

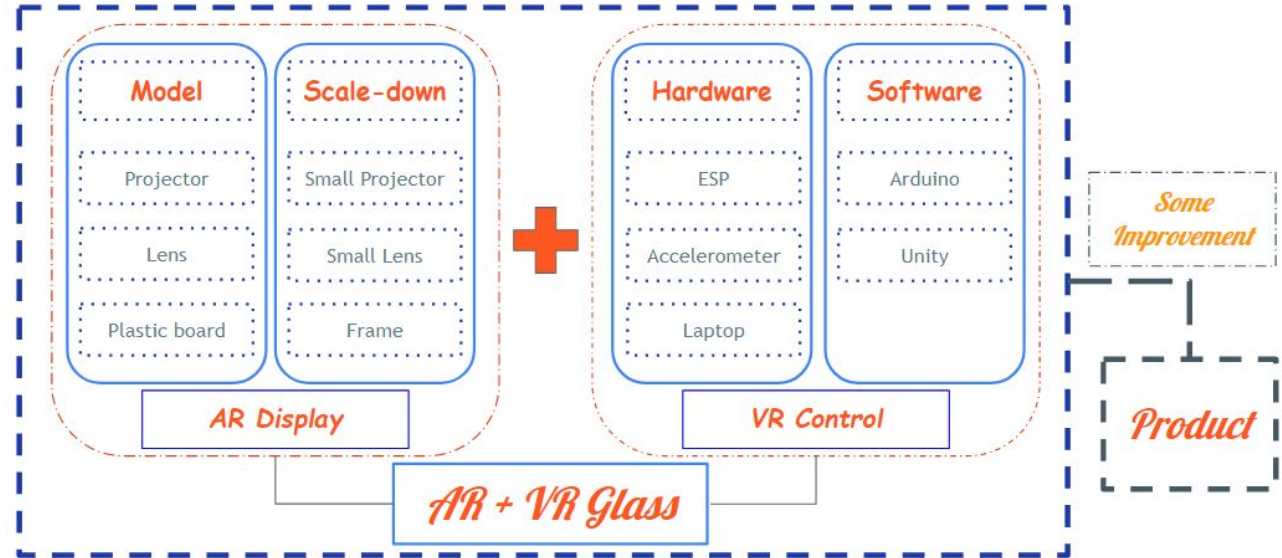
# **The Implementation of an Augmented Reality Display and a Virtual Reality Controller on Glasses**



