GRAEAE

RELEASING ART FROM THE SCREEN

An open, light-aware display for wallet-held digital art, and a fair, privacy-preserving network for sharing it

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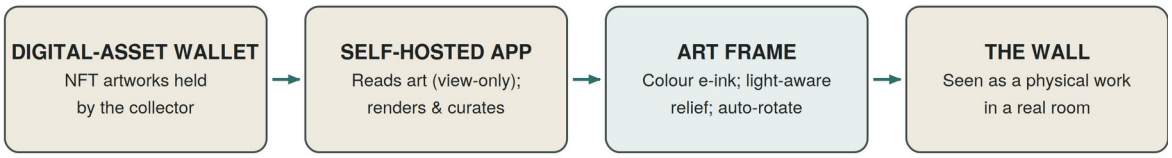
From wallet to wall



Custody never leaves the owner; the frame holds no keys.

White Paper

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Executive summary

Digital artworks, including those recorded as non-fungible tokens (NFTs), are created, traded and held in purely electronic form. Living with art, however, is a physical experience: a work on a wall, lit by the room, in the proportions its maker intended. That experience is hard to reproduce today. Connected screens glow like televisions, show every work in the same rectangle, and tie owners to closed hardware and fixed catalogues.

Graeae takes a different approach. It is an art frame that you assemble yourself from commonly available components, running open software that you host yourself. Works are shown on a reflective colour e-ink panel that is read by the light already in the room, so the frame looks like an object on the wall rather than a screen. Graeae senses the direction of that light and renders the highlights, shadows and canvas texture of thick brushwork, giving a flat file the presence of a painted surface. The frame turns physically between portrait and landscape to suit each work, and sets square pieces inside a polaroid border.

An optional ecosystem surrounds the frame. Owners keep full custody of their assets through view-only wallet connections, and the frame never holds a private key. An owner may choose to lend works to a shared library so that other people, including those who own no art of their own, can show them. When a work is shown this way, a camera on the frame confirms, entirely on the device and without ever storing or sending any image, that a person actually looked at it, and value is passed to the owner on that basis. What rewards an artist is real attention, not an idle screen in an empty room.

This paper sets out the problem in detail, the design of the device and its software, and the ecosystem that links owners, artists, makers and viewers. The methods described here are the subject of a patent application filed by the inventor, Srinivas Kasturi. Reference software will be released openly after filing.

1. The problem

Art that cannot be seen. An NFT is a certificate and, in most cases, a pointer to an image. An owner can prove they hold a work and can trade it, yet living with it, which is why most people acquire art at all, stays awkward. The piece sits in a wallet and is glanced at on a phone.

Screens that look like screens. Most connected frames use emissive panels, either backlit LCD or OLