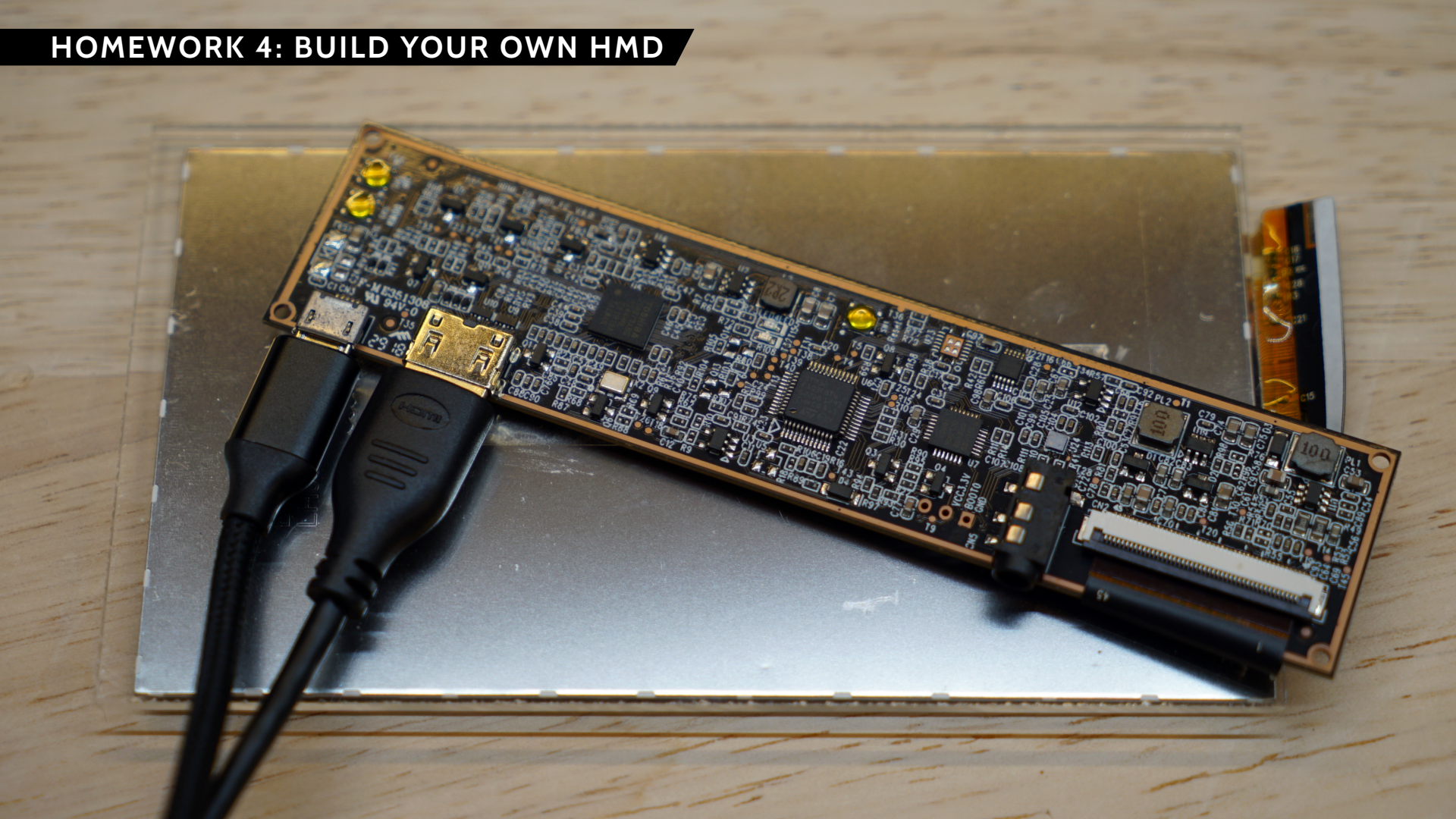

HOMEWORK 4: BUILD YOUR OWN HMD

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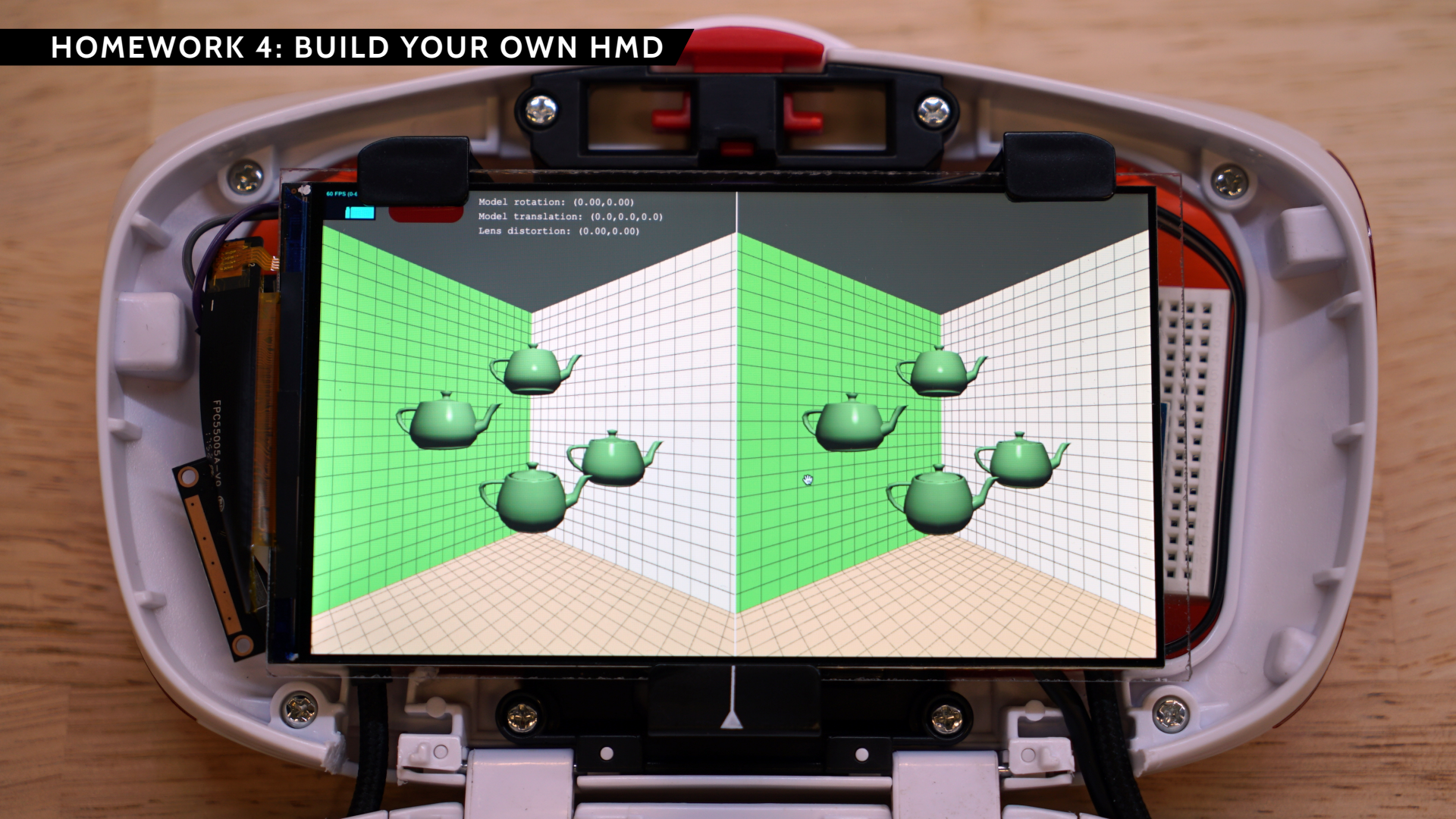

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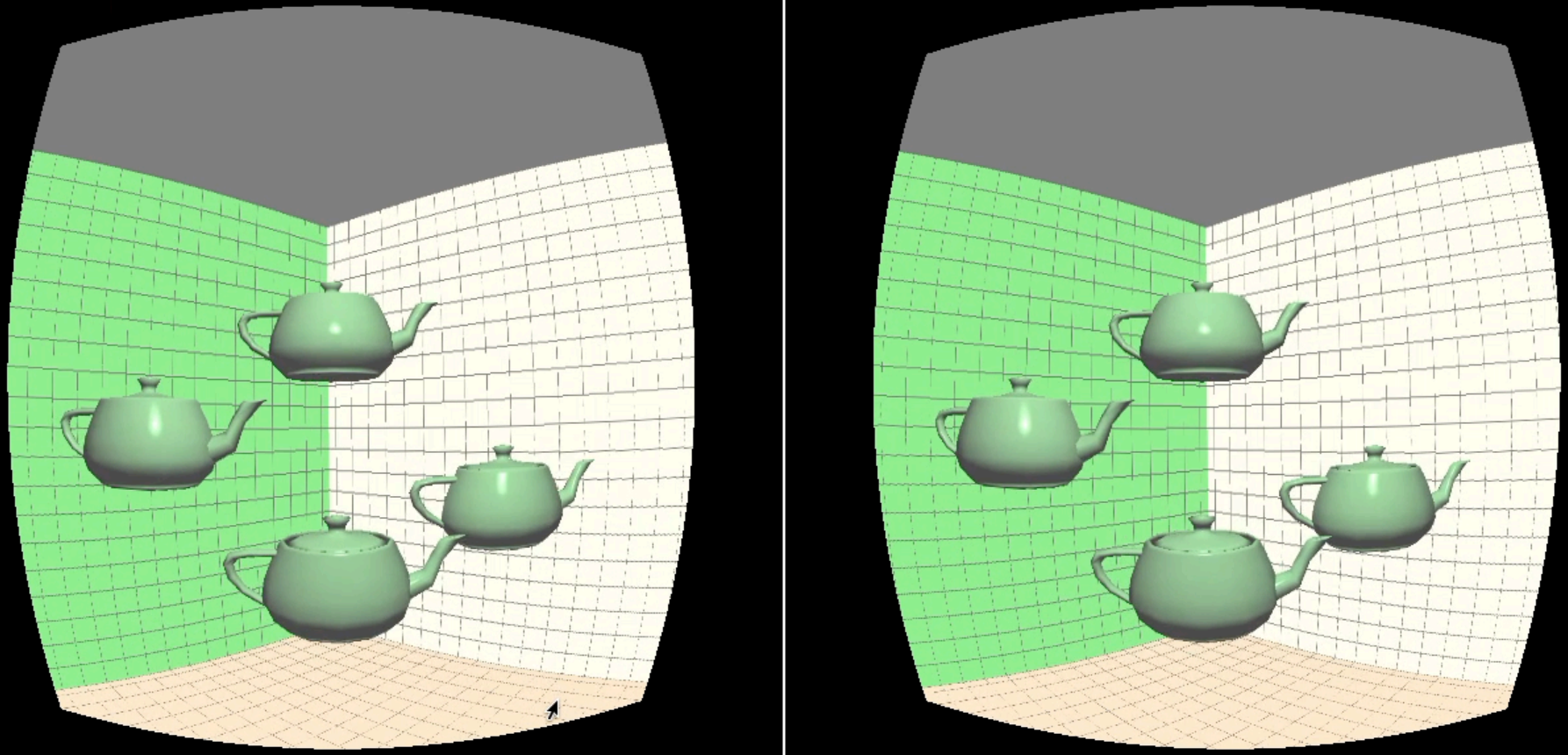