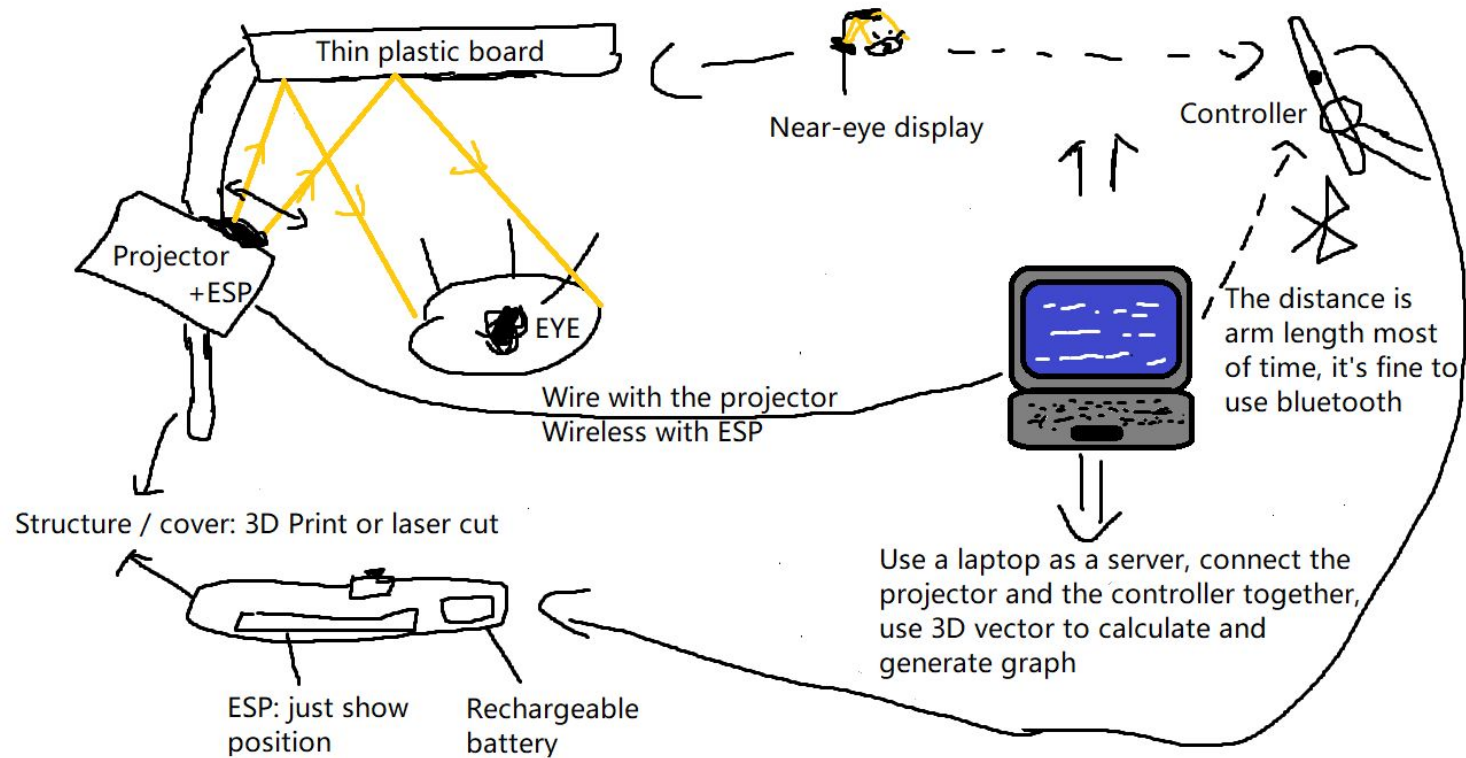
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2022 - 2023

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# Basic Information - Design Draft



