Implement of Augmented Reality Display and VR User Control on Glasses

Edward Tian
2022 - 2023
PRISMS
Applied Physics

Description

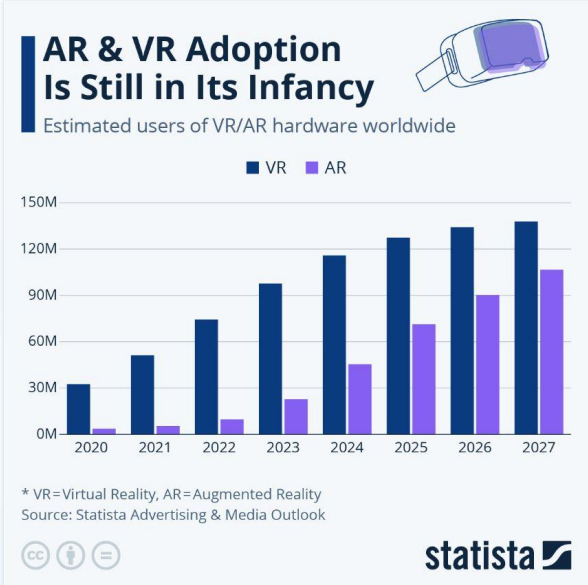
A near-eye augmented reality display with simple user control using lens and ESP. A combination of augmented reality display and virtual reality control is to be designed.

Content

Description of Problem / Issue

Augmented reality and virtual reality are the newest technologies that are still in development and they will definitely help people in the future, and a lot of researchers and companies are developing AR technologies. A lot of AR and VR products are implemented around the world, such as Google Glasses, Meta VR headset, and Microsoft AR headset in the US army.

But the products nowadays still have some issues, like the user control may not be perfect. So in this research, a AR display glass with a VR-like controller is to be developed.



Objectives & Approach

The first objective is to successfully display the graphical information from a server (laptop) on a large scale model. It can be in a single color, but it will be better if it is in multiple colors. I will use geometrical optics to calculate the proper position for the projector and lenses. I will build this model on an optical table. When a clear image is formed on the screen, the first objective is achieved.

The second objective is to build a scale-downed model for the glass. This requires a tiny projector. I will order a half-hand-sized projector online to complete the object. To hold the structure, I will use a 3D printer to print some parts and a laser cutter to cut some plywood to build the frame. The sign of success to this objective is I can see a clear projection on the glasses when the projector is connected to the server.

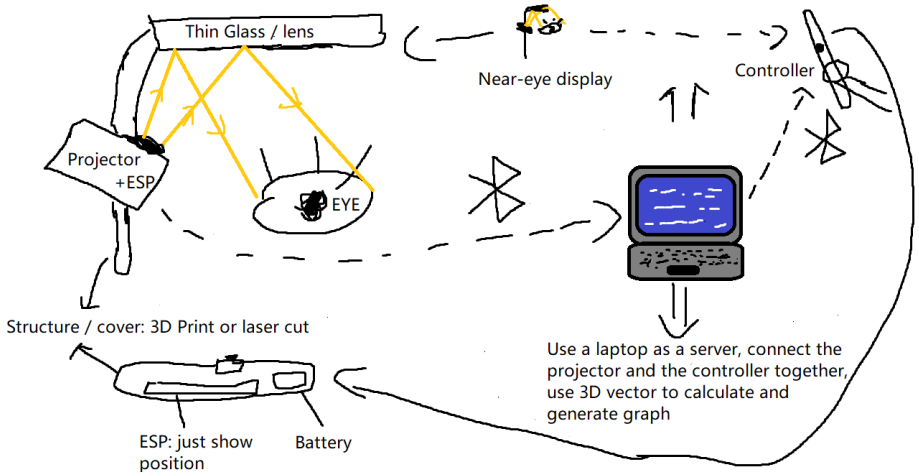
The third objective is to know the position and the angle the projector is facing. A piece of ESP and an accelerometer will be used here. Attach the ESP and accelerometer with the frame, then connect the ESP with the server with Bluetooth, and receive the data from the accelerometer. The third objective is accomplished when the correct displacement and rotation is shown on the server.

