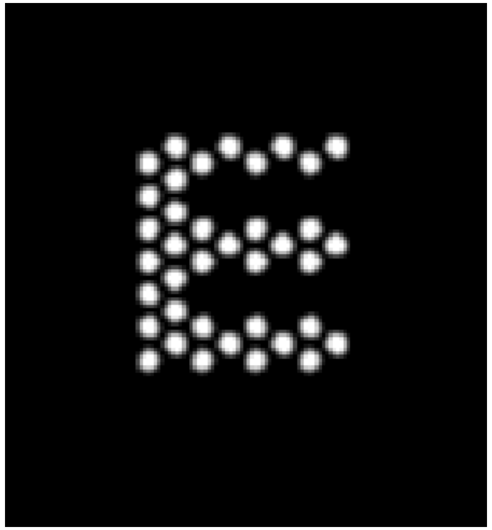
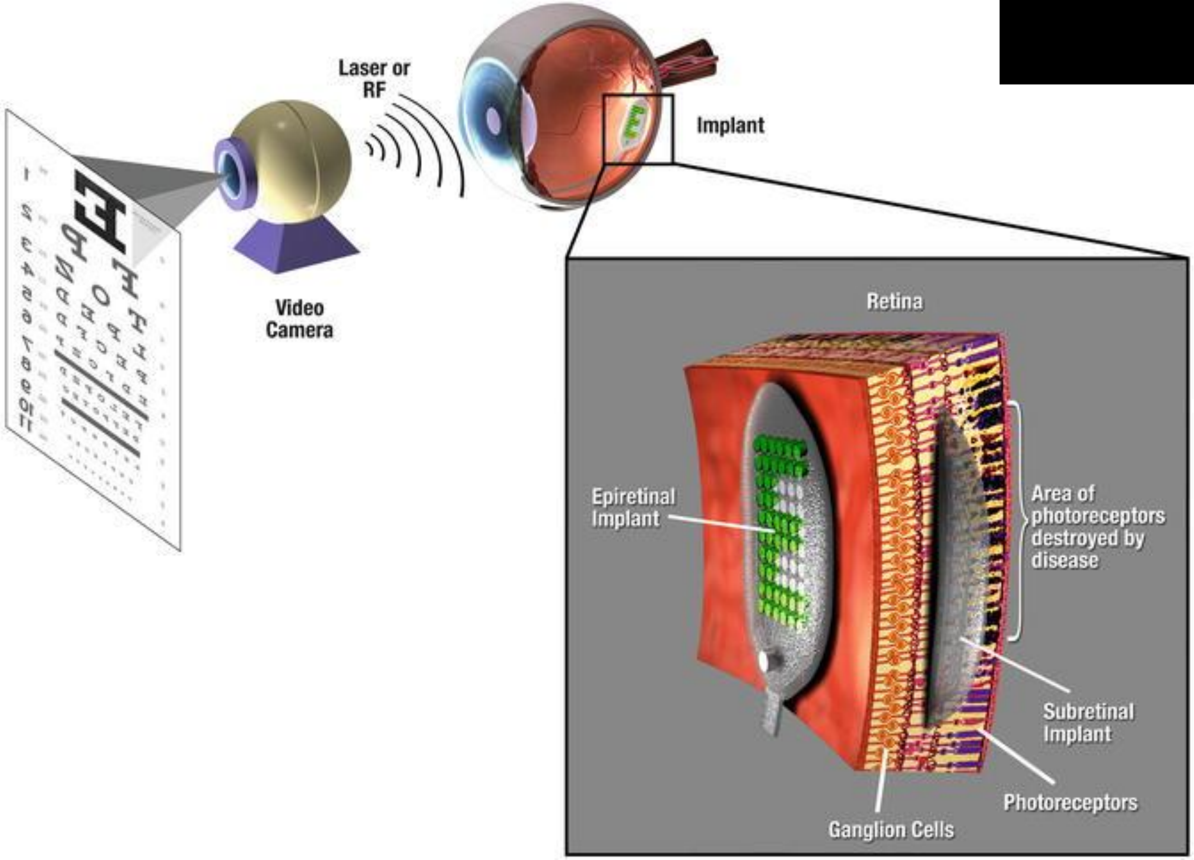
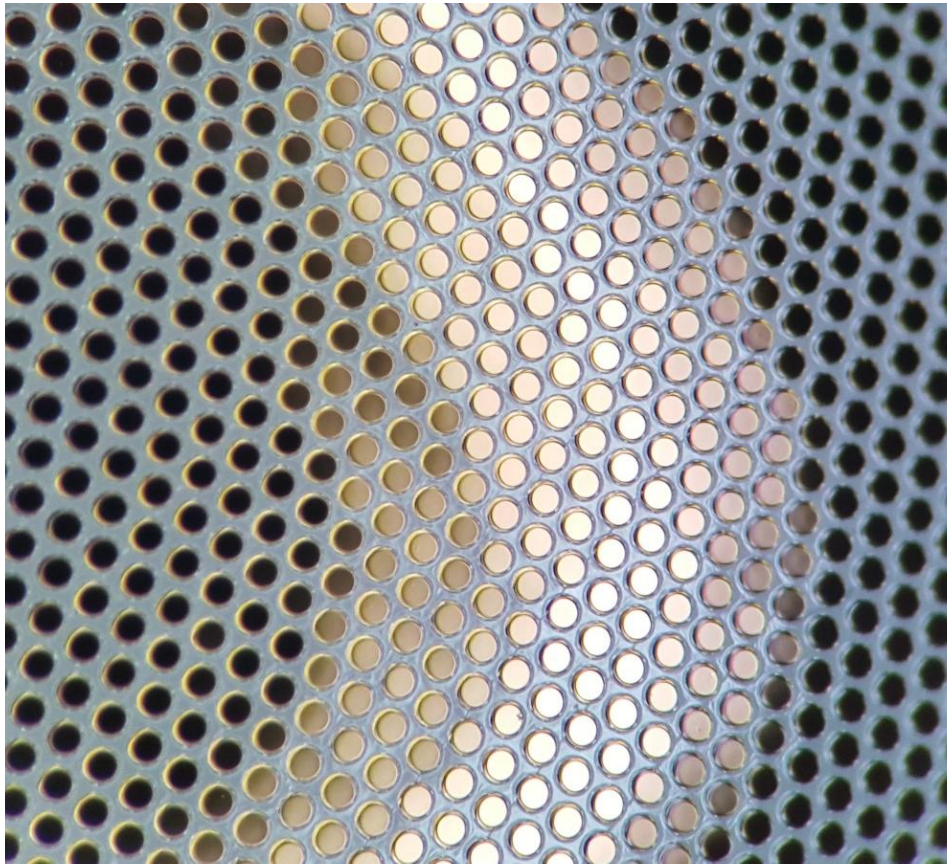
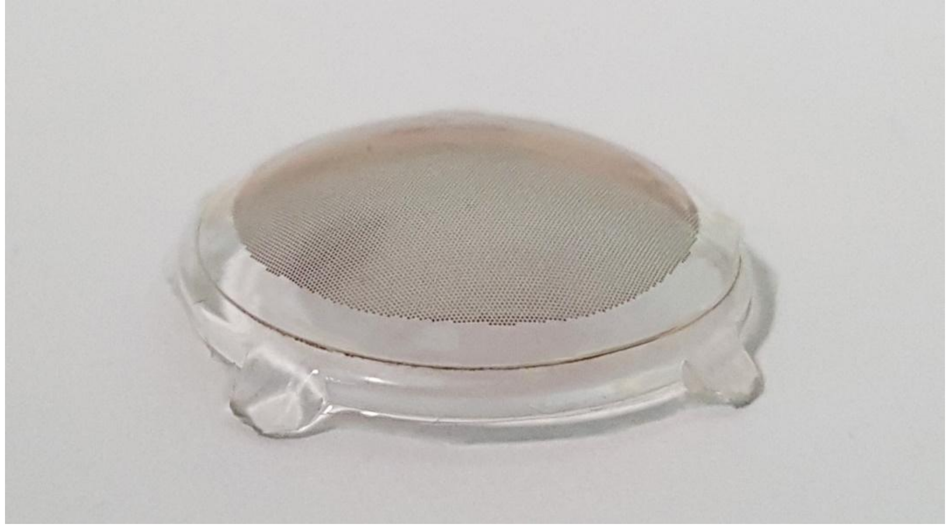
Polyretina