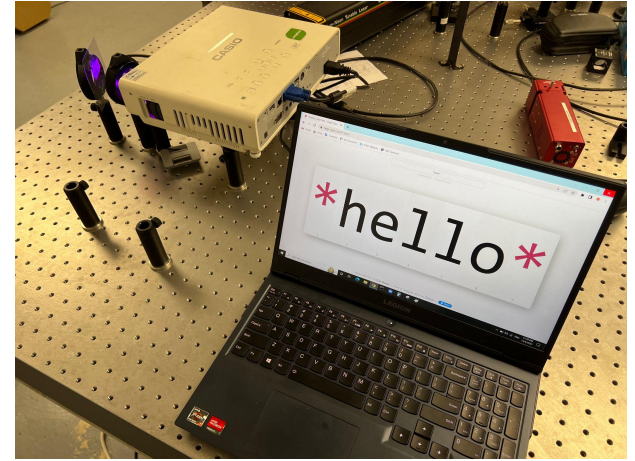
# Basic Information - AR Display Model



The plastic board reflects the information from the projector

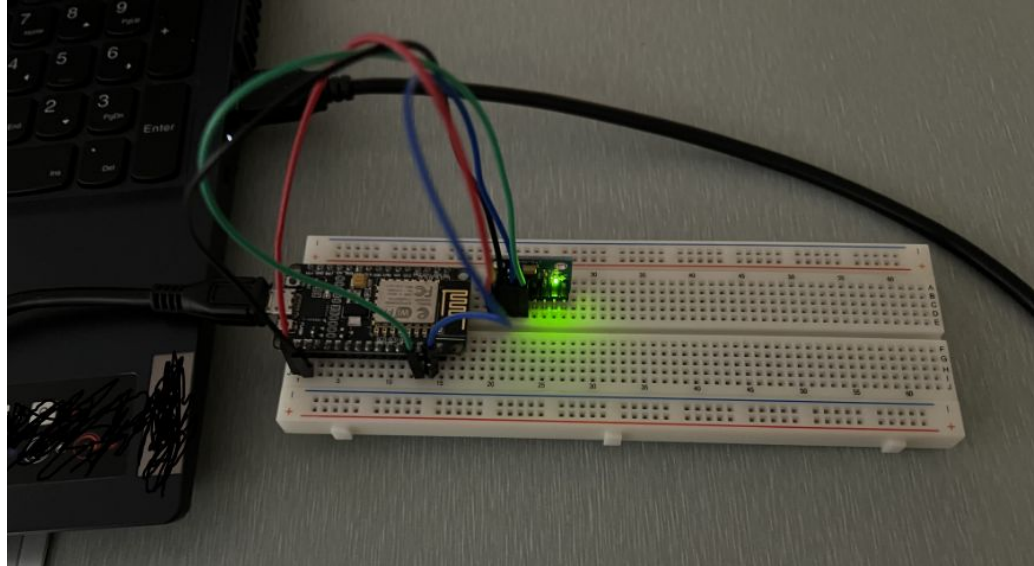


The overview of the AR display model



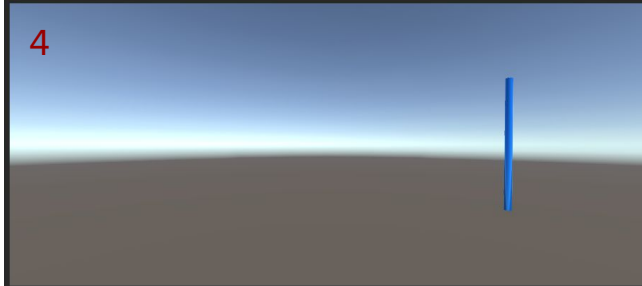
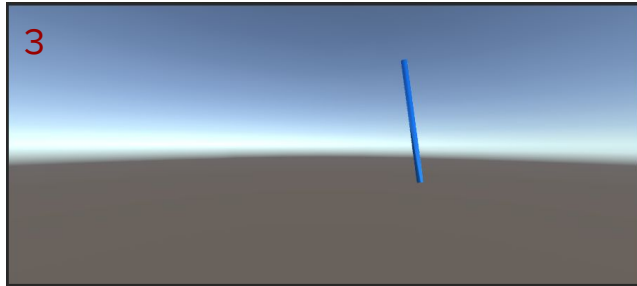
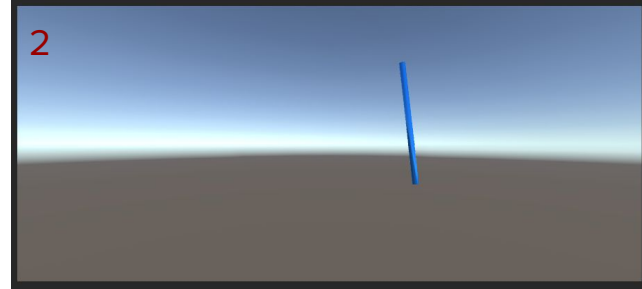
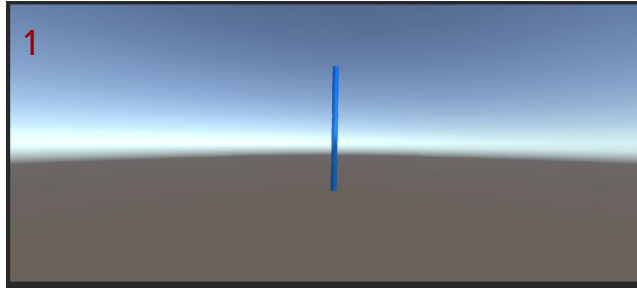
The laptop screen  
(compare with the first image)