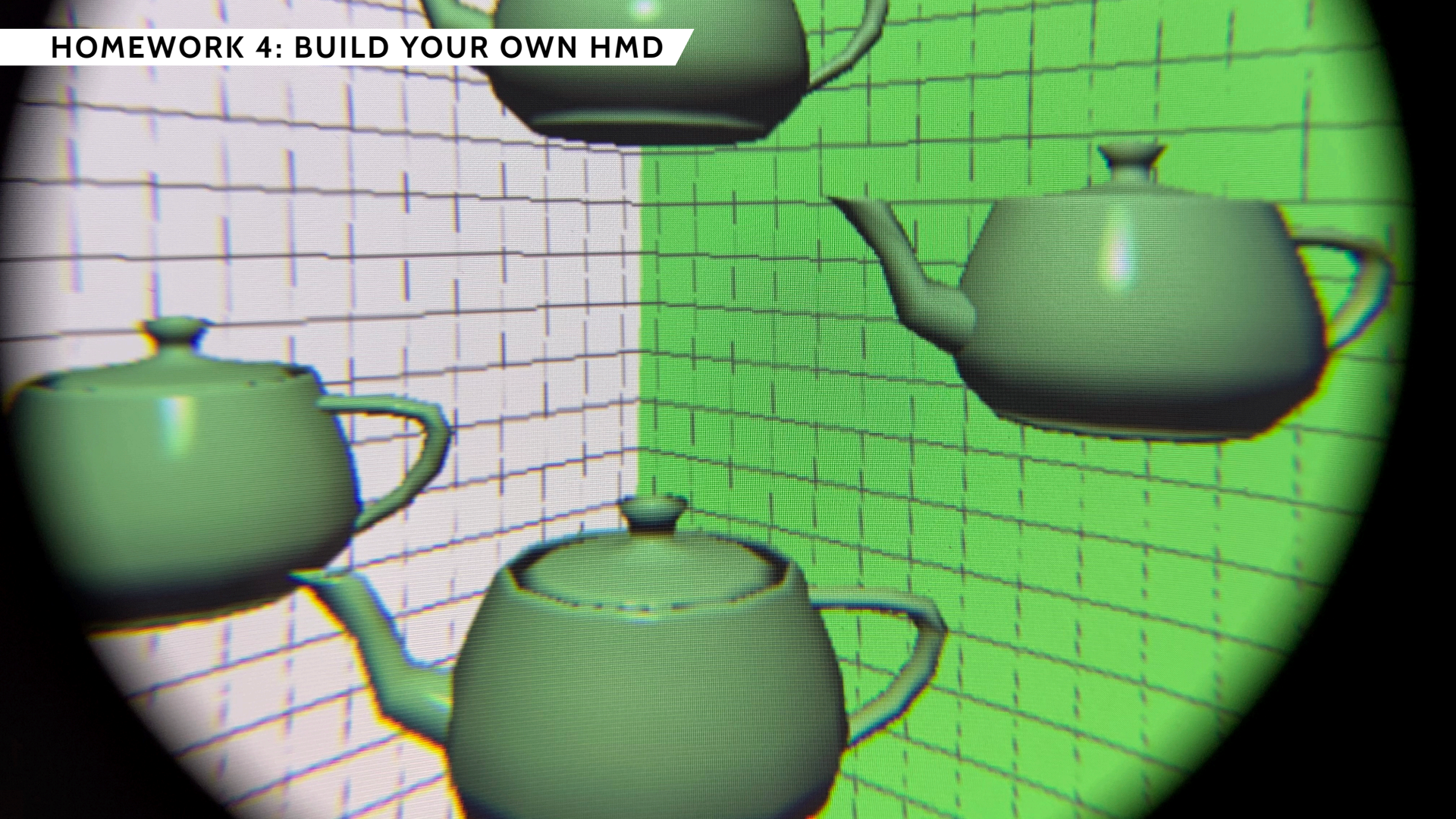
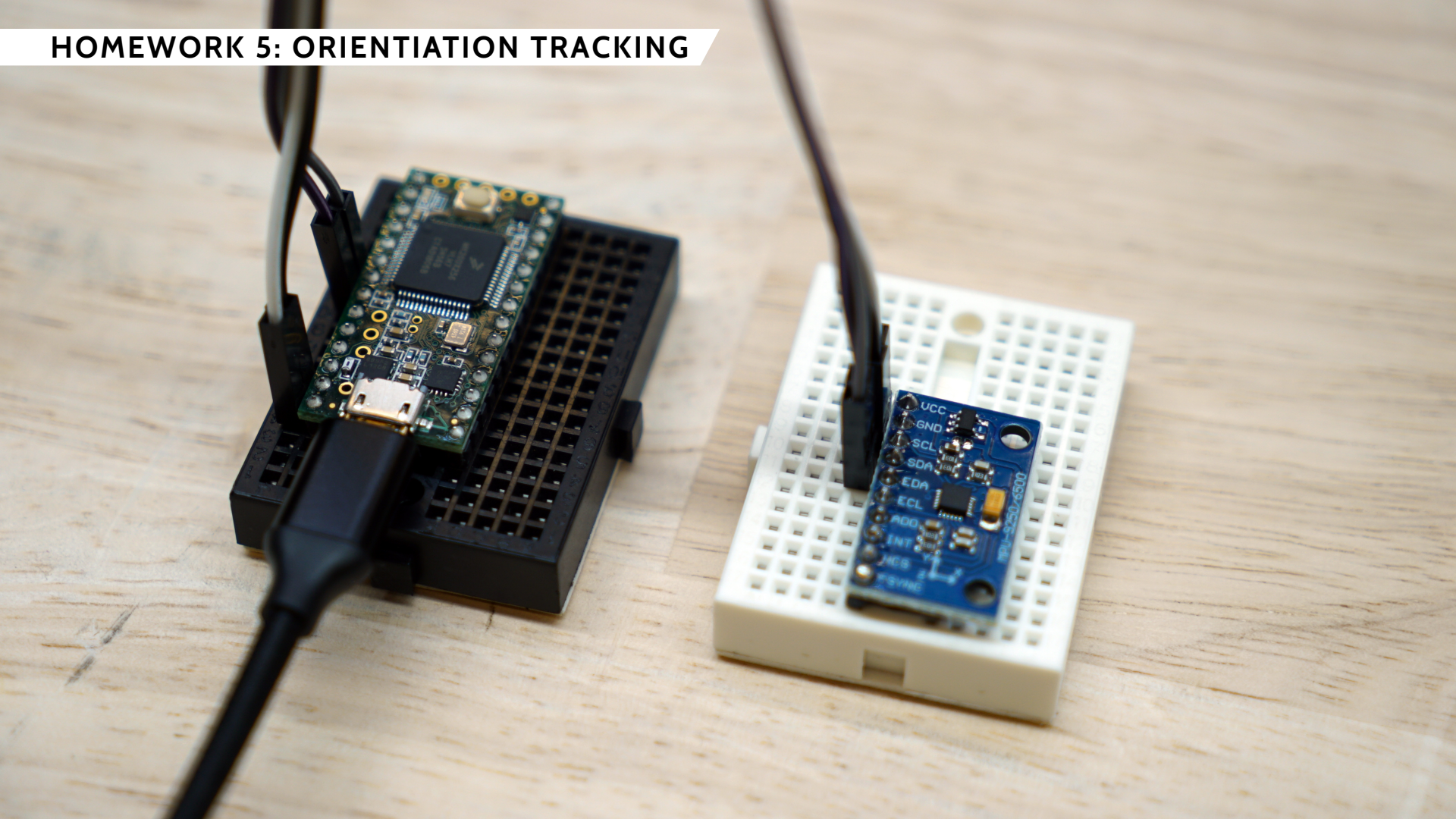