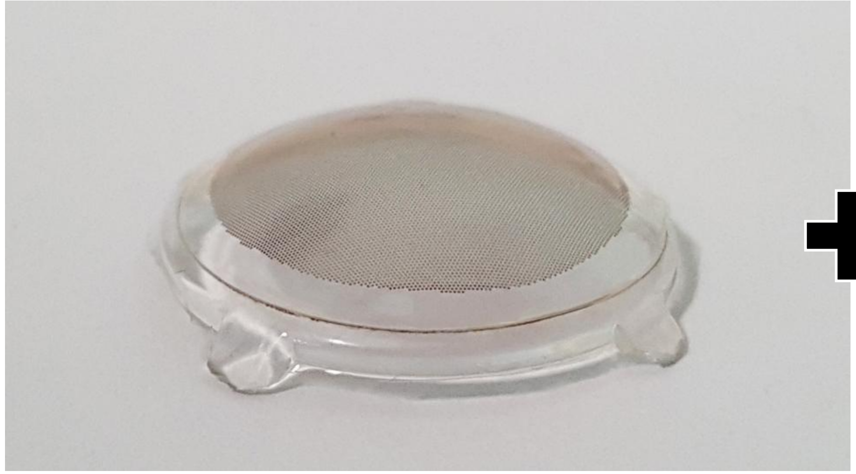



Laser or RF
Implant
Video Camera
Retina
Epiretinal Implant
Area of photoreceptors destroyed by disease
Subretinal Implant
Photoreceptors
Ganglion Cells



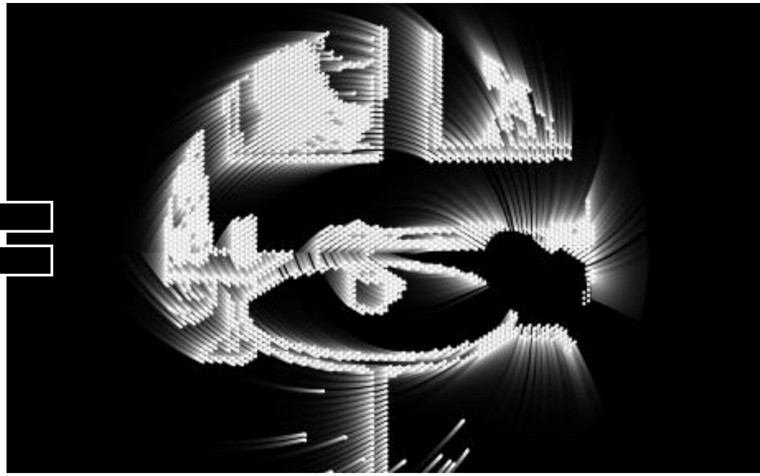


Polyretina VR



+

=



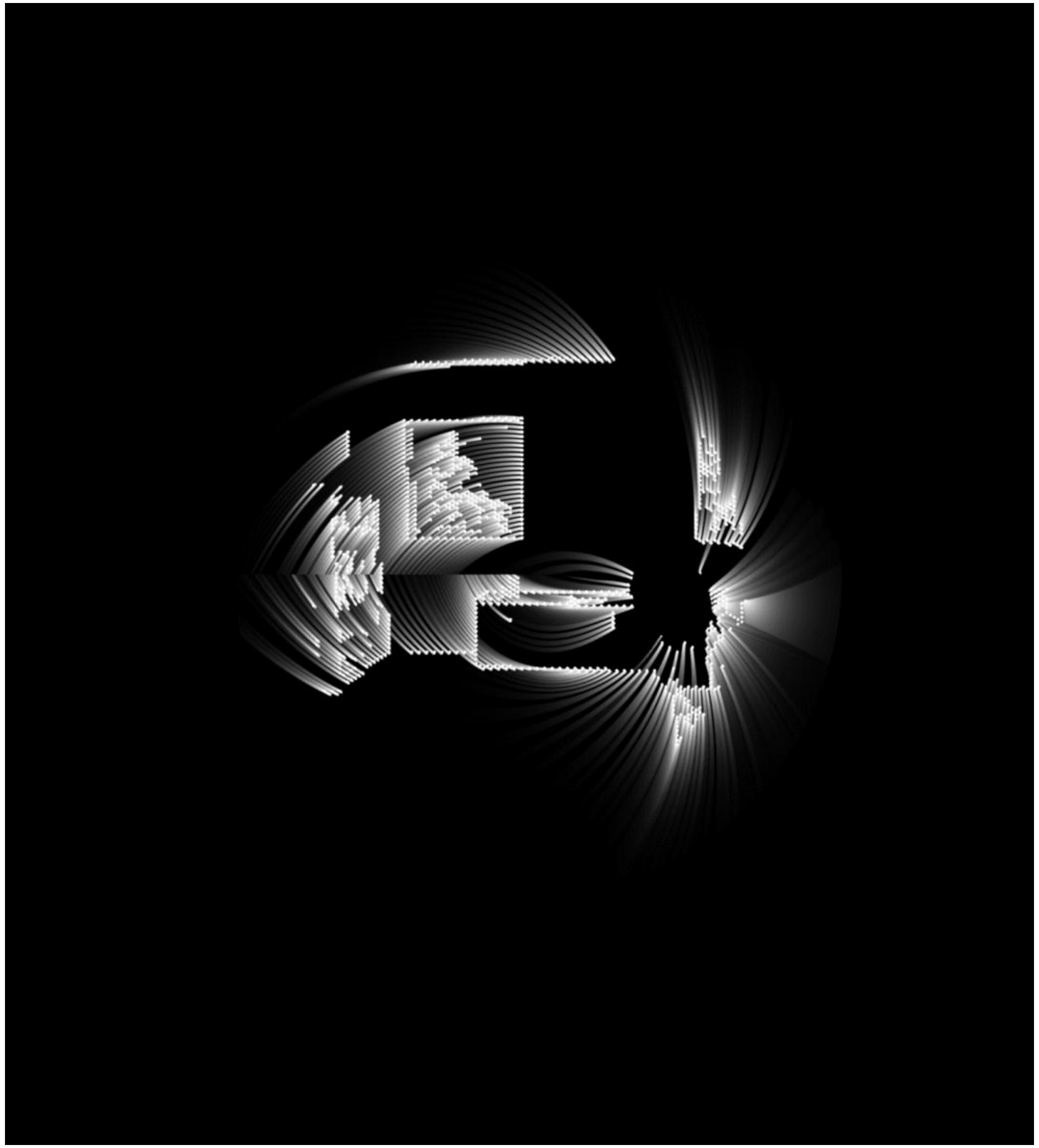
Limitations

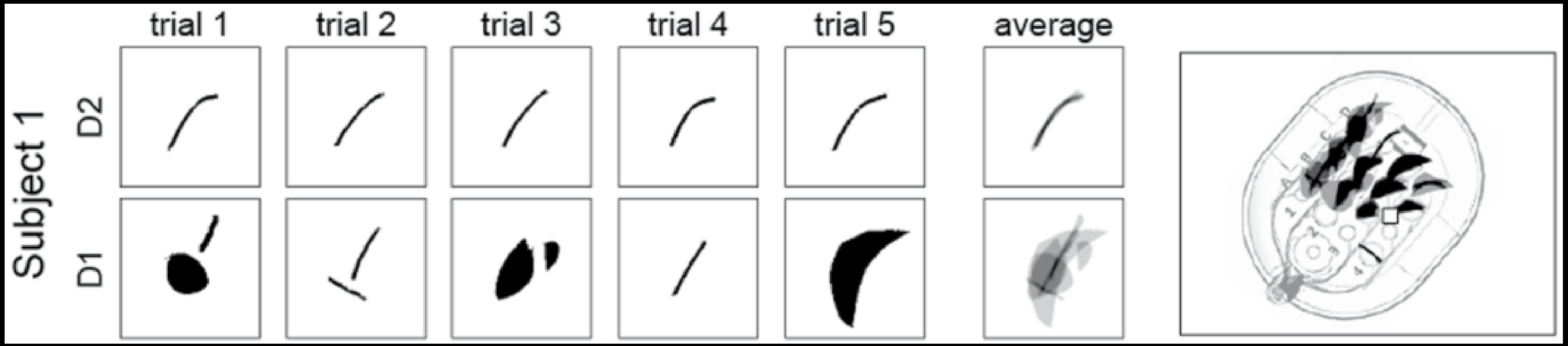
Limitations

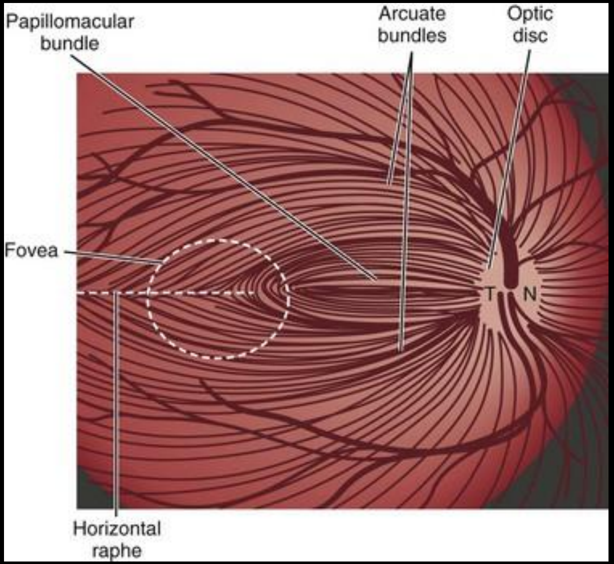
- Limited colour space: Black and white.
- Low resolution: ~10,000 pixels.
- Small field of view: 45 degrees.
- Slow refresh rate: 5Hz.

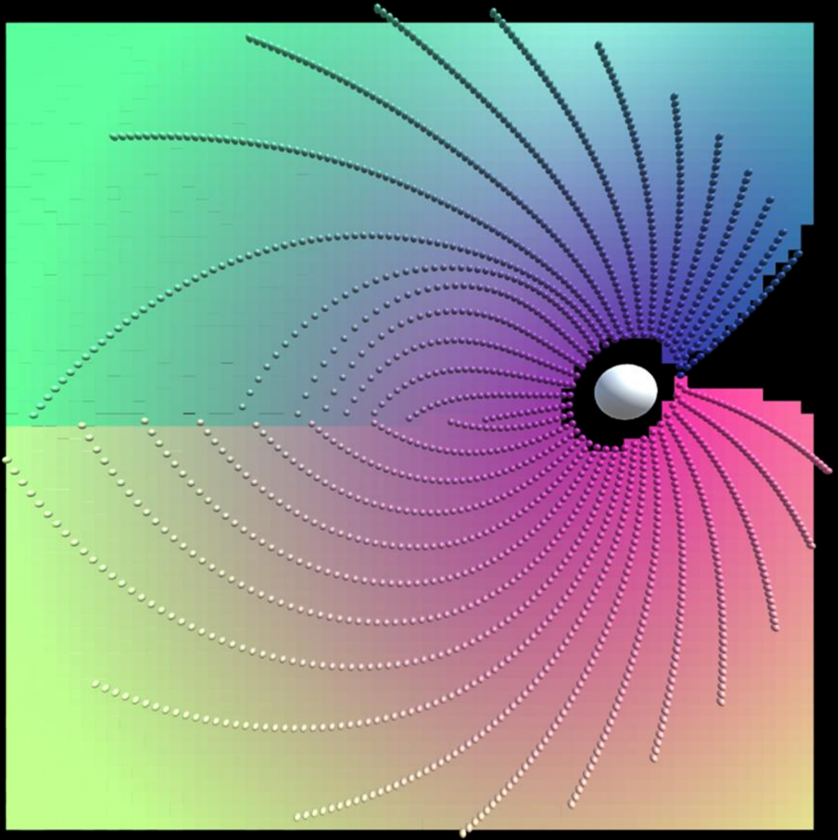
Distortions

- Axon fibres.
- Desensitisation.









RGB A where:
R = Phi0, G = Rho, B = B, A = C

$$\phi(\phi_o, r) = \phi_o + b(\phi_o) \cdot (r - r_o)^{c(\phi_o)}$$

$$RMS = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\phi_i - \hat{\phi}_i)^2}$$

$$c = 1.9 + 1.4 \tanh\{-(\phi_o - 121)/14\}$$

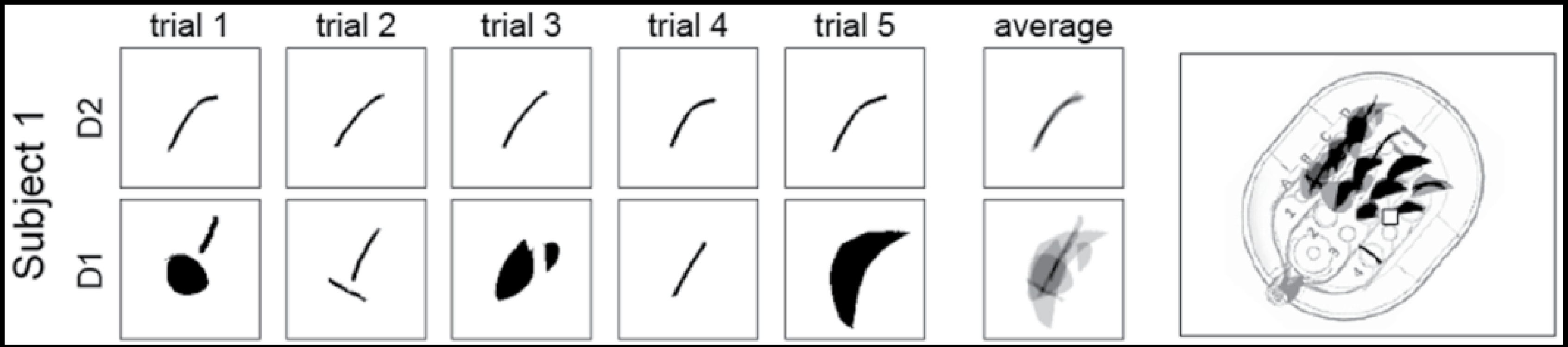
$$\ln b = \beta_s + 3.9 \tanh\{-(\phi_o - 121)/14\}$$

