HOLOGRAMS, MAN.

HOLOGRAMS!!

Bending light, perception, and code to make magic

Fun / Experiments · Having Fun with Tech

About Me

- Twitter: @adpead
- About.me: https://about.me/allan_pead
- Linkedin: https://www.linkedin.com/in/adpead/

- Blog: https://explorationspace.co.za

- Raspberry Pi South Africa
- https://www.facebook.com/groups/1493503984198019

- Cape Town MS Developer User Group
- https://www.meetup.com/Cape-Town-Ms-Dev-User-Group/

Microsoft Internet of Things Most Valuable Professional
Microsoft Developer Technologies Most Valuable Professiona

MVP Microsoft® Most Valuable Professional

Allan Pead

THE STORY

"I saw a glowing cowboy in a Cape Town mall"

Time Traveler
Wonderland Arcade · N1 City, Cape Town · circa 1991

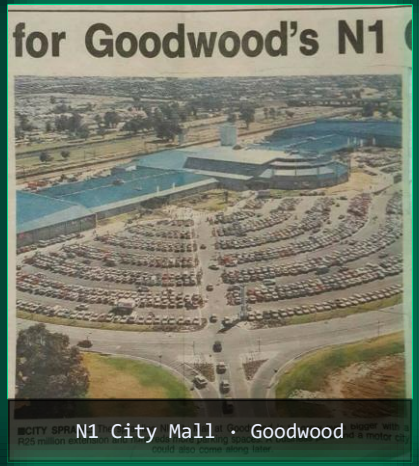
A cowboy. Floating. In mid-air.

No visible screen. Just magic.

I had to build one, sometime. 🤔

N1 CITY · WONDERLAND ARCADE · CAPE TOWN

CIRCA 1991–1995



N1 City Mall · Goodwood

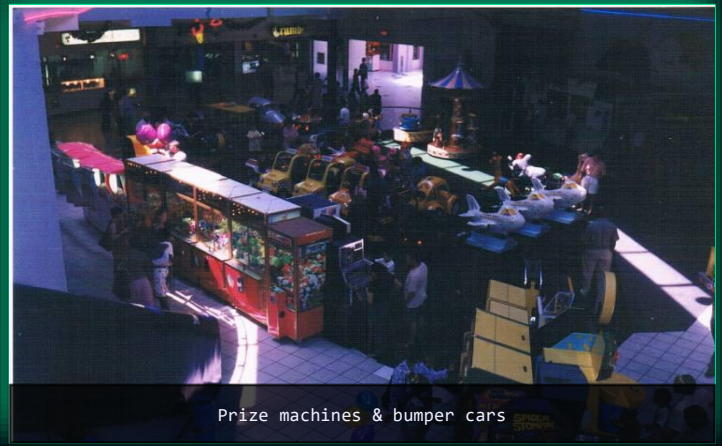

The Octopus — Wonderland's icon


Arcade floor · racing section


Packed Saturday crowd


The famous octopus


Kids' castle area & carousel


Prize machines & bumper cars

THEN THERE WAS THIS.

HOLOGRAM TIME TRAVELER

Sega · 1991 · Rick Dyer (Dragon's Lair)

"The World's First 3D Holographic Video Game"

- CRT TV projects up into a concave spherical mirror
- Characters float in mid-air — only ~5 inches tall
- Black background footage is the key to the illusion
- Real live actor filmed for the FMV cowboy
- $18 million in revenue from its arcade debut
- **Only 606 cabinets were ever made**

Cabinet – US version

Japanese version with Hologram topper

How do you play it today?

M.A.M.E.

Multiple Arcade Machine Emulator · Free · mamedev.org

```
roms/
  └─ timetrav.zip
chd/timetrav/
  └─ timetrav.chd
       (~11.8 GB)
```

```
$ mame timetrav
```

▶ mamedev.org · github.com/mamedev/mame

HYPSEUS-SINGE

SDL2 Laserdisc Emulator · DirtBagXon · GPL-3.0

"The Laserdisc-Native Emulator"

Daphne (1999) → Hypseus → Hypseus-Singe

Time Traveler setup:

- Build from source OR download release
- Get hypseus_singe_timetraveler.zip (791 MB)
  - → archive.org (DirtBagXon uploads)
- Requires Hypseus v2.11.2+ (Zip ROM format)
- Optional: Anaglyph 3D video pack (4.8 GB)

```
$ hypseus timetrav vldp \
    -framefile singe/timetrav/timetrav.txt
```

▶ github.com/DirtBagXon/hypseus-singe

Famous Holograms

Star Wars (1977)

R2-D2 projects Princess Leia — the galaxy's most iconic distress call beamed into being.

"Help me Obi-Wan Kenobi, you're my only hope"

Courtesy of Lucasfilm

Famous Holograms

Back to the Future II (1989)

Jaws 19's holographic shark lunges out of the cinema screen at Marty. He nearly jumps out of his skin.

"You're gonna need a bigger screen"

Famous Holograms

Star Trek: The Next Generation

The holodeck — a fully immersive synthetic reality. Basically a religion for a generation of engineers.

"Computer, end program"

Courtesy of Paramount Pictures

Famous Holograms

Tupac at Coachella (2012)

The moment the internet lost its mind and everyone realised... it was already happening. Kind of.

"What's up Coachella?!"

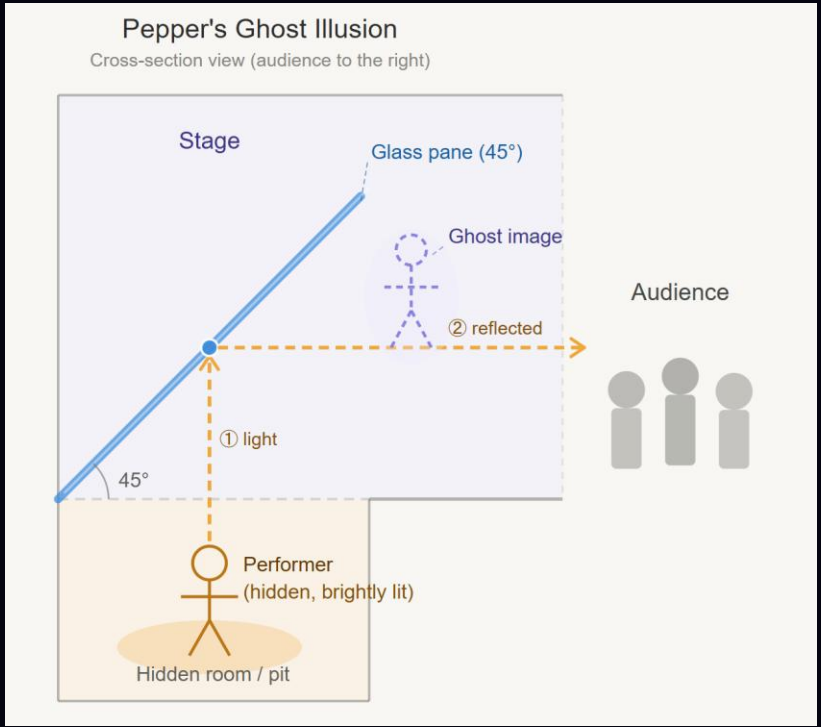
PEPPER'S GHOST

Origin: 1862 — John Henry Pepper's stage illusion

A brightly-lit actor hidden off-stage is reflected in a large pane of angled glass on stage. Audiences see a ghost overlaid on the real scene.