# Basic Information - VR Controller Model



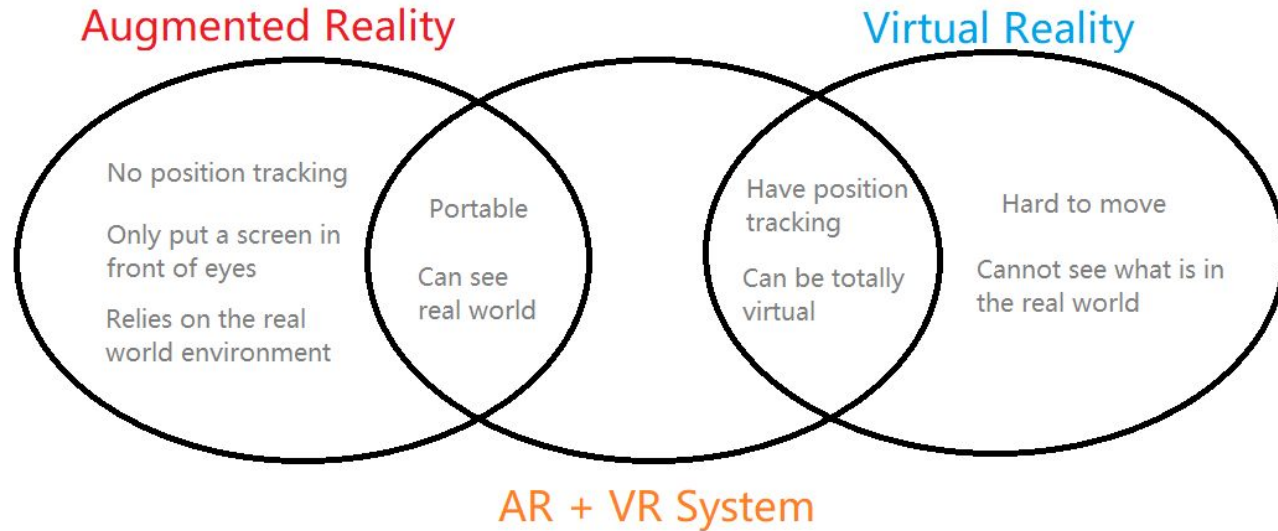
The VR controller model includes a breadboard, an ESP8266 processor, and a MPU6050 accelerometer. The model is currently sending information to the laptop in the image.

# Basic Information - Position Tracking



Screenshots of the Unity project, the blue bar shows the rotation and position information of the VR controller model.  
(could have a live demonstration here)