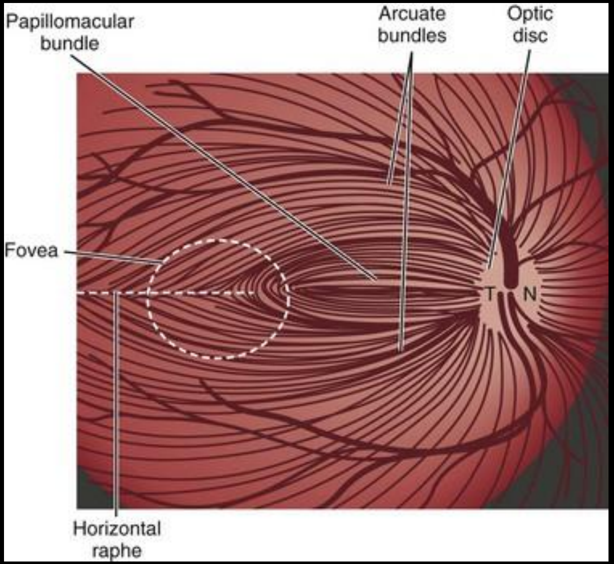
$$x' = x - 15$$

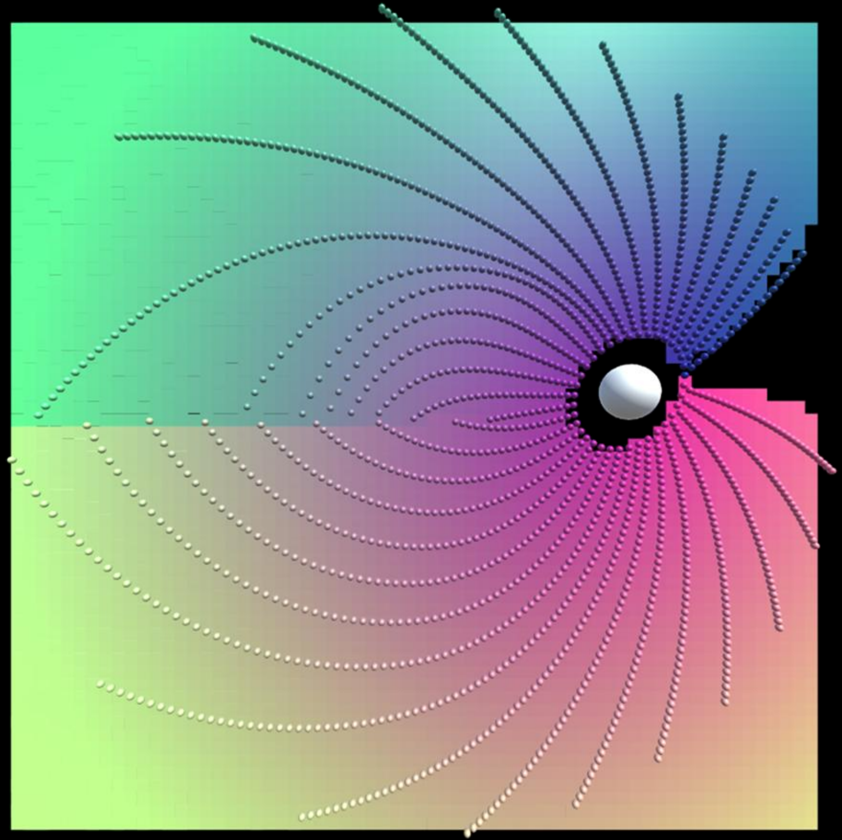
$$y' = y - 2(x/15)^2 \quad \text{for } x > 0$$
$$y' = y \quad \text{else}$$

Second, transformation to polar coordinates (r, ϕ):

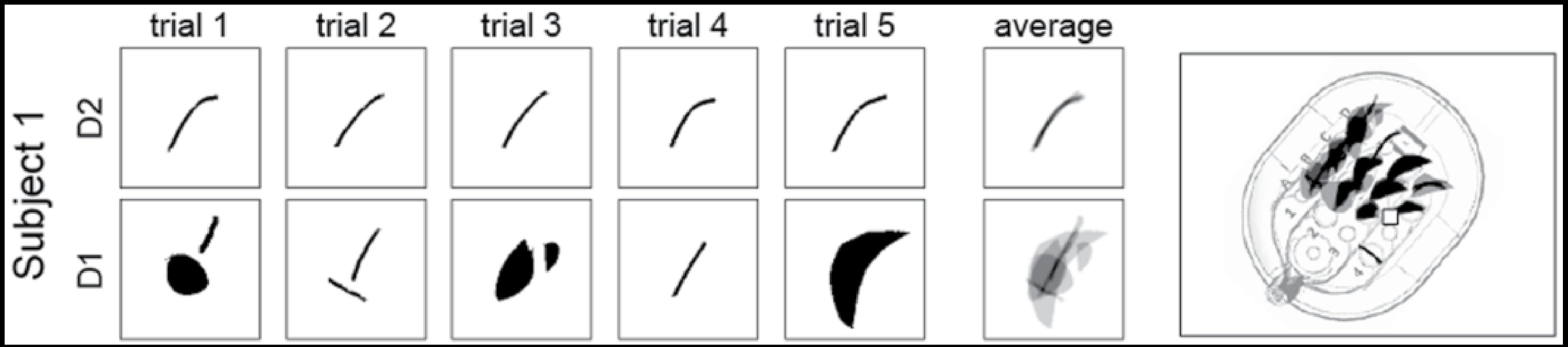
$$r = \mathrm{sqrt}\left[(x')^2 + (y')^2\right]$$
$$\phi = \arctan(y'/x')$$