The 45° reflection principle

Source display → angled reflector → viewer sees floating image



PERSISTENCE OF VISION

The eye retains an image for ~1/25th of a second after it disappears.

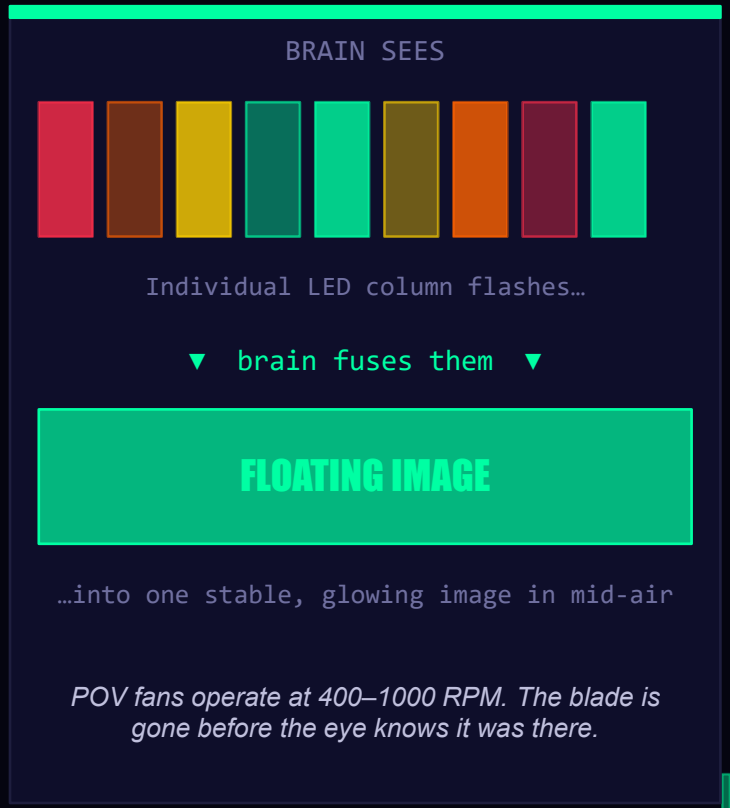
A spinning LED column illuminated at precisely the right rotational moment appears, to your brain, as a complete 2D image floating in mid-air.

No display surface. Just photons and timing.

PERSISTENCE OF VISION

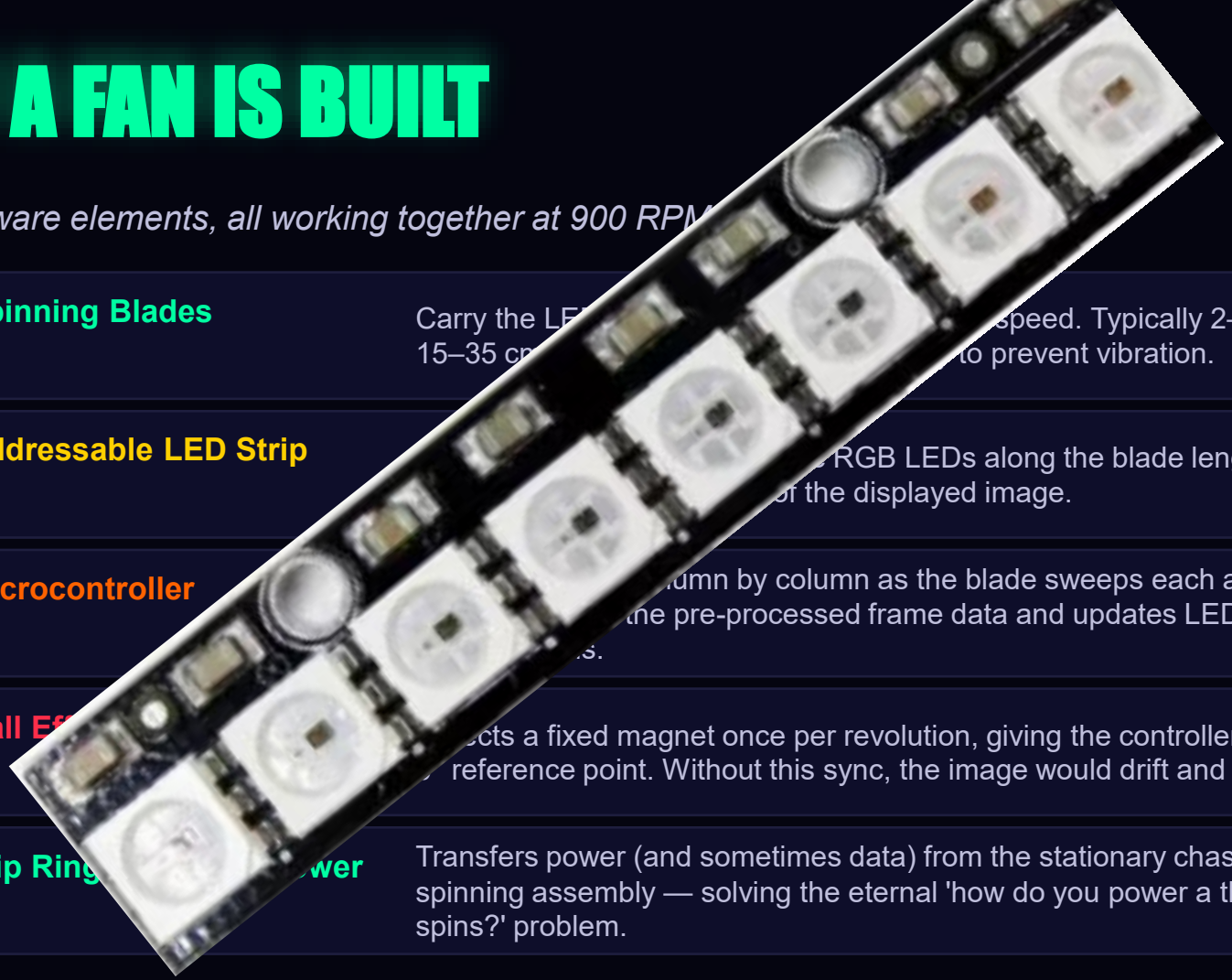
The eye doesn't see the world in real-time.

When a visual stimulus disappears, the brain retains the impression for approximately **16–100 milliseconds**. This lag is called the **persistence of vision**.



HOW A FAN IS BUILT

Five hardware elements, all working together at 900 RPM



Spinning Blades

Carry the LE… speed. Typically 2–4 blades of 15–35 cm… to prevent vibration.

Addressable LED Strip

… RGB LEDs along the blade length. Each …f the displayed image.

Microcontroller

…umn by column as the blade sweeps each angular …he pre-processed frame data and updates LEDs in …s.

Hall Ef…

…cts a fixed magnet once per revolution, giving the controller a precise … reference point. Without this sync, the image would drift and smear.