The fourth objective is to build a simple user controller. Do the same thing as the second and the third objectives. The only difference is to build a cylinder container which contains ESP and accelerometer inside. Success condition is still showing the displacement and rotation on the server.

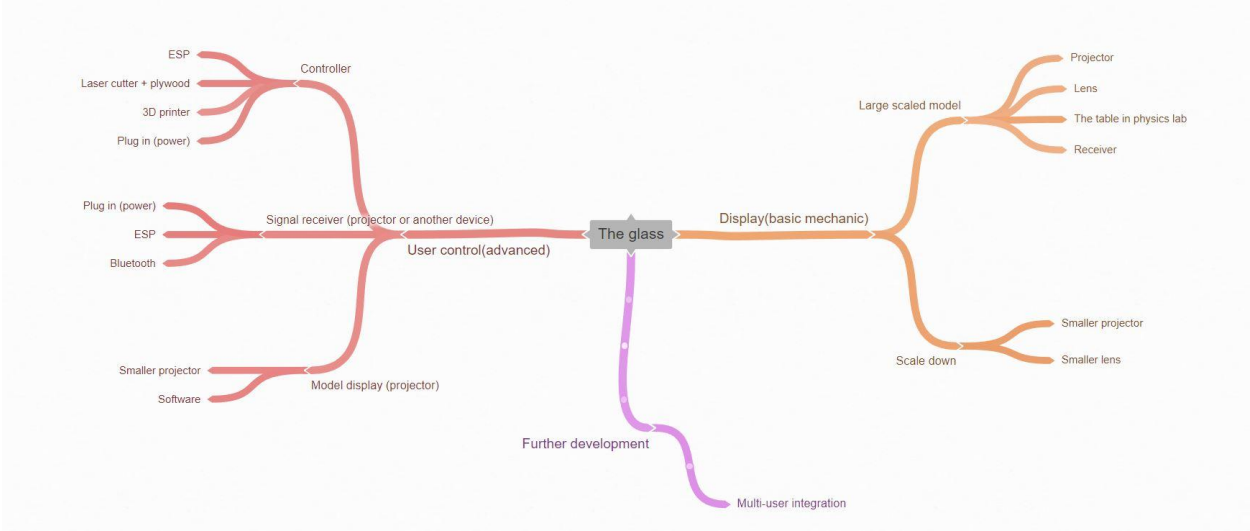
The fifth objective is to create a simple scene to give user feedback when he is moving head or the controller around. I will use Unity to create a new scene with only a colored cylinder and a camera. The data from two accelerometers before will be implemented in the Unity objects. The camera shows what the user should see, and the cylinder should be in the position of the controller. The goal of this phase is to allow users to both see what's in the real world and the colored cylinder on the controller.

The sixth objective is to build more controllers and glasses, which makes different users see the models in different positions. This is just repentance of the steps before.