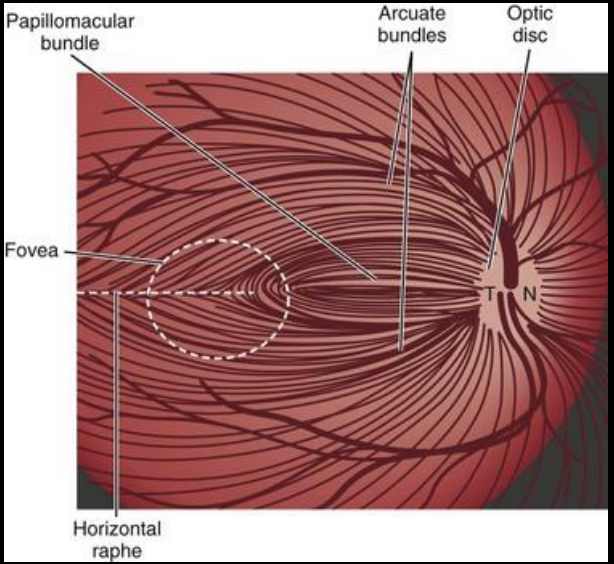


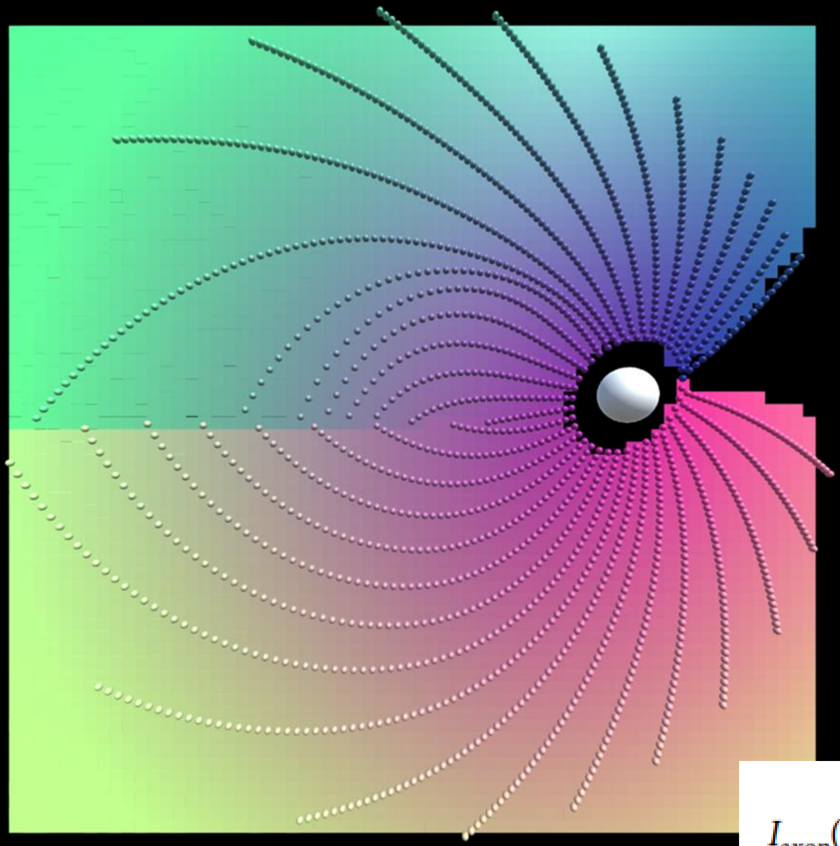




RGB A where:
R = Phi0, G = Rho, B = B, A = C

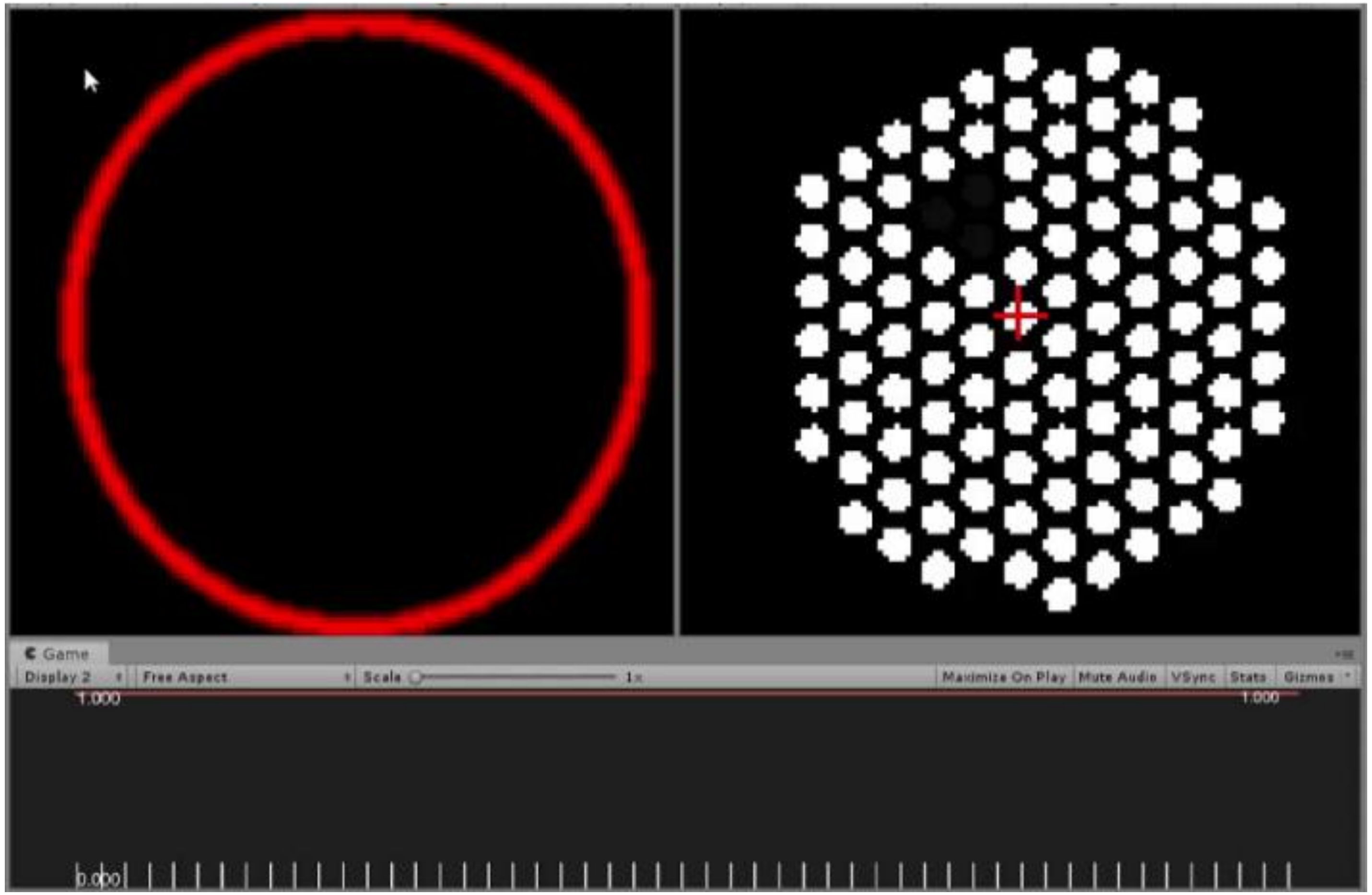


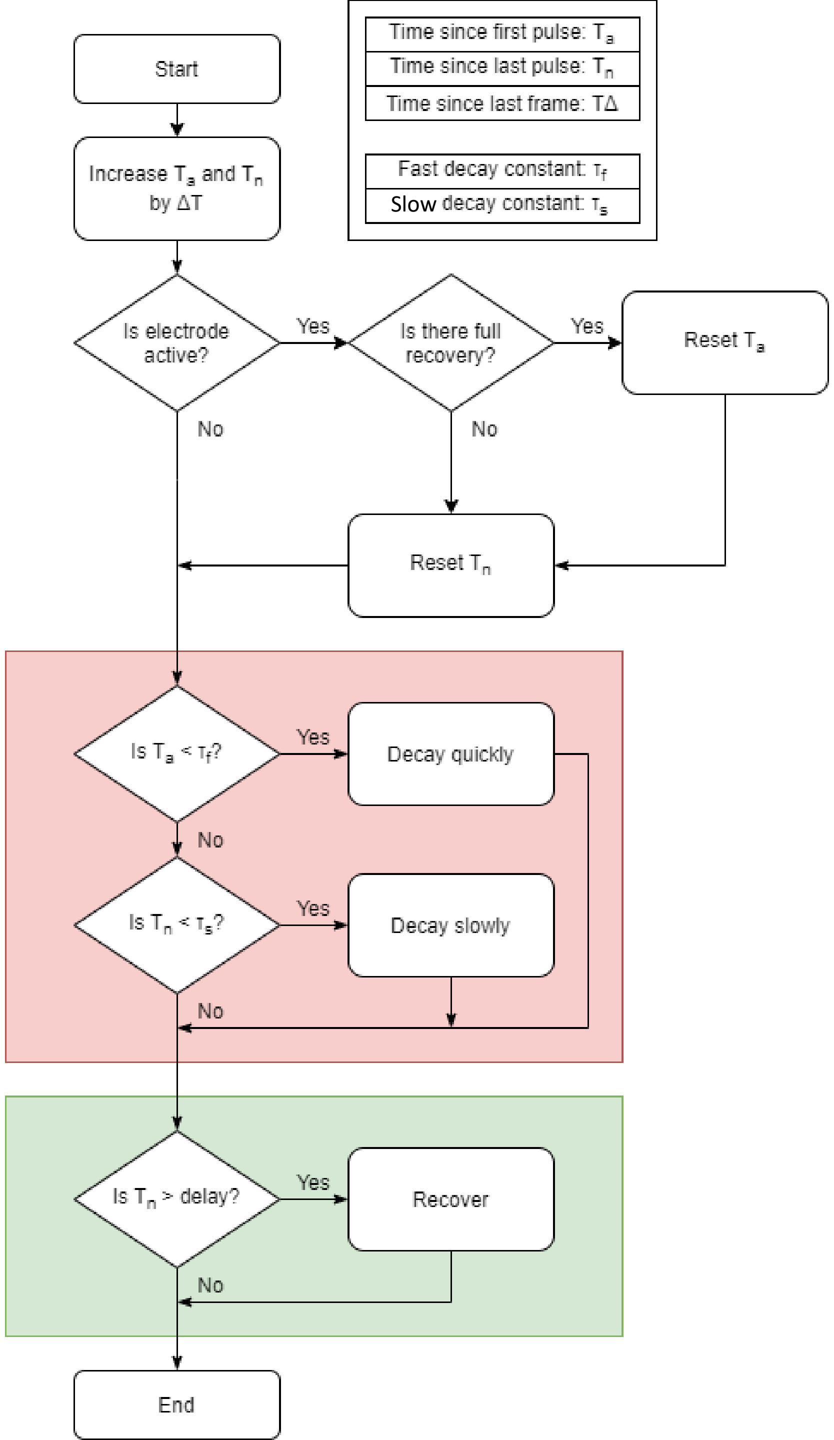


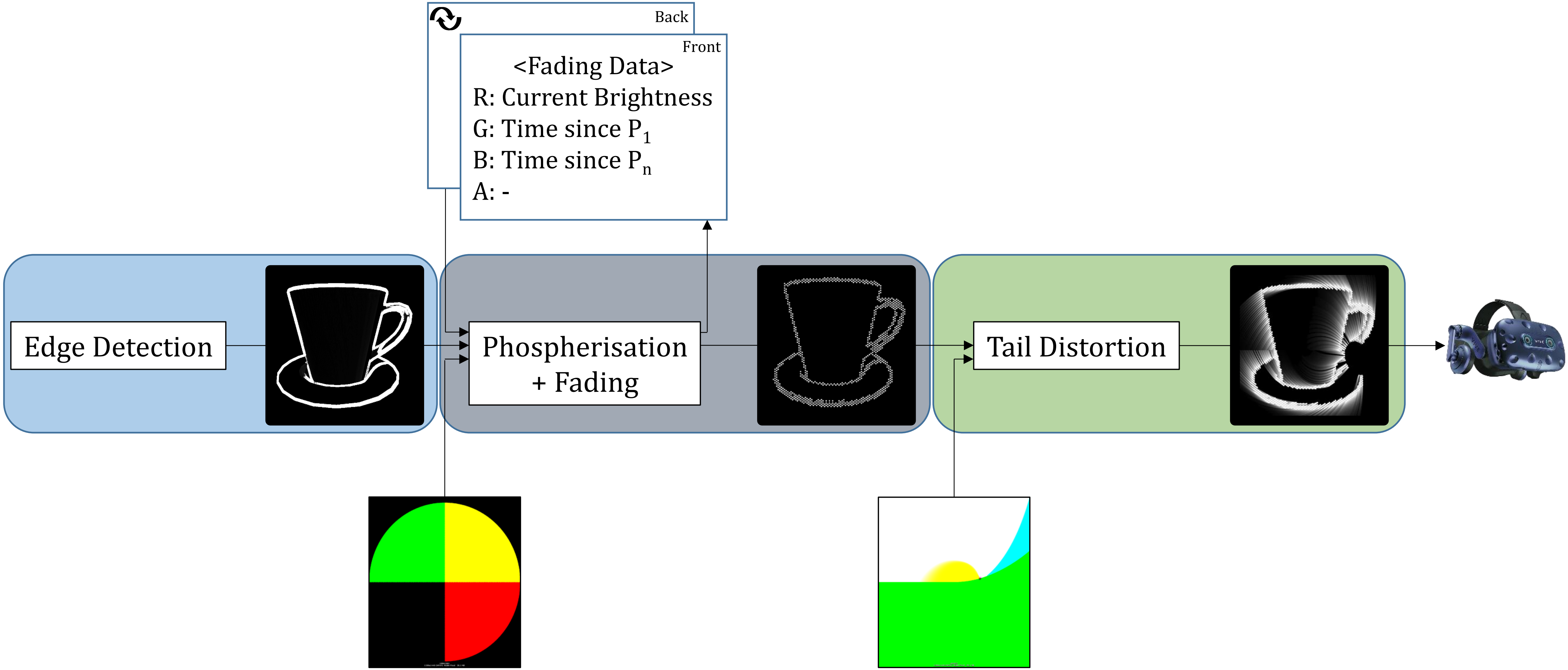


RGB A where:
R = Phi0, G = Rho, B = B, A = C

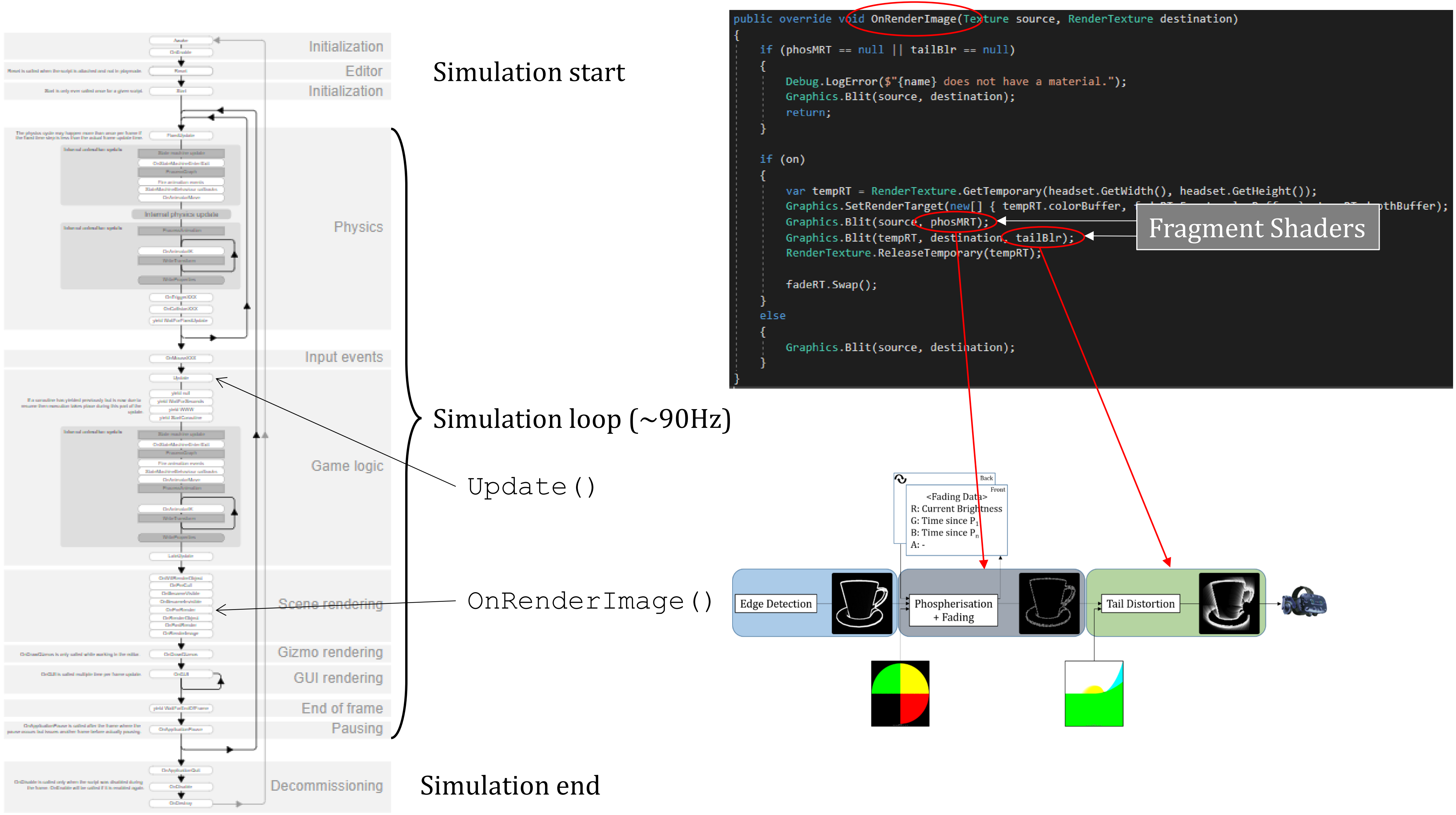
$$I_{\text{axon}}(x, y; \rho, \lambda) = I_{\text{score}}(x, y; \rho)\exp\left(-\frac{(x - x_{\text{soma}})^2 + (y - y_{\text{soma}})^2}{2\lambda^2}\right),$$


Game
Display 2
Free Aspect
Scale
1x
Maximize On Play
Mute Audio
VSync
Stats
Gizmos
1.000
1.000
0.000

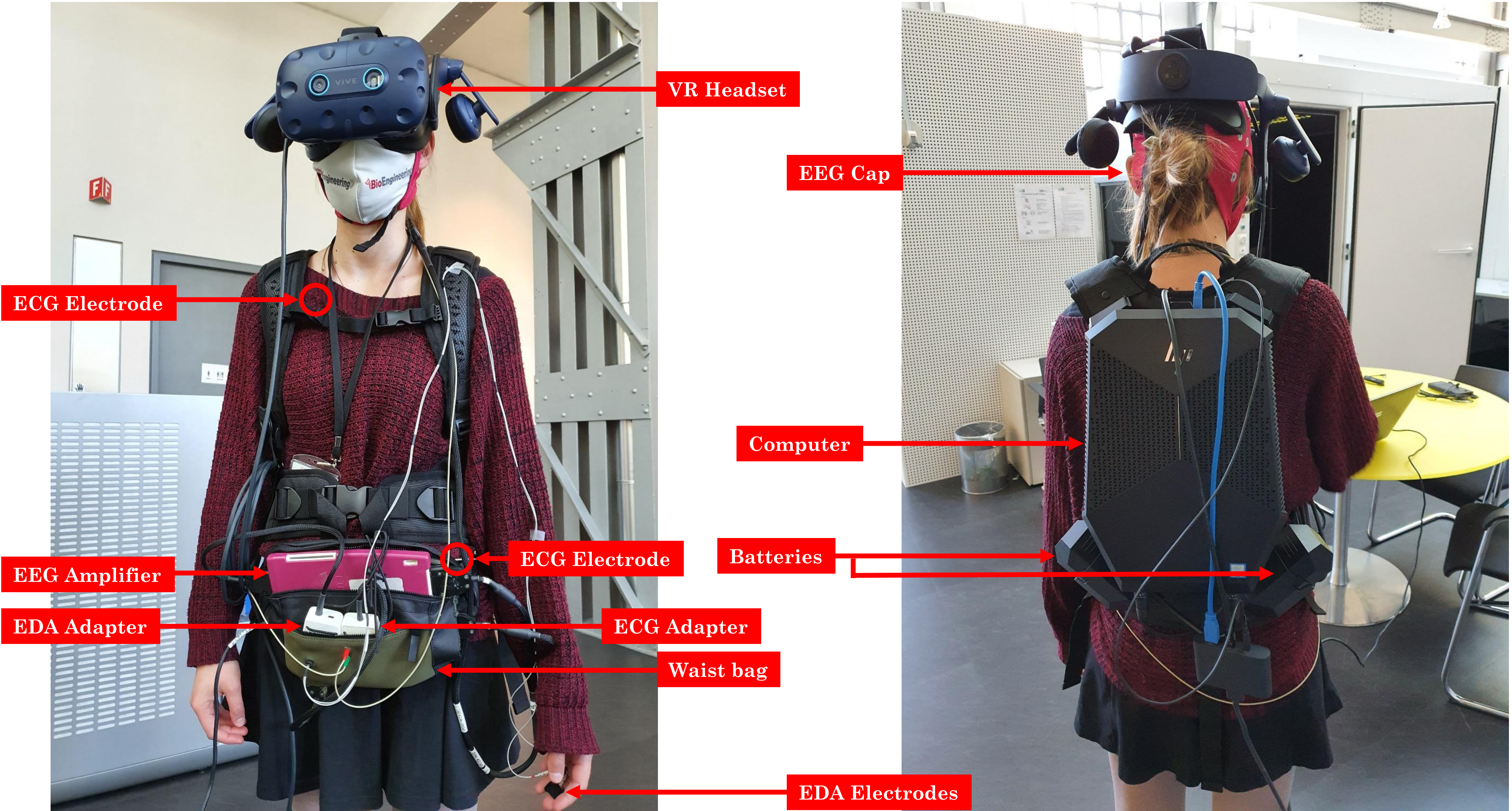

Time since first pulse: T_a
Time since last pulse: T_n
Time since last frame: $T\Delta$
Fast decay constant: τ_f
Slow decay constant: τ_s
Start
Increase T_a and T_n by ΔT
Is electrode active?
Yes
No
Is there full recovery?
Yes
No
Reset T_a
Reset T_n
Is $T_a < \tau_f$?
Yes
No
Decay quickly
Is $T_n < \tau_s$?
Yes
No
Decay slowly
Is $T_n >$ delay?
Yes
No
Recover
End



Back
Front
<Fading Data>
R: Current Brightness
G: Time since P_1
B: Time since P_n
A: -
Edge Detection
Phospherisation + Fading
Tail Distortion