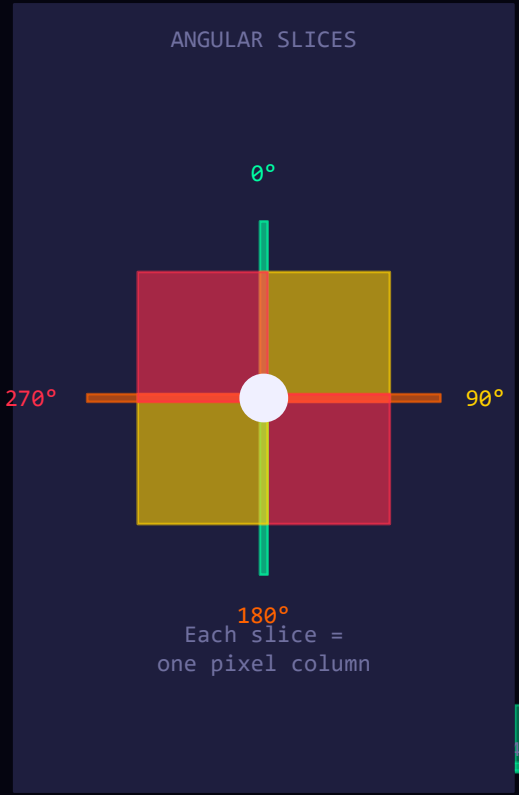
Slip Ring … …wer

Transfers power (and sometimes data) from the stationary chassis to the spinning assembly — solving the eternal 'how do you power a thing that spins?' problem.

IMAGE TO FLOATING IMAGE

Five steps from a PNG file to a glowing mid-air picture:

1	**Image Slicing**	The source image is pre-processed into vertical columns, one per angular position around the full 360° circle.
2	**Rotation**	The motor spins the blade at constant speed — typically 450–900 RPM.
3	**Position Sensing**	The Hall effect sensor detects the fixed magnet once per revolution, giving the controller a precise 0° reference.
4	**Column Rendering**	As the blade sweeps each angle, the microcontroller lights the matching column of pixels on the LED strip — in microseconds.
5	**Persistence of Vision**	The blade completes a full revolution faster than the eye can detect. The brain fuses all column flashes into a single stable image.



THE MATHS

Frame Rate

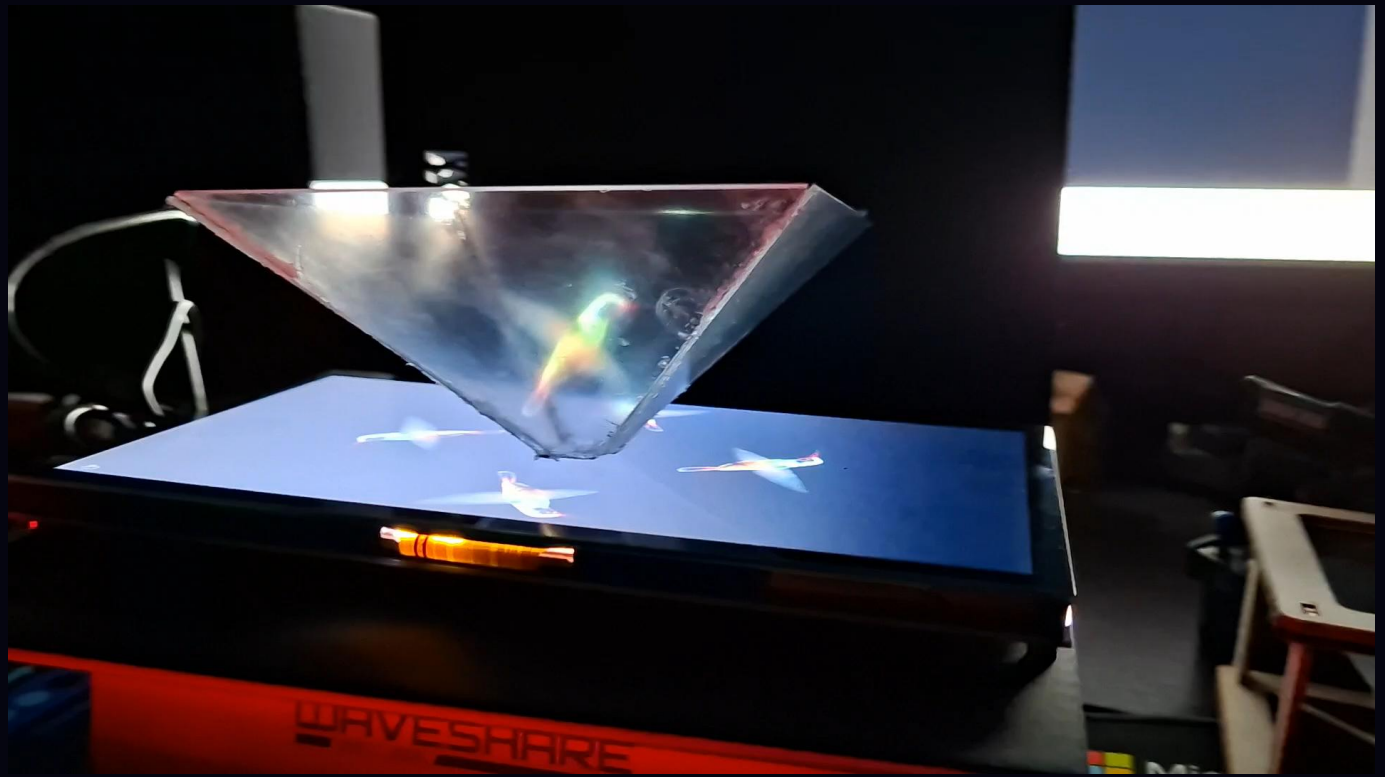
The perceived frame rate equals the rotational speed in revolutions per second:

$$\text{FPS} = \text{RPM} \div 60$$

900 RPM → 900 ÷ 60 = **15 FPS** (visible but flickery)

For smooth video (≥ 24 FPS) you need **≥ 1440 RPM**

PYRAMID / MULTI-PERSPECTIVE



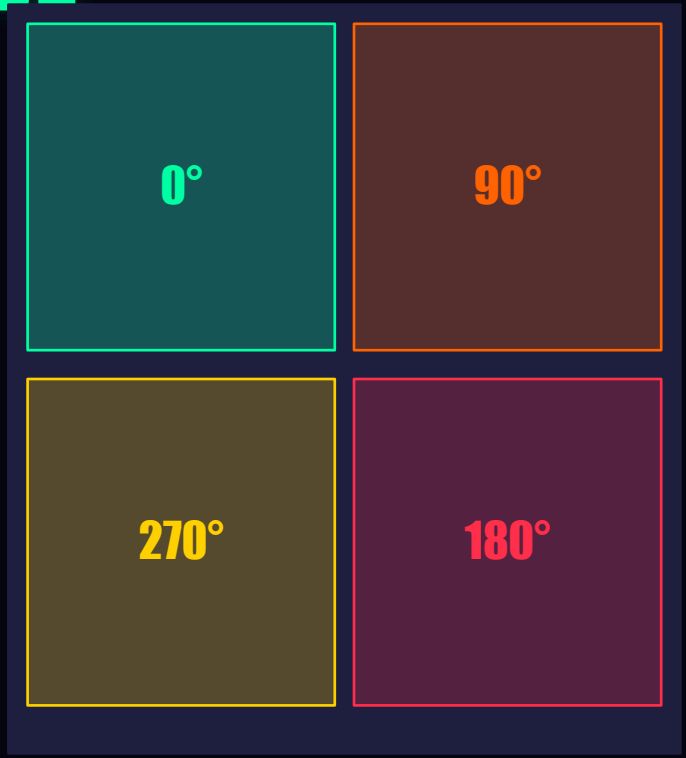
PYRAMID / MULTI-PERSPECTIVE

4 angled reflections converge

A 4-sided transparent acrylic pyramid sits on a display. Each quadrant shows the same 3D object from a different angle (0°, 90°, 180°, 270°).

The reflections converge inside the pyramid — making the object appear to float in mid-air.

`Materials: acrylic sheet · craft knife · tape`
`Time: ~1 hour`



4 quadrants → 1 floating image

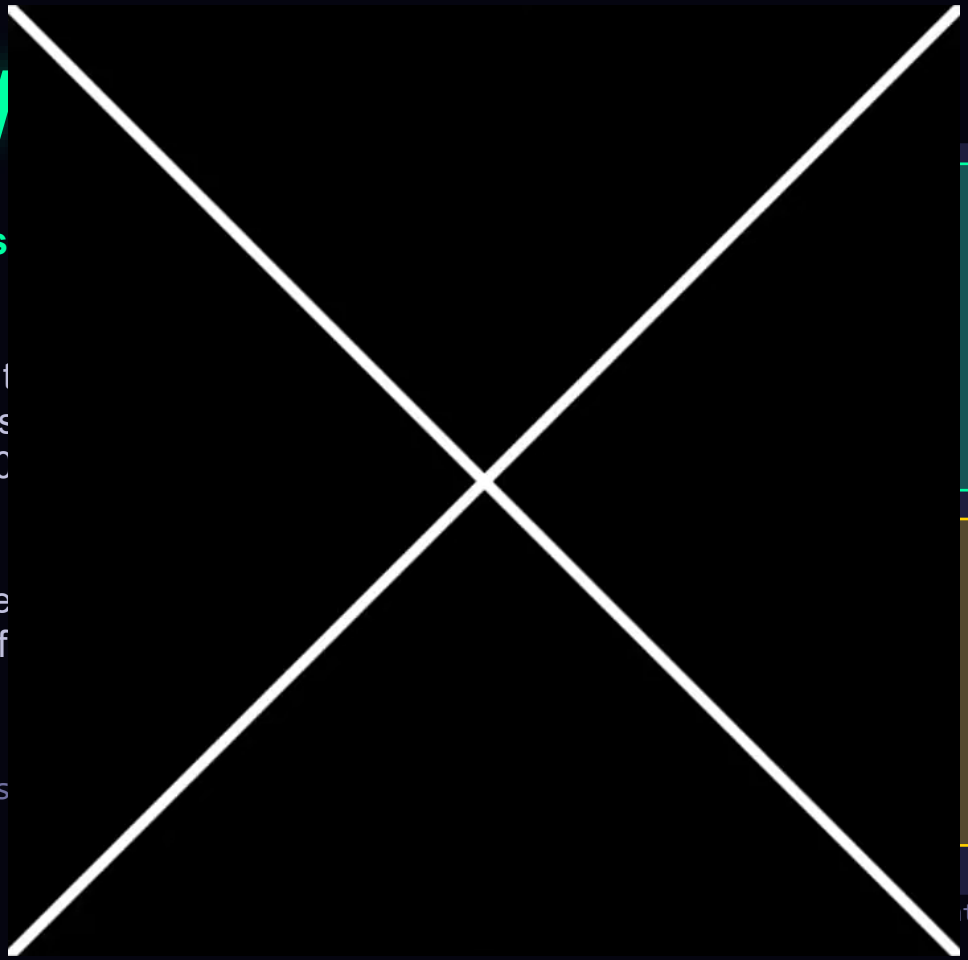
PYRAMID A

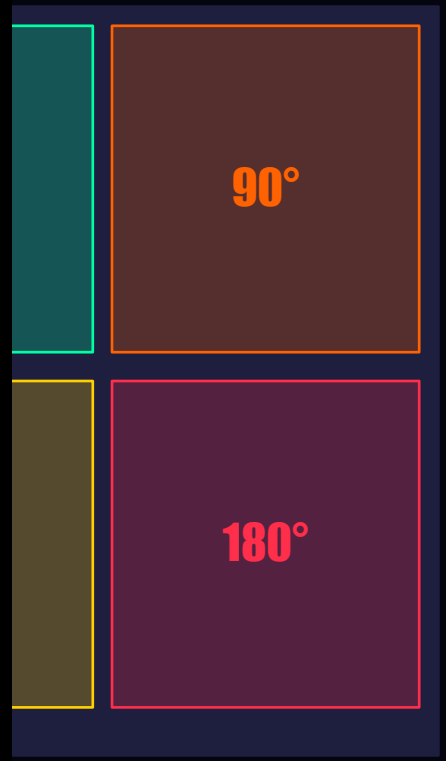
4 angled reflections

A 4-sided transparent
Each quadrant shows
different angle (0°, 90

The reflections conve
the object appear to f

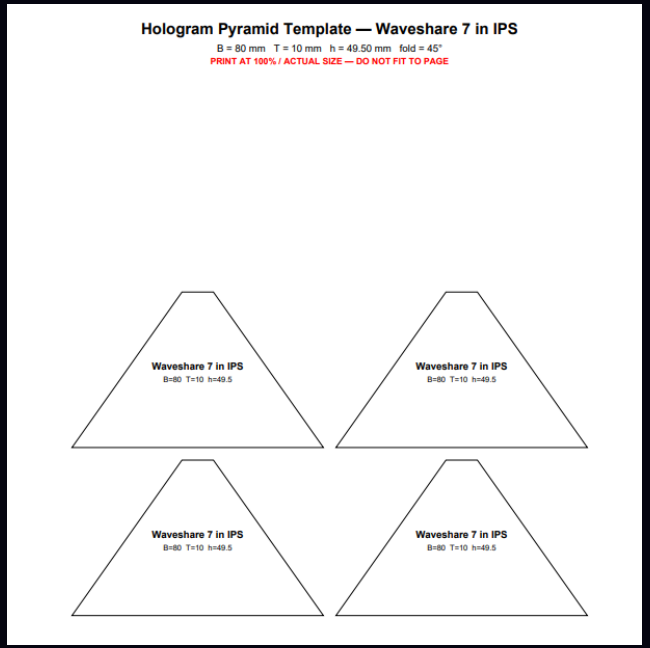
```
Materials: acrylic s
Time: ~1 hour
```





ts → 1 floating image

PYRAMID Templates



Hologram Pyramid Template — Waveshare 7 in IPS

B = 80 mm T = 10 mm h = 49.50 mm fold = 45°

PRINT AT 100% / ACTUAL SIZE — DO NOT FIT TO PAGE

Waveshare 7 in IPS
B=80 T=10 h=49.5

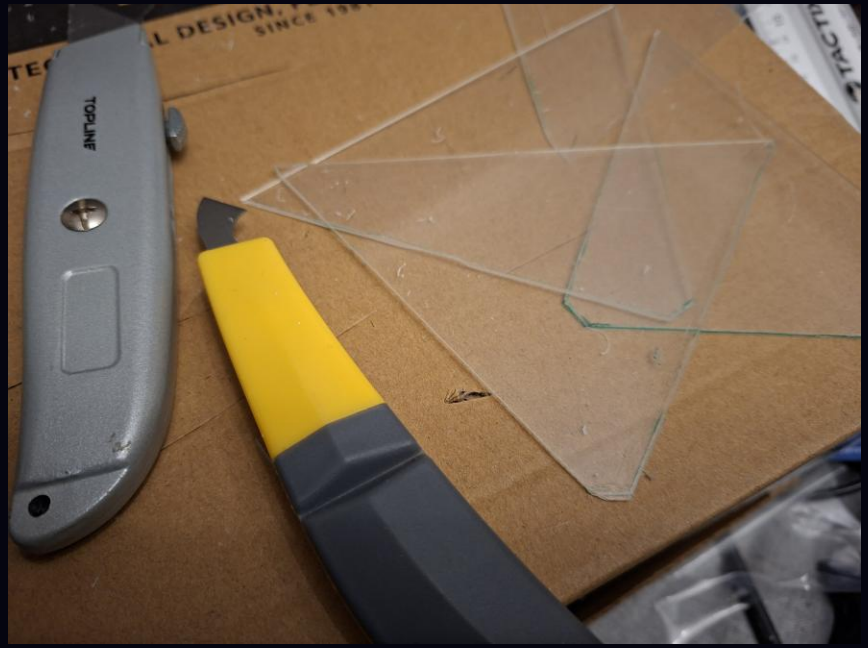
Waveshare 7 in IPS
B=80 T=10 h=49.5

Waveshare 7 in IPS
B=80 T=10 h=49.5

Waveshare 7 in IPS
B=80 T=10 h=49.5

bitly

PYRAMID Arts and Craft



"YOU ALREADY LIVE WITH HOLOGRAMS"

These tricks are hiding in technology you use every day.

HUDs in cars & aircraft

Speed + nav projected onto your windshield

AR Headsets

HoloLens, Apple Vision Pro — waveguide combiners

Teleprompters

Those tall glass panels? Pepper's Ghost.

★ *Same physics as the arcade. Same optics. Different application.*

HEADS-UP DISPLAYS

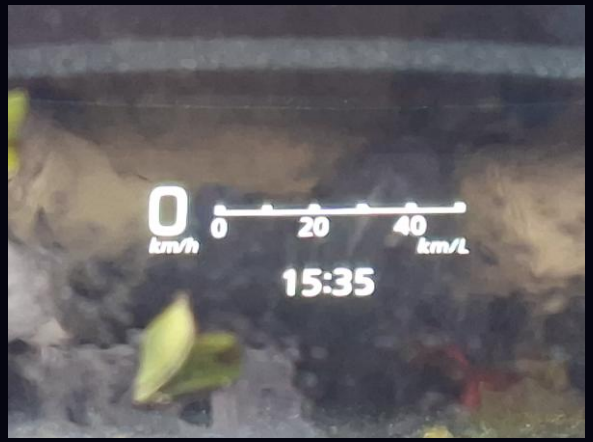
How it works

A partially-silvered **combiner glass** at an angle reflects the display toward your eyes while staying transparent to the real world.

The image is optically focused at distance — no refocusing between display and horizon.

Where you see them

- Fighter jets & commercial cockpits (1950s origin)
- Modern car dashboards Mercedes, BMW, Mazda
- AR headsets HoloLens, Apple Vision Pro
- Smart cycling helmets, Google Glass



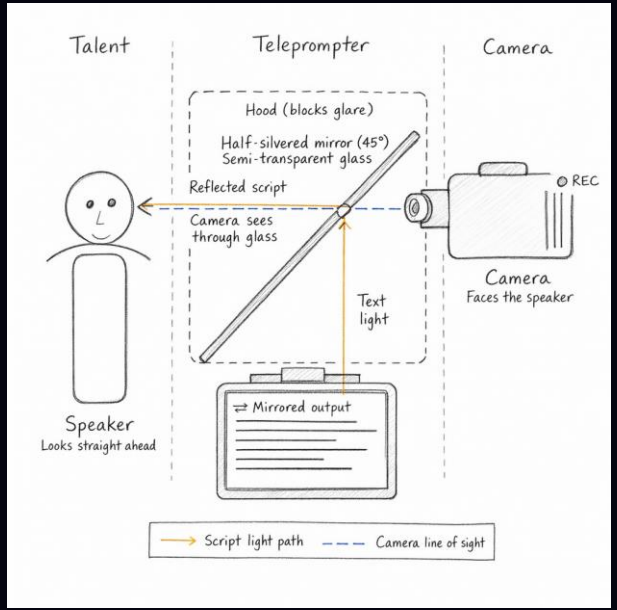
TELEPROMPTERS

The teleprompter **is literally a Pepper's Ghost rig.**

A monitor displays the script below. Beamsplitter glass at 45° reflects the text toward the speaker. The camera looks through the glass from behind — and sees only the speaker.

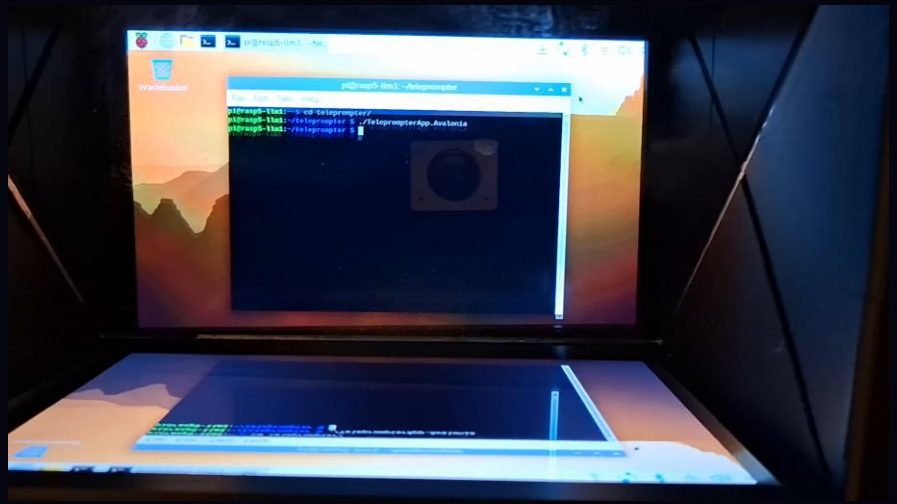
The ghost is text. Not a person.

News anchors · Presidential speeches · YouTube production · Keynote presenters



REAL WORLD APPLICATION

TELEPROMPTERS



Like and Subscribe!! 👍

LET'S RECREATE TIME TRAVELLER

01

Pyramid Hologram

02

Pepper's Ghost

03

Time Traveler Arcade

PYRAMID HOLOGRAM

Hardware

- Raspberry Pi 4 or 5 + microSD
- Small HDMI display (7–10 inch)
- Clear acrylic pyramid (DIY)

Software

- Raspberry Pi OS Bookworm (Wayland)
- Mame
- Hyperseus

PYRAMID HOLOGRAM

How??? 🤔

There's a compositor in Linux?

The display server problem

- On Linux, a **display server** is the software layer that owns the screen,
- Receives input, and draws application windows.
- For decades this was **X11**. Wayland is the modern replacement
- GPU-native.
-

In Wayland, the compositor IS the display server.

One program composites all windows and sends the result to the screen. **It owns the screen completely.**

For the pyramid hologram, this is exactly the leverage point we need.

★ *The compositor sits between app rendering and the physical screen.*

THE RENDERING PIPELINE

How a frame travels from app code to physical screen in a wlroots compositor:

Client Application	renders into a wl_buffer (shared mem or GPU texture)
▼	
wl_surface.commit()	buffer handed to compositor via Wayland protocol
▼	
Scene Graph Composition	GPU composites all surfaces into a virtual FBO
▼	
Output Transform Shader	← THE PYRAMID SOLUTION LIVES HERE — Process per quadrant
▼	
KMS/DRM Page Flip	finished framebuffer sent to display kernel subsystem
▼	
Physical Screen	pixels at correct refresh rate

THE CORE IDEA

Make the transform a property of the compositor's output stage — **not the content.**

Virtual Framebuffer (FBO)

All Wayland clients composite here at one-quadrant resolution. Every app fills the entire virtual area — it sees a completely normal fullscreen desktop.

GPU shader →

Physical Output Framebuffer

The virtual FBO is sampled four times by a GPU shader — once per quadrant. Each sample applies a UV transform encoding the flip + rotation for that quadrant.

What this means:

- Any Wayland application works unmodified — video, games, browser, terminal, live camera feed
- The pyramid transform is completely invisible to the app
- Stack apps like a phone launcher — hologram shows whatever is on top

Pyramid Compositor

pyramid-compositor

A Wayland compositor that drives a **Pepper's Ghost holographic pyramid** display. It takes any standard Wayland application and replicates it across four mirror-corrected quadrants on a screen, producing the illusion of a floating 3-D hologram when viewed through a reflective acrylic pyramid placed on top of the display.

Target platform: **Raspberry Pi 5** running **Raspberry Pi OS Bookworm** (Debian 12, aarch64).

```
sudo XDG_RUNTIME_DIR=/run/user/1000 \
    WLR_RENDER_DRM_DEVICE=/dev/dri/renderD128 \
    pyramid-compositor
```

```
mpv --vo=gpu --gpu-context=wayland --hwdec=auto --loop /home/pi/earth.mp4
```

Pyramid Compositor

pyramid-compositor

A Wayland compositor that
display. It takes any standard
mirror-corrected quadrants
hologram when viewed thro
the display.

Target platform: **Raspberry**
12, aarch64).

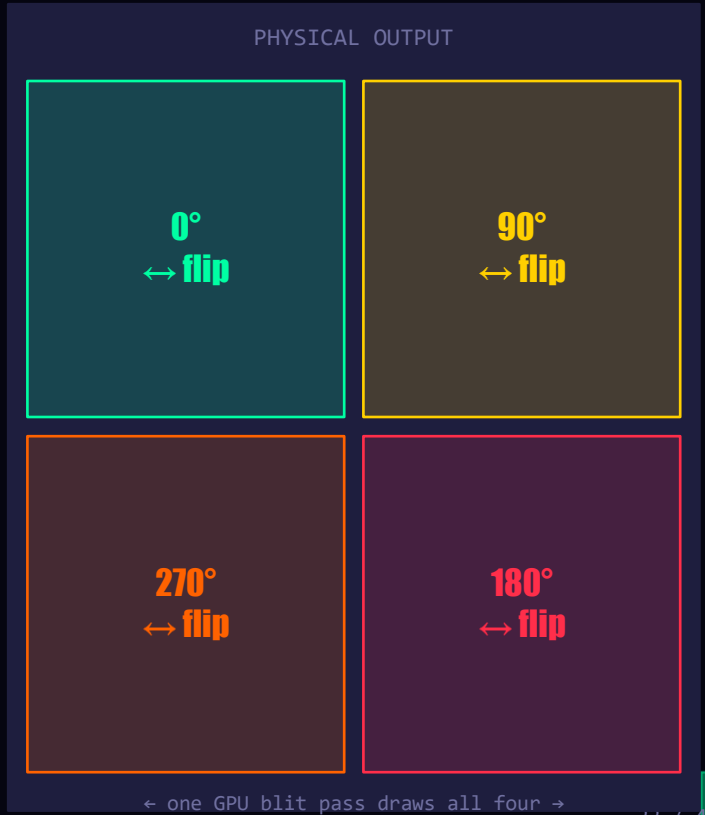
sudo XD
WLR_
pyra

mpv --vo=gpu --gpu-context=wayland --hwdec=auto --loop /home/pi/earth.mp4

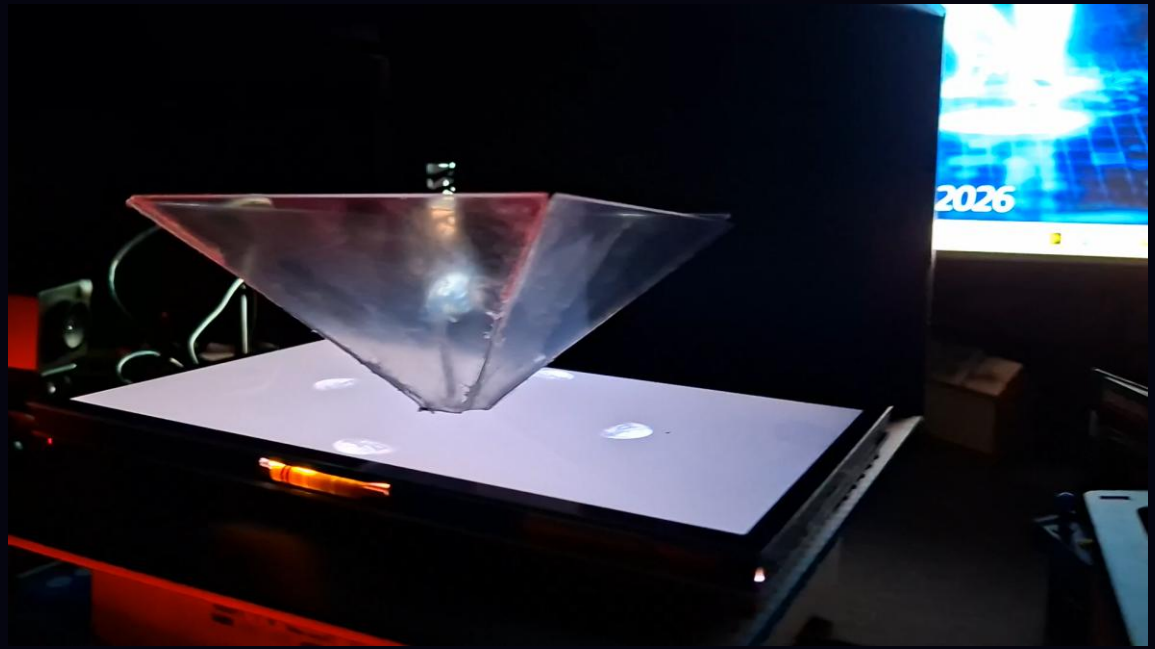
THE SHADER TRANSFORM

1. Translate to texture centre (so rotation is around the image centre)
2. Horizontal scale of −1 (the mirror flip)
3. 2D rotation by the quadrant's angle (0°, 90°, 180°, 270°)
4. Translate back from centre