Device



Operations



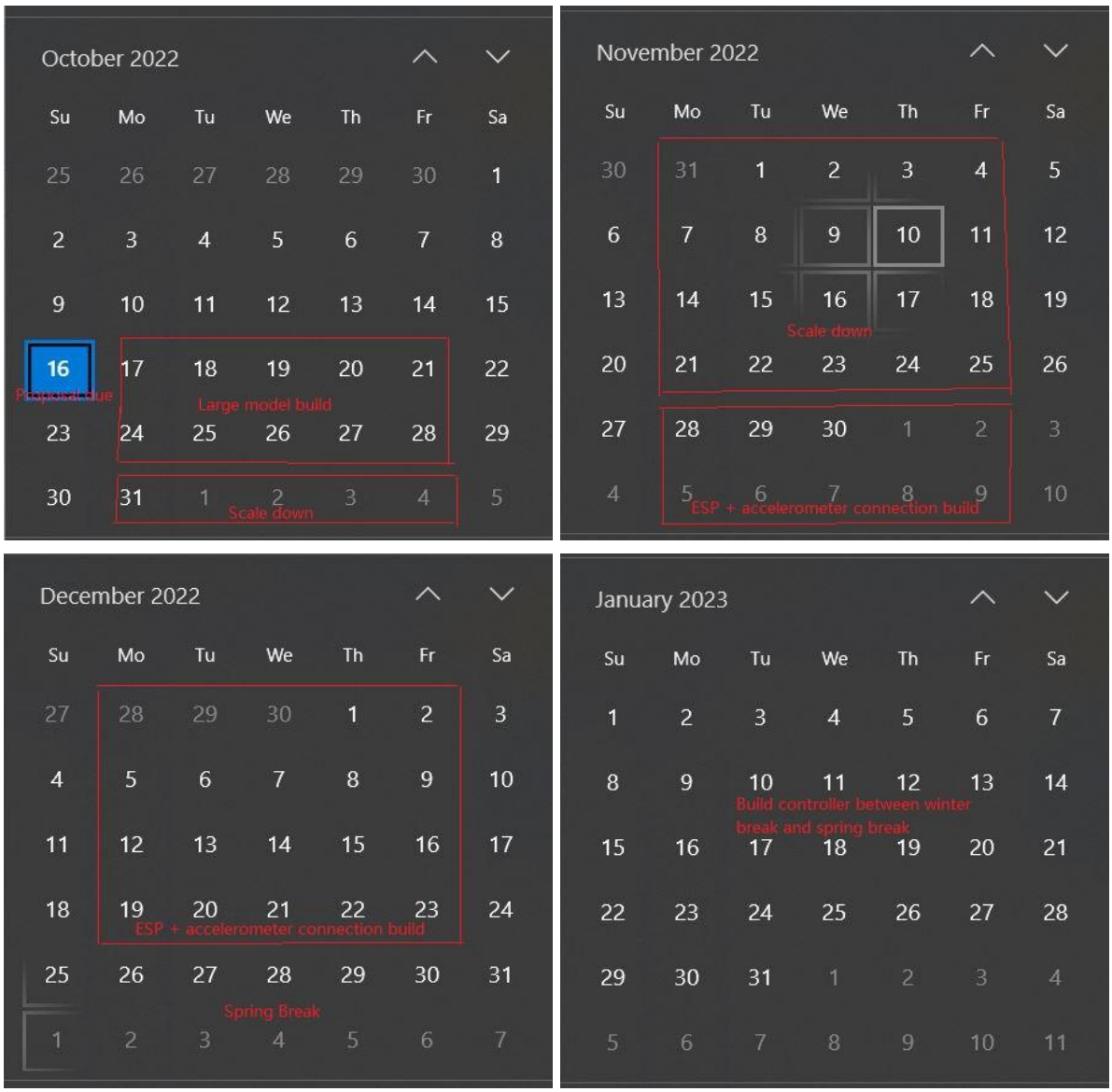
Method

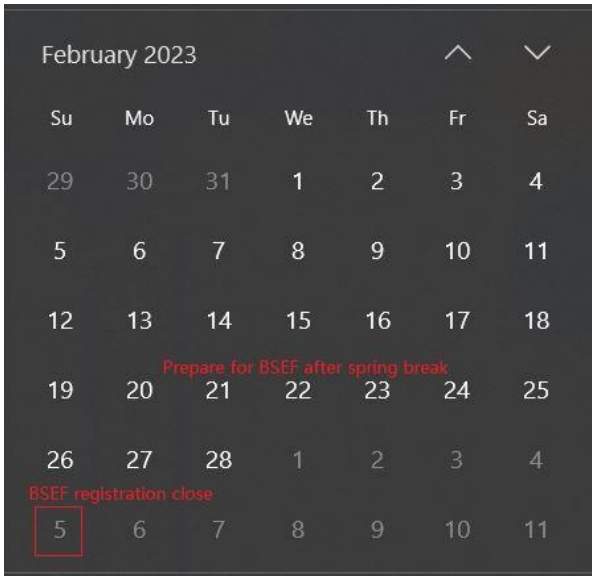
Phase 1: Geometrical optics calculations. The expected result should be like the outcome in the research paper I read before. I'll use the tables and lens in the physics lab. I might need Dr. Weijing Wang's support in this phase.