HOMEWORK 4: BUILD YOUR OWN HMD



HOMEWORK 5: ORIENTIATION TRACKING



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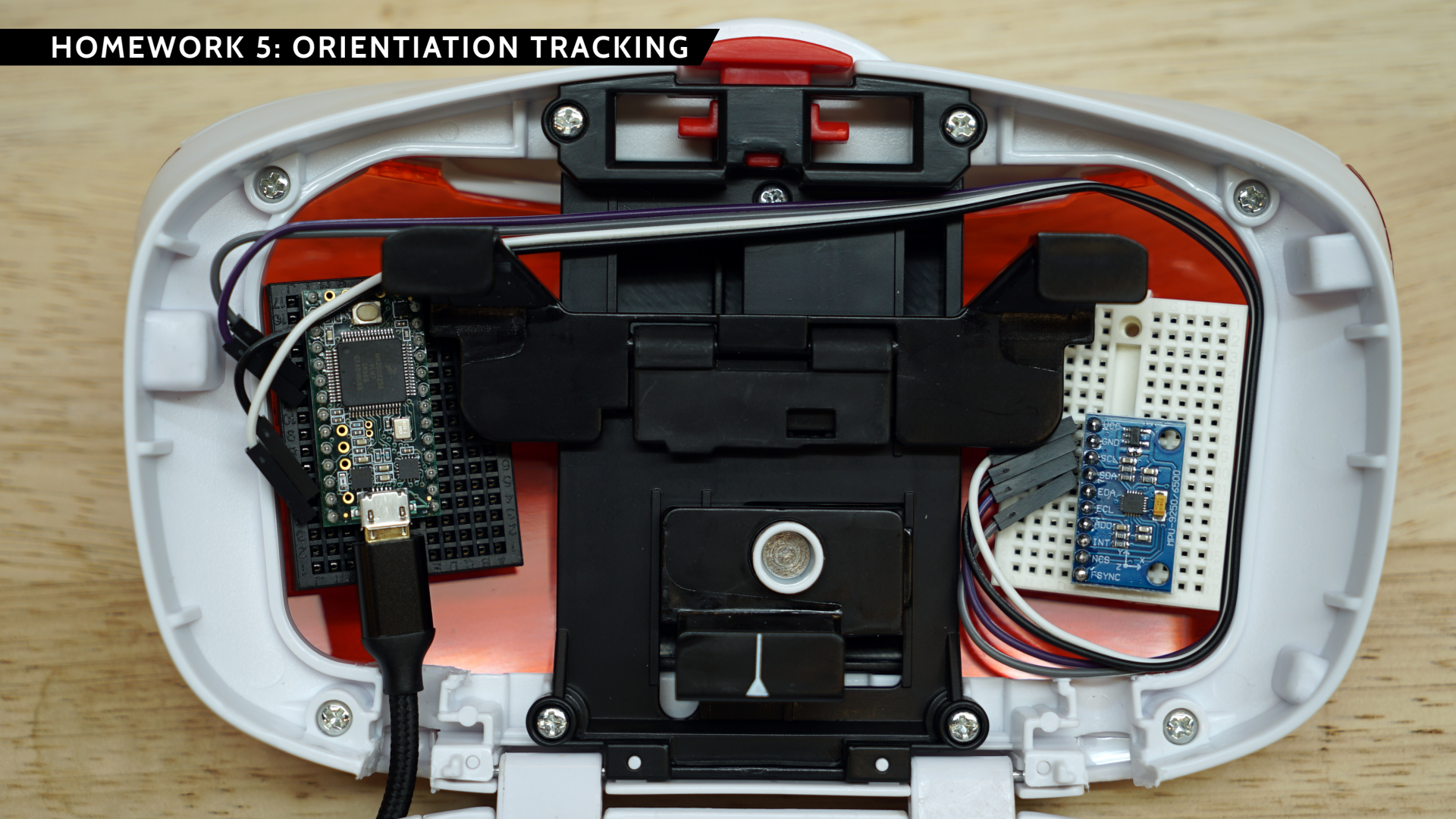