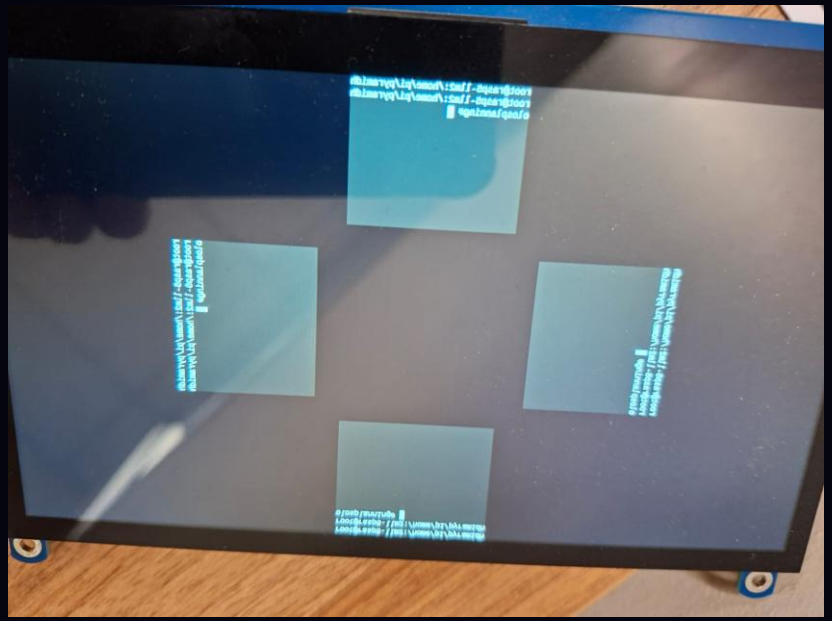
Result: the GPU does the entire spatial correction
No CPU involvement. No performance penalty. Runs on every frame automatically.



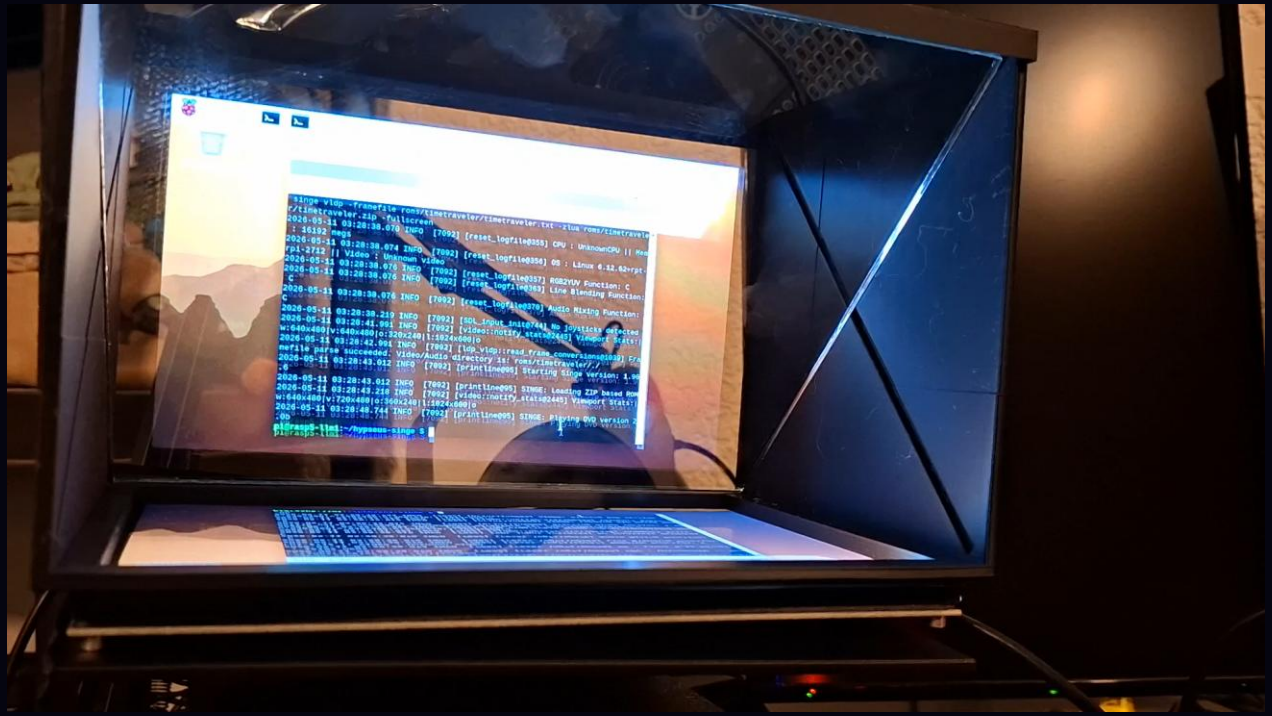
Automatically Render 4 Quadrants



Automatically Render 4 Quadrants



PEPPER'S GHOST



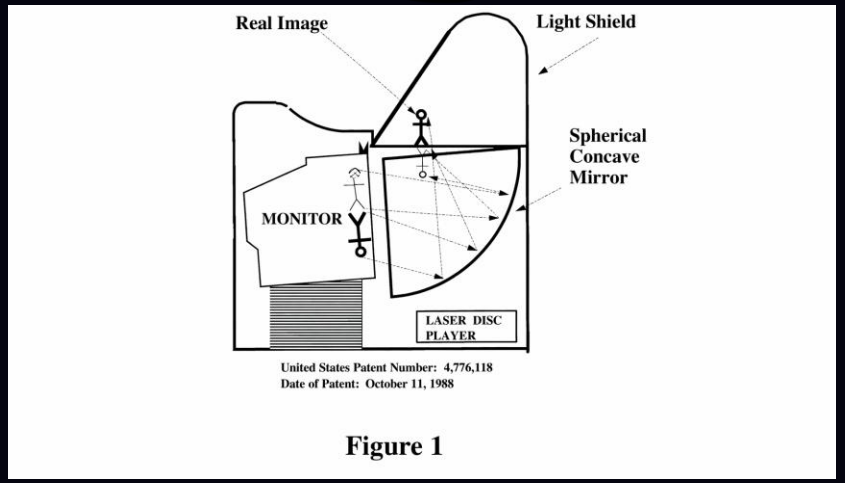
SEGA'S IDEA FOR TIME TRAVELER ARCADE

Sega's original technique

Found the original designs! 🥳

CRT screen faces **diagonally** inside the cabinet.

- A curved parabolic reflector
- **upward and outward** — making the cowboy appear to float above the cabinet surface with no visible screen.
- Dome curved at 80 degrees. Gloss Black outer coating



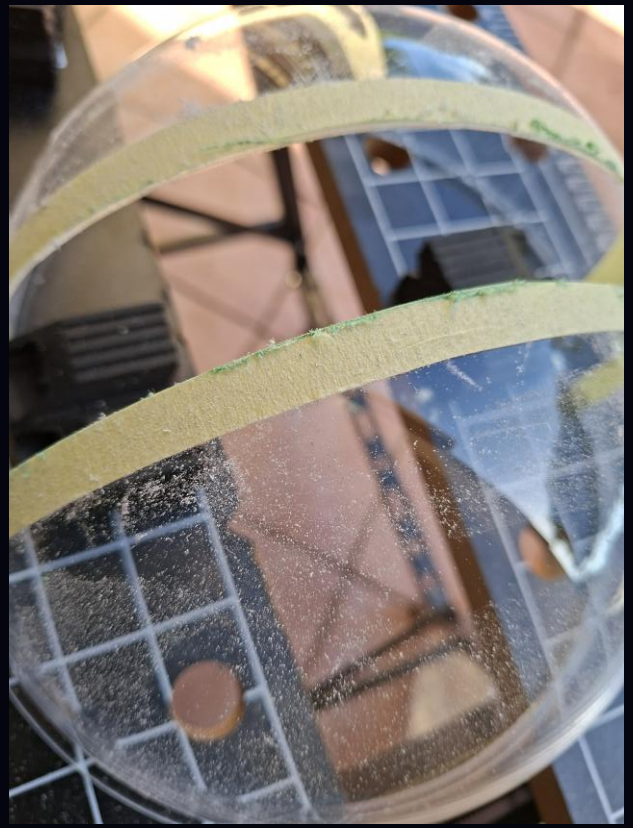
THE DOMES

How do you make a dome?

- Mini Arcade - 200 mm diameter domes.
- Manufactured

THE DOMES

- Domes cut in half.
- Dremel cutting discs



THE DOMES

- Spray paint time!!
- Rustoleum Gloss Black
- Spray only the outside of dome
- 4 Coats of paint

THE DOMES

- Spray paint time!!
- Rustoleum Gloss Black
- Spray only the outside of dome
- 4 Coats of paint

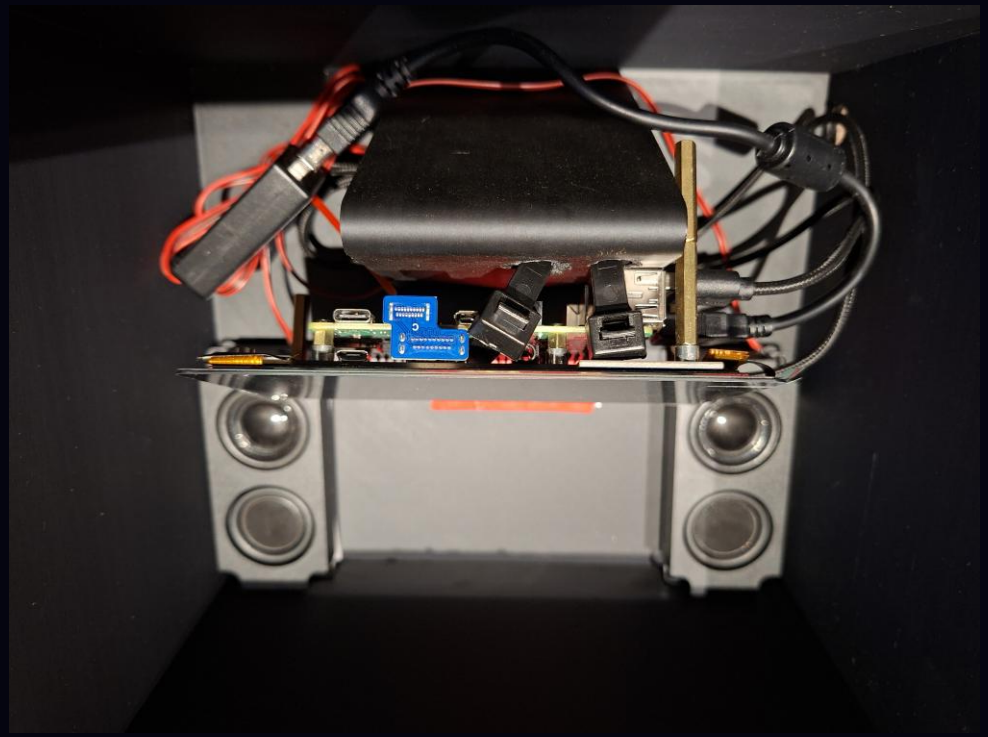
LIGHT COVER

- **More Spray Paint!!**

- Everything but the dome mirror should be matt black
- Rustoleum FLAT Spray Paint
- 4 Coats

PARTS

- Waveshare USB Sound Card
- 5 W Speakers
- Raspberry Pi 4
- Waveshare 5.5 Inch Capacitive Touch Amoled



- **Amoled best for the rendering of BLACK**

TIME TRAVELER ARCADE

1991 Achievement UNLOCKED

TIME TRAVELER ARCADE

Other Holograms too!

TIME TRAVELER ARCADE

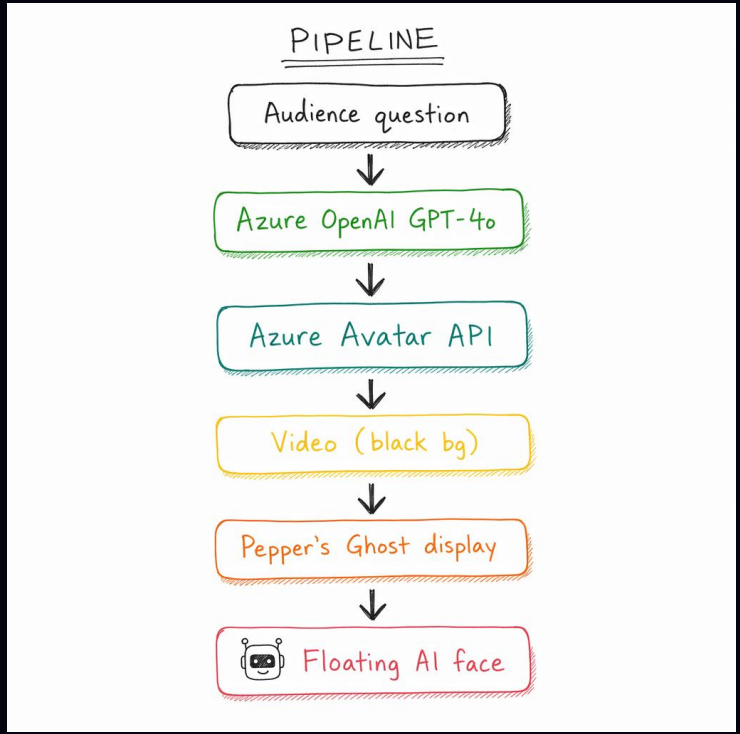
Other Holograms too!

AI AVATAR

Azure Cognitive Services generates a real-time talking human avatar video on a **black background.**

Displayed behind a Pepper's Ghost enclosure — the face appears to float and speak as a hologram.

Optional: Wire Azure OpenAI (GPT-4o) to take live audience questions → pipe to Avatar API.



Stack

Azure Speech (Avatar) · Azure OpenAI GPT-4o · HTML/JS · 3D-printed enclosure

AZURE AI AVATAR

https://learn.microsoft.com/en-us/azure/ai-services/speech-service/text-to-speech-avatar/what-is-text-to-speech-avatar

RESOURCES + REPO

GitHub

Software

- Hologram Player (.NET MAUI)
- Heads Up Display (.NET MAUI)
- Wayland Pyramid Compositor (C++)
- Teleprompter (.NET Avalonia)
- ESP32 Holofan

Design

- 3D Printer Designs
- Pyramid Templates (PDF)
- Azure Live Avatar (HTML)

SCAN FOR REPO

github.com/[apead]
/devconf-2026

THANK YOU

QUESTIONS?

We don't just need chatbots.
We need holograms in our lives.
Holograms, man. Holograms!

https://www.devconf.co.za/rate-capetown

Level 101 · Fun / Experiments · 40 minutes