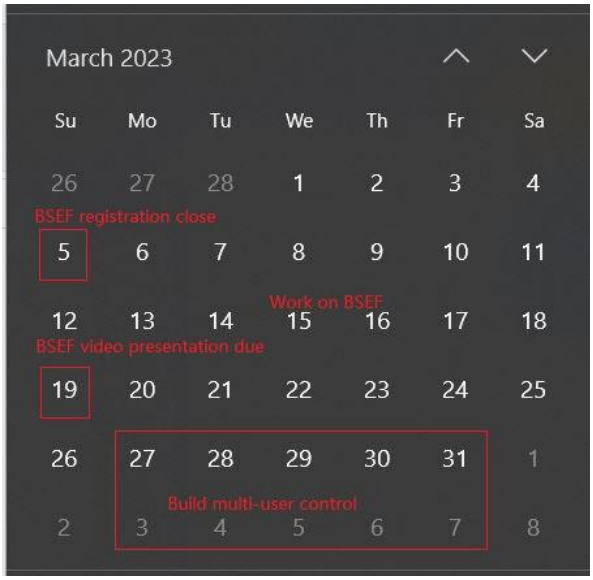
Phase 2 & 4: Applied Engineering works. I'll use some small lenses, and the 3D printers and laser cutters in PiLab. I might need Mr. Heim and Mr. Kemp's support in this phase.

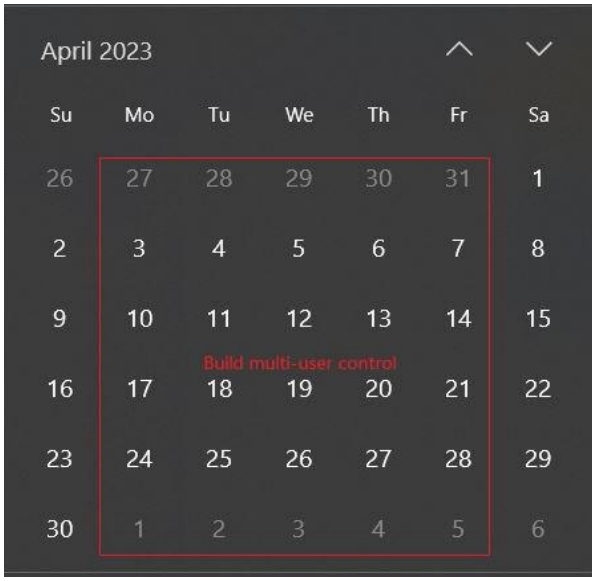
Phase 3, 4 & 5: Receiving data from ESP, and then sending them into a Unity project. I need ESP-related stuff in PiLab. I might need Mr. Heim, Mr. Kemp and Mr. Tang's support in this phase.

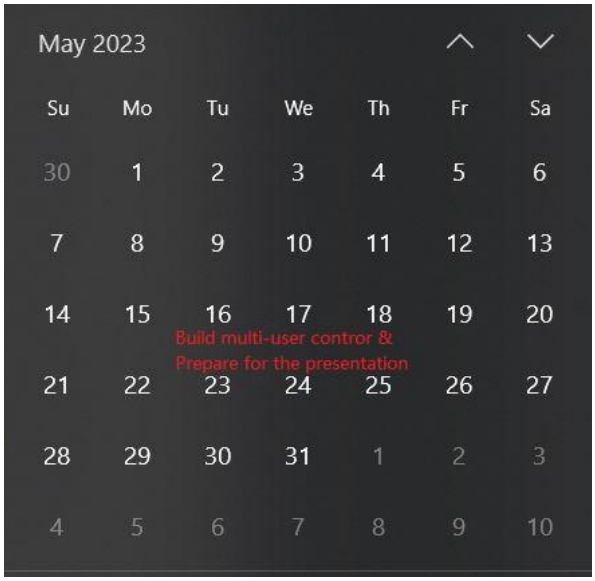
Timeline


October 2022
Su Mo Tu We Th Fr Sa
25 26 27 28 29 30 1
2 3 4 5 6 7 8
9 10 11 12 13 14 15
16 17 18 19 20 21 22
23 24 25 26 27 28 29
30 31 1 2 3 4 5
Proposal due
Large model build
Scale down
November 2022
Su Mo Tu We Th Fr Sa
30 31 1 2 3 4 5
6 7 8 9 10 11 12
13 14 15 16 17 18 19
20 21 22 23 24 25 26
27 28 29 30 1 2 3
4 5 6 7 8 9 10
Scale down
ESP + accelerometer connection build
December 2022
Su Mo Tu We Th Fr Sa
27 28 29 30 1 2 3
4 5 6 7 8 9 10
11 12 13 14 15 16 17
18 19 20 21 22 23 24
25 26 27 28 29 30 31
1 2 3 4 5 6 7
ESP + accelerometer connection build
Spring Break
January 2023
Su Mo Tu We Th Fr Sa
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30 31 1 2 3 4
5 6 7 8 9 10 11
Build controller between winter break and spring break