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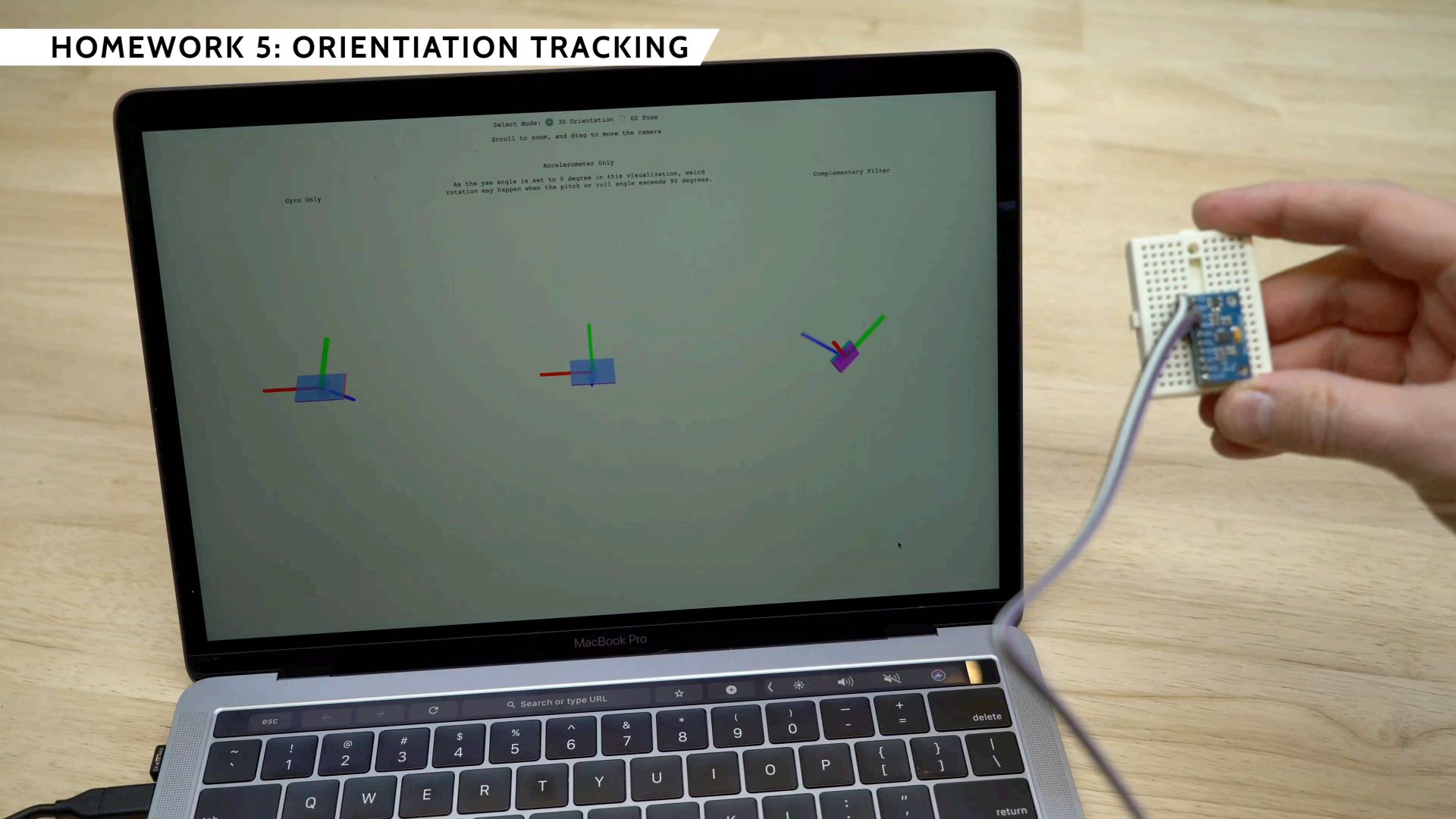