# Application - Ideas



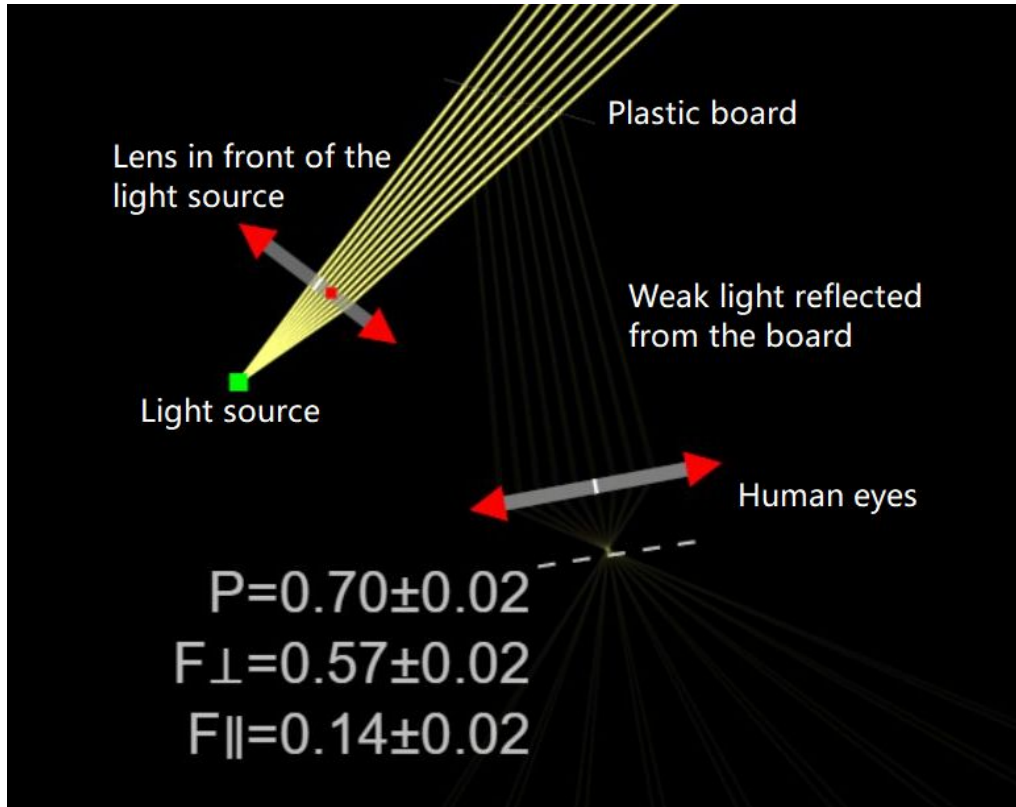
The diagram shows the logic relationship among AR, VR, and my AR + VR project. The AR + VR system integrates advantages of AR and VR, to use in broader areas

# Application - Applicable Areas

- Long distance control in...
  - Surgery: Doctors can control robot arms to do surgery from far away with hand motion
  - Planet exploration: Movement of astronauts can be recorded and sent to the exploration robots on another planet
  - Gigantic or tiny works: Workers motion can be used to control gigantic machines to build bridges, or control laser to make chips
- Entertainment
- Education



# Approach - AR Near-eye Display



The screenshot of optics simulator shows how the light from the projector is going to be transmitted to human eye.

# Approach - VR Position Tracking

General idea: add up short time displacement with short time acceleration

Calculate displacement  $x$  from acceleration  $a$  with integration.

$$v = \int a dt, \quad (1)$$

$$x = \int v dt, \quad (2)$$

When  $\Delta t \rightarrow 0$ , we can express (1) and (2) as

$$\lim_{\Delta t \rightarrow 0} \sum_{i=0}^n \frac{1}{2} \overline{a_i} \Delta t^2 \quad (3)$$

$$\text{where } \overline{a_i} = \frac{a_i + a_{i+1}}{2}$$

With formula (3), the displacement information can be calculated from the acceleration data sent from the accelerometer.