February 2023
Su Mo Tu We Th Fr Sa
29 30 31 1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
Prepare for BSEF after spring break
19 20 21 22 23 24 25
26 27 28 1 2 3 4
BSEF registration close
5 6 7 8 9 10 11


March 2023
Su Mo Tu We Th Fr Sa
26 27 28 1 2 3 4
BSEF registration close
5 6 7 8 9 10 11
Work on BSEF
12 13 14 15 16 17 18
BSEF video presentation due
19 20 21 22 23 24 25
26 27 28 29 30 31 1
Build multi-user control
2 3 4 5 6 7 8


April 2023
Su Mo Tu We Th Fr Sa
26 27 28 29 30 31 1
2 3 4 5 6 7 8
9 10 11 12 13 14 15
Build multi-user control
16 17 18 19 20 21 22
23 24 25 26 27 28 29
30 1 2 3 4 5 6


May 2023
Su Mo Tu We Th Fr Sa
30 1 2 3 4 5 6
7 8 9 10 11 12 13
14 15 16 17 18 19 20
Build multi-user contror &
Prepare for the presentation
21 22 23 24 25 26 27
28 29 30 31 1 2 3
4 5 6 7 8 9 10

Budget

Name	Supplier	Price per Unit	Quantity	Estimated cost	Reason
AAXA Pico KP10101 (Small Projector)	Amazon	$125.99	1	$130	For the scale down model
Accelerometer or Magnetometer	Amazon	Less than $10	2	$20	To know where the projector and controller are facing
USB A to A cable (30 ft)	Amazon	$9.99	1	$10	To connect the projector and laptop

Supports (including but not limited to)

Advisors: Mr. Heim, Dr. Weijing Wang, Mr. Kemp, Mr. Tang.
Consumable parts: ESP related stuff in PiLab,(Nov 2022 - May 2023) Lenses in Physics Lab (Oct 2022 - May 2023)
Equipment: A laser projector in any classroom,(Oct 2022 - Nov 2022) Optics equipment in Physics lab,(Oct 2022 - Nov 2022) 3D printer and laser cutter in PiLab (Nov 2022 - Feb 2023)

Clarity: If someone else is using the same equipment at the same time with me, I'll talk with them to share the equipment.

Biography Sketch

I'm Edward Tian, a junior at PRISMS. To complete this Applied Physics research, I am really grateful to my advisor Mr. Heim to help me plan the research and give me advice on general issues. For technology support, I would like to give a great thank to my Applied Engineering II and AP Computer Science teacher Mr. Heim, Honors Physics teacher Mr. Tian, AP Physics teacher Dr. Weijing Wang, AI in Action teacher Dr. Weihsing Wang, Pre-Calculus teacher Mr. Jones, Calculus BC teacher Dr. Bleckner and AP Computer Science teacher Ms. Gupta. At last, I give special thanks to Mr. Kemp and Mr. Tang who support me although I do not have their classes.

Reference

1. Seokil Moon, Chang-Kun Lee, Seung-Woo Nam, Changwon Jang, Gun-Yeal Lee , Wontaek Seo, Geeyoung Sung, Hong-Seok Lee & Byoungho Lee. (2019). Augmented reality near-eye display using Pancharatnam-Berry phase lenses. Nature, 9:6616.
2. Felix Richter, AR & VR Adoption Is Still in Its Infancy, Statisia, https://www.statista.com/chart/28467/virtual-and-augmented-reality-adoption-forecast/
3. Maggie Harrison, Microsoft's AR Headset was a Complete Disaster During a Military Test, Futurism, https://futurism.com/the-byte/microsoft-headset-disaster-military-test