HOMEWORK 6: POSITIONAL TRACKING

HOMEWORK 6: POSITIONAL TRACKING

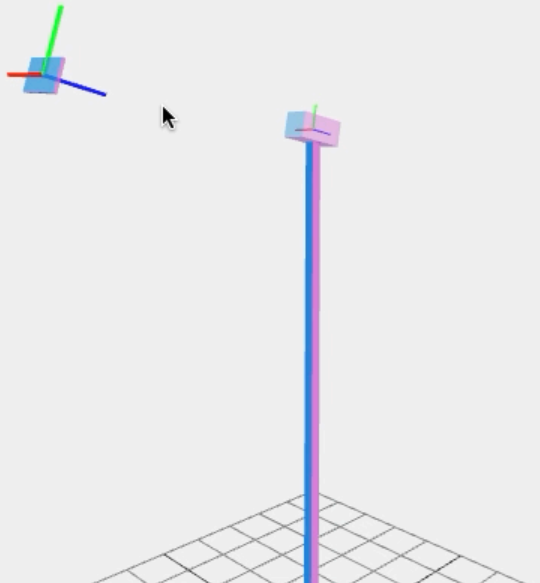
HOMEWORK 6: POSITIONAL TRACKING

Select Mode: ○ 3D Orientation ◉ 6D Pose

Scroll to zoom, and drag to move the camera

Translation (X,Y,Z in cm): -6.95, 5.56, -58.96,

Rotation (P,Y,R in deg) : 11.80, 4.17, 3.66,



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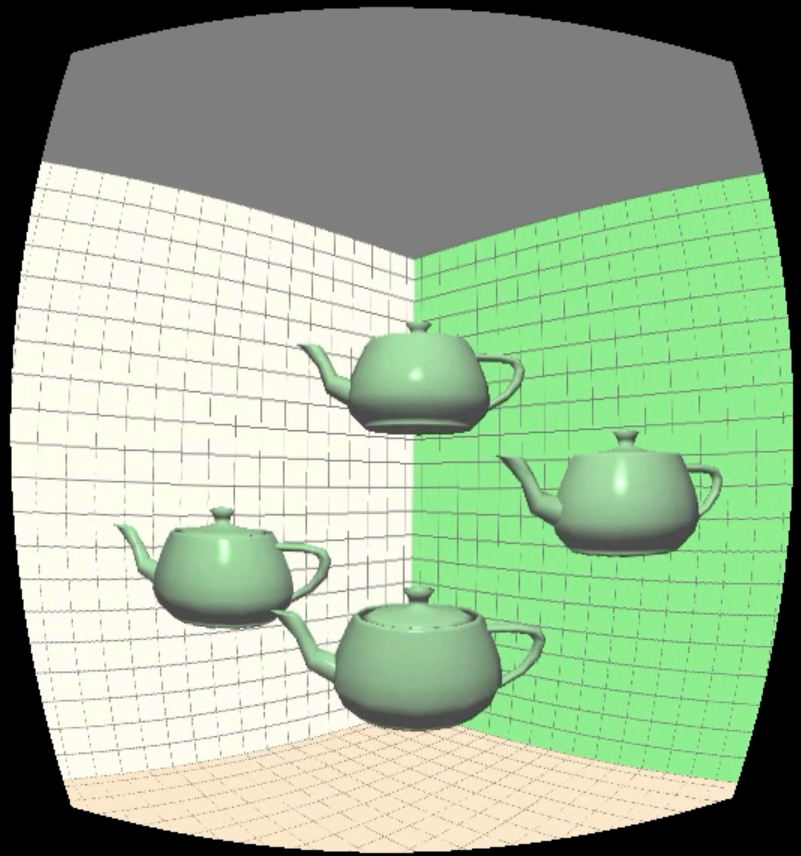
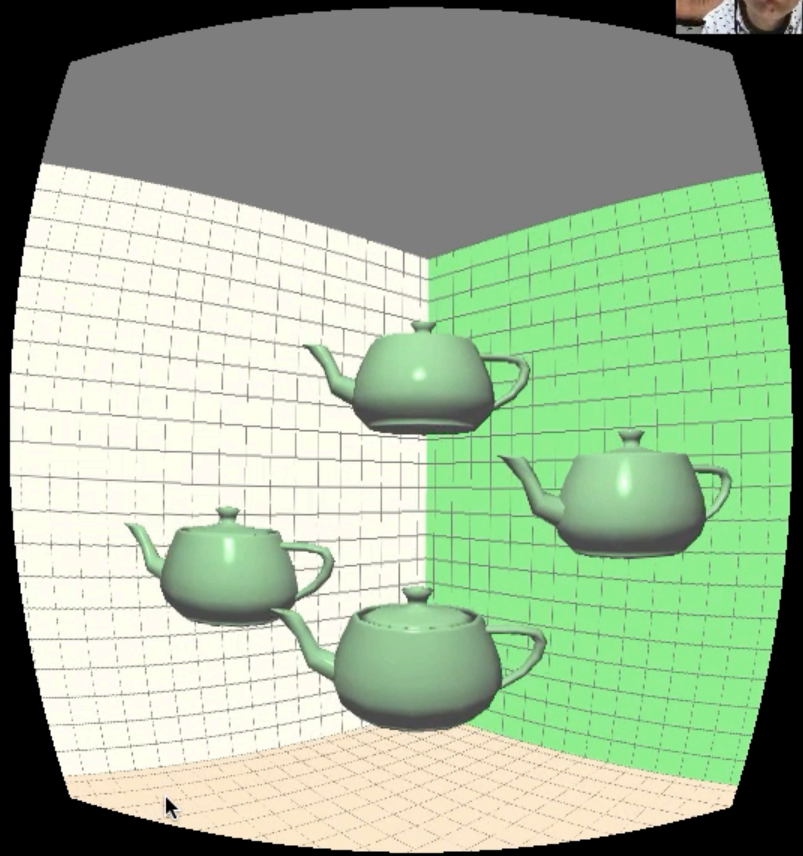




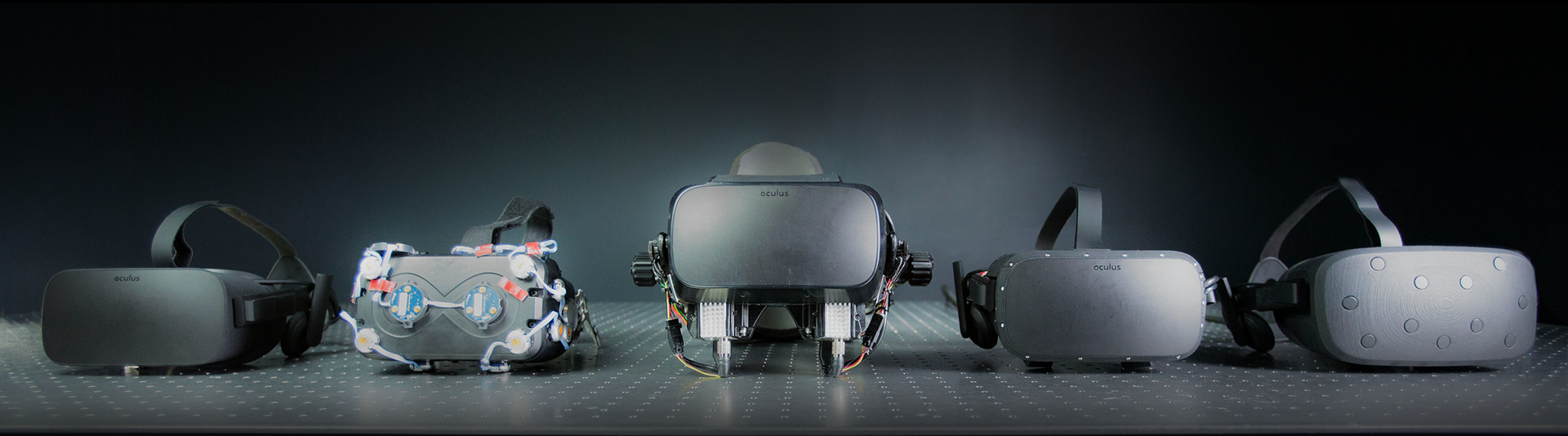
MEET THE PROS

MICROSOFT HOLOLENS

Mark Bolas
Joel Kollin
Ishan Chatterjee


VALVE CORPORATION
Jeremy Selan
Lakulish Antani
Alan Yates
Kerry Davis
Jeep Barnett