# Approach - VR Position Tracking

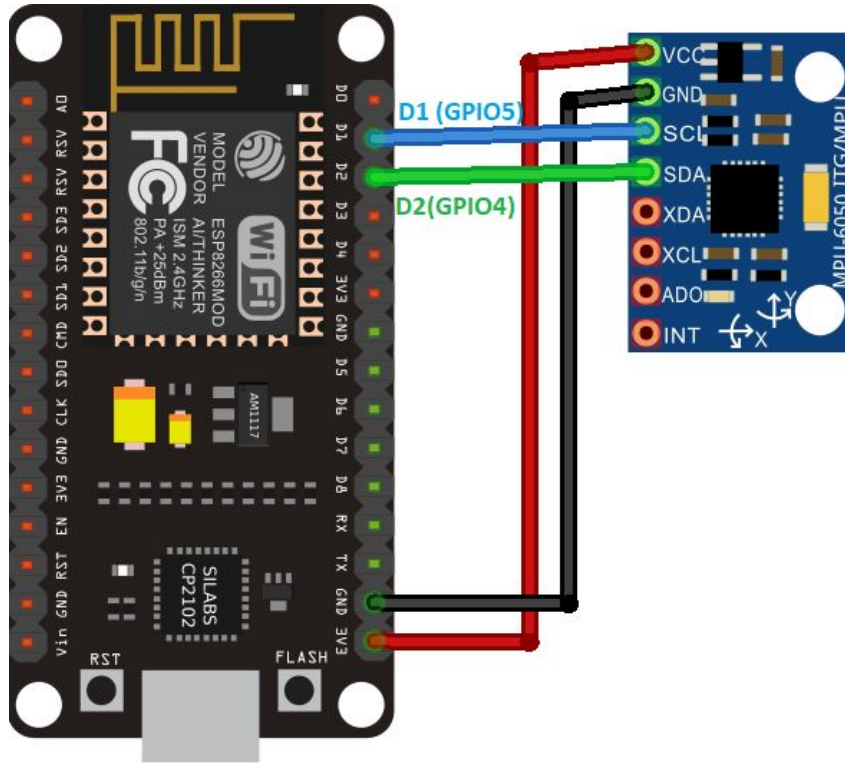
```
void loop() {  
  /* Get new sensor events with the readings */  
  mpu.getEvent(&a, &g, &temp);  
  
  ro_x += g.gyro.x * DELAY / 1000.0 * 180.0 / pi;  
  ro_y += g.gyro.y * DELAY / 1000.0 * 180.0 / pi;  
  ro_z += g.gyro.z * DELAY / 1000.0 * 180.0 / pi;  
  
  /* Print out the values */  
  // Serial.print("Rotation X: ");  
  Serial.print(ro_x);  
  Serial.print(",");  
  // Serial.print(" Y: ");  
  Serial.print(ro_y);  
  Serial.print(",");  
  // Serial.print(" Z: ");  
  Serial.print(ro_z);  
  Serial.print(",");  
  // Serial.println(" rad  ");  
  
  // Serial.print("Acceleration X: ");  
  Serial.print(a.acceleration.x);  
  Serial.print(",");  
  // Serial.print(" Y: ");  
  Serial.print(a.acceleration.y);  
  Serial.print(",");  
  // Serial.print(" Z: ");  
  Serial.print(a.acceleration.z);  
  Serial.println();  
  // Serial.print(" m/s^2  ");  
}
```

← Arduino code running on ESP8266

```
void UpdatePosition() {  
  //objectRigidbody.AddForce(Vector3.up * 9.8f * Time.deltaTime, Force  
  //acc_ini_x = acc_x;  
  //acc_ini_y = acc_y;  
  //acc_ini_z = acc_z;  
  if (acc_x == 0) vel_x = 0;  
  if (acc_y == 0) vel_y = 0;  
  if (acc_z == 0) vel_z = 0;  
  transform.Translate((vel_x + 0.5f * acc_x * 0.1f) * Time.deltaTime,  
    (vel_z + 0.5f * acc_z * 0.1f) * Time.deltaTime,  
    |(vel_y + 0.5f * acc_y * 0.1f) * Time.deltaTime);  
  vel_x += acc_x * Time.deltaTime;  
  vel_y += acc_y * Time.deltaTime;  
  vel_z += acc_z * Time.deltaTime;  
}
```