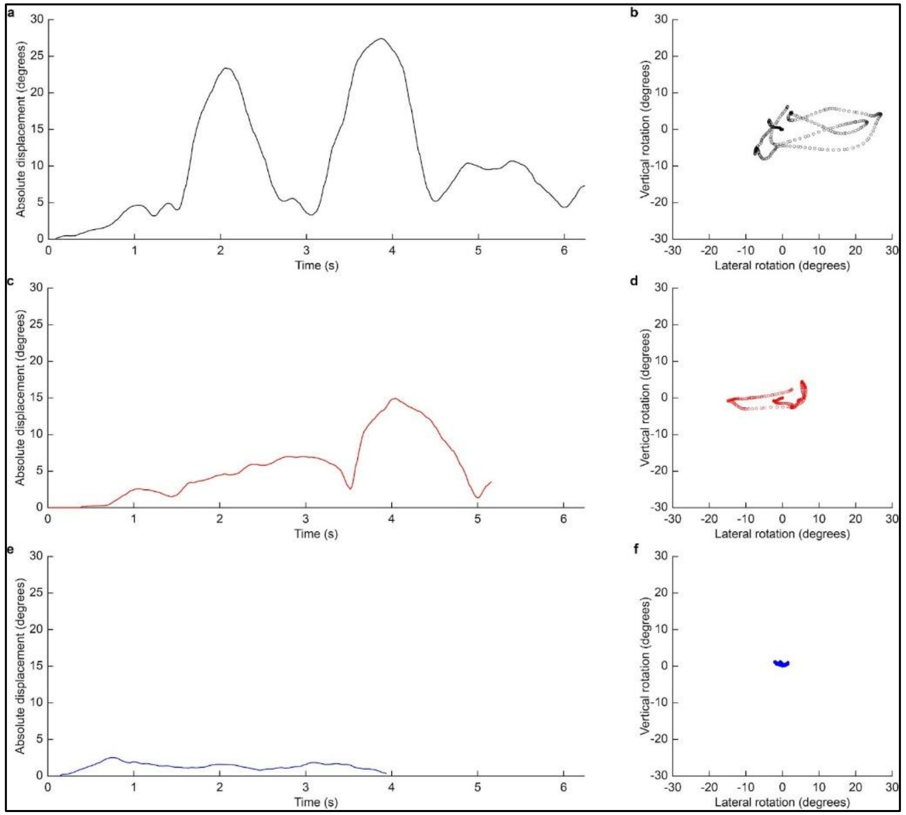

Initialization
Editor
Initialization
Physics
Internal physics update
Input events
Game logic
Scene rendering
Gizmo rendering
GUI rendering
End of frame
Pausing
Decommissioning
Simulation start
Simulation loop (~90Hz)
Update()
OnRenderImage()
Simulation end
public override void OnRenderImage(Texture source, RenderTexture destination)
{
if (phosMRT == null || tailBlr == null)
{
Debug.LogError($"{name} does not have a material.");
Graphics.Blit(source, destination);
return;
}
if (on)
{
var tempRT = RenderTexture.GetTemporary(headset.GetWidth(), headset.GetHeight());
Graphics.SetRenderTarget(new[] { tempRT.colorBuffer,
Graphics.Blit(source, phosMRT);
Graphics.Blit(tempRT, destination, tailBlr);
RenderTexture.ReleaseTemporary(tempRT);
fadeRT.Swap();
}
else
{
Graphics.Blit(source, destination);
}
}
Fragment Shaders
Back
Front
<Fading Data>
R: Current Brightness
G: Time since P_1
B: Time since P_n
A: -
Edge Detection
Phospherisation + Fading
Tail Distortion

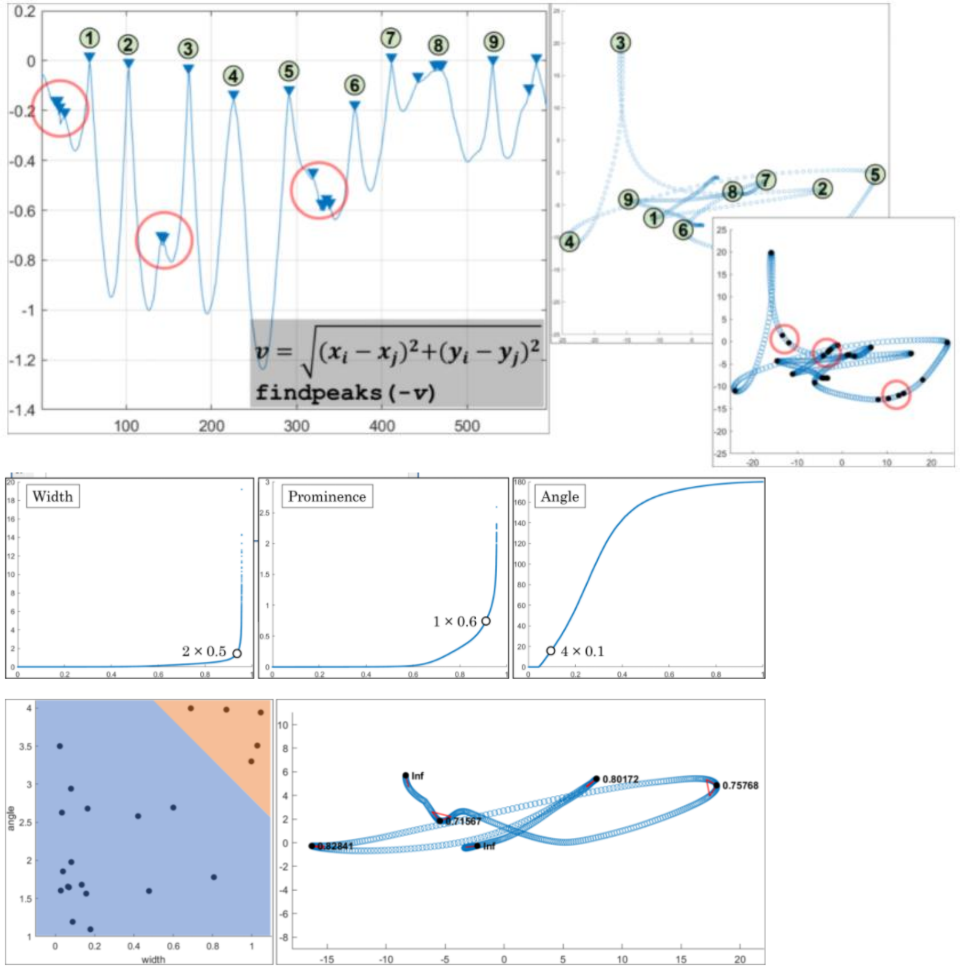
Augmented Reality Study – Complete Setup



Augmented Reality Study – Complete Setup

Head and Eye Movement analysis





Virtual reality validation of naturalistic modulation strategies to counteract fading in retinal stimulation

Jacob Thomas Thorn[1], Naïg Aurelia Ludmilla Chenais[1], Sandrine Hinrichs[1], Marion Chatelain[1] and Diego Ghezzi[1,2]

Virtual reality simulation of epiretinal stimulation highlights the relevance of the visual angle in prosthetic vision

Jacob Thomas Thorn[1], Enrico Migliorini[1] and Diego Ghezzi[1,2]

A Simulation of Strategies to Counteract Phosphene Fading in Retinal Prostheses

Jacob Thorn, Naïg Chenais, Sandrine Hinrichs and Diego Ghezzi, *Member*, *IEEE*