FACEBOOK REALITY LABS

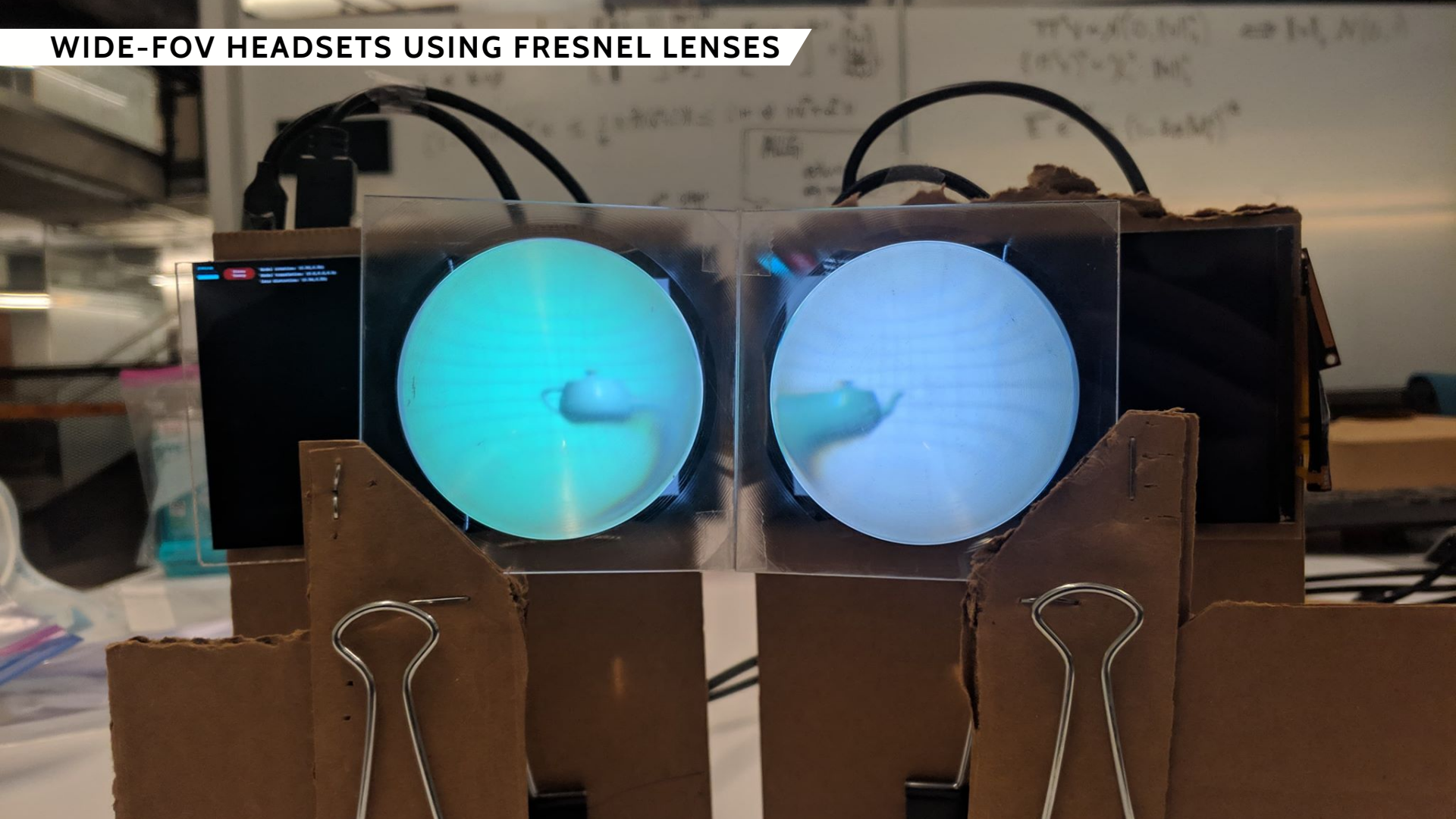


Douglas Lanman
Marina Zannoli

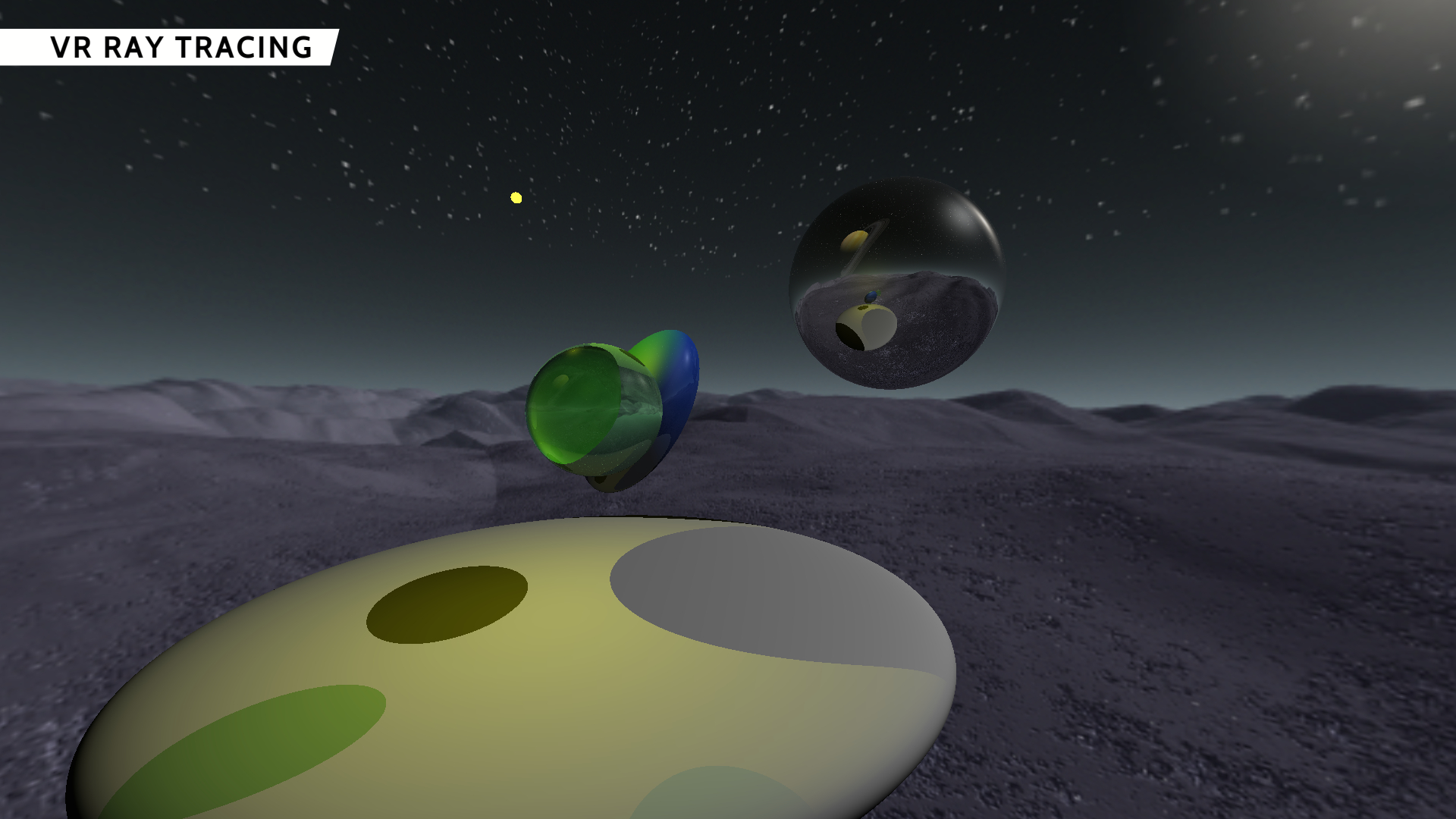
FINAL PROJECTS

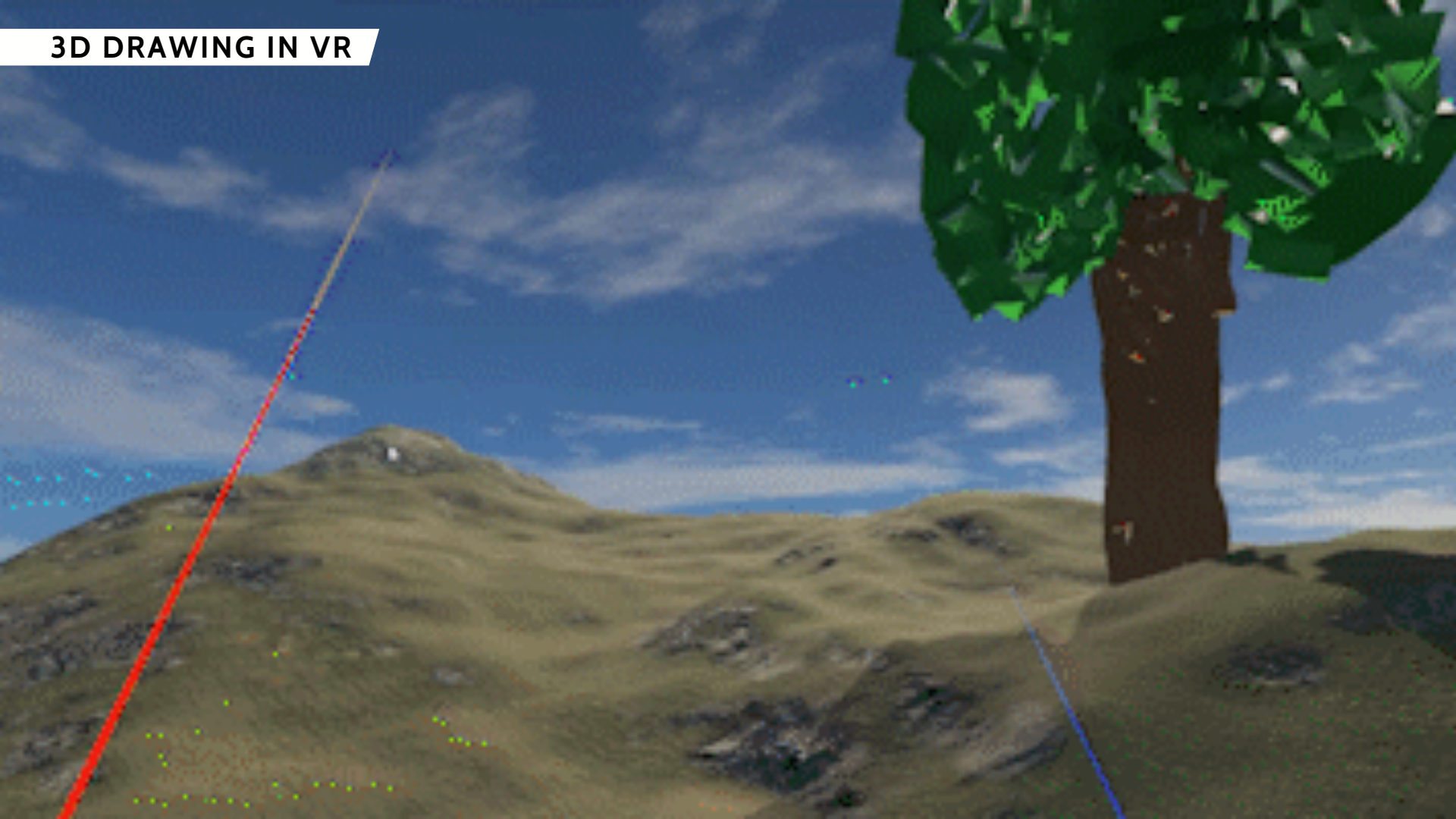
Time	Description
12:30 - 12:40pm	**Introduction**
12:30 - 12:40pm	Overview of CSE 490V and Final Projects
12:40 - 1:10pm	**Hardware**
12:40 - 12:50pm	Wide-FOV VR Headsets using Fresnel Lenses
12:50 - 1:00pm	360° Vision using FOV Compression
1:00 - 1:10pm	Finger Tracking using Magnetometers
1:10 - 1:40pm	**Body and Hand Tracking**
1:10 - 1:20pm	Inverse Kinematics and Full-Body Tracking
1:20 - 1:30pm	Exploring Two-Handed Interactions
1:30 - 1:40pm	VR Wings
1:40 - 2:00pm	**Eye Tracking**
1:40 - 1:50pm	Eye Tracking for VR Gaming
1:50 - 2:00pm	Real-Time Foveated Ray Tracing
2:00 - 2:30pm	**Rendering**
2:00 - 2:10pm	VR Ray Tracing
2:10 - 2:20pm	Foveated Ray Tracing
2:20 - 2:30pm	VR Volume Rendering
2:30 - 2:40pm	**Audio**
2:30 - 2:40pm	Showcasing Spatial Audio for VR Gaming
2:40 - 3:20pm	**Training and Education**
2:40 - 2:50pm	AR Basketball Training
2:50 - 3:00pm	VR Batting Cage
3:00 - 3:10pm	3D Drawing in VR
3:10 - 3:20pm	VR Galaxy Explorer
3:20 - 3:50pm	**Applications**
3:20 - 3:30pm	Crime Scene Investigation
3:30 - 3:40pm	Sketching in AR
3:40 - 3:50pm	VR Dueling
3:50 - 4:00pm	**Conclusion**
3:50 - 4:00pm	Course Summary and Q&A

WIDE-FOV HEADSETS USING FRESNEL LENSES



EYE TRACKING FOR VR GAMING


VR RAY TRACING


3D DRAWING IN VR

VR BATTING CAGE