↑ C# code running on the laptop ↑

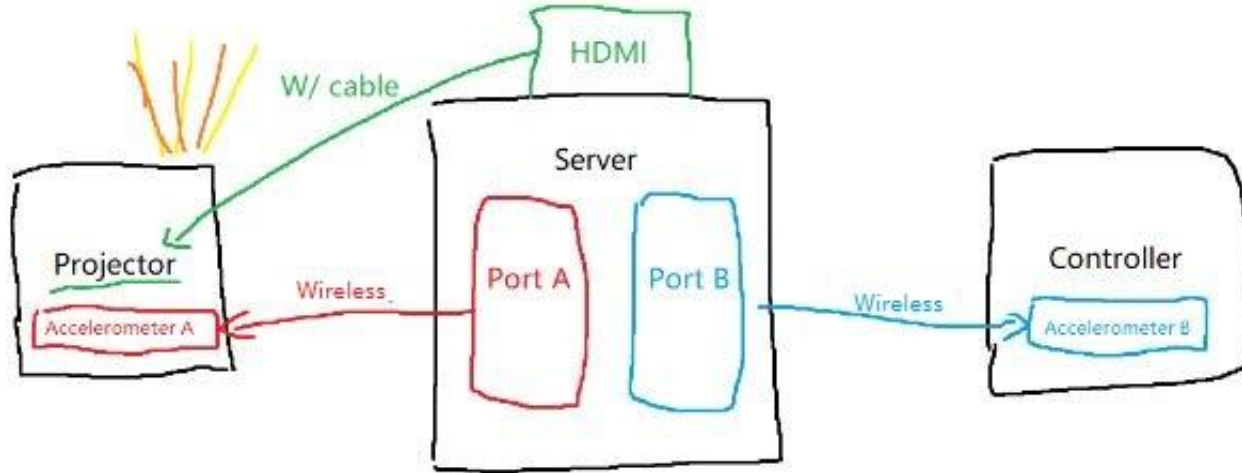
# Approach - Connection Setup



The graph shows how the ESP8266 is connected with the MPU6050 accelerometer. Link:

<https://randomnerdtutorials.com/esp8266-nodemcu-mpu-6050-accelerometer-gyroscope-arduino/>

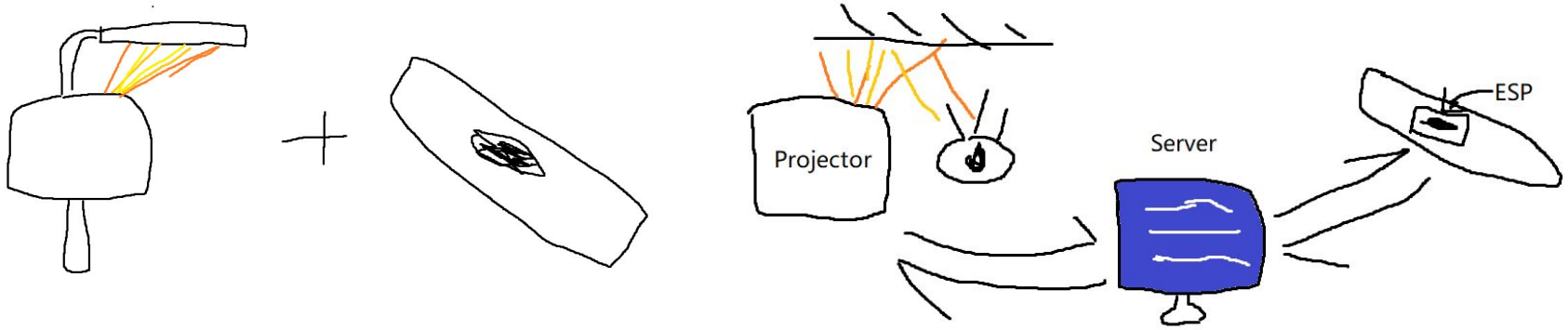
# Approach - Connection Setup (cont'd)



The graph above shows how the final product will be like. Two accelerometers will connect with the server on different ports, and The projector will display what the server shows about the accelerometer data

# Conclusion

- What to make: an AR glass with VR position tracking
- Why to make: to build a glasses which integrates the advantages of AR and VR
- How to make: use optics for display, an accelerometer for positioning, and a laptop as a server



# Thanks for Listening



March 2023

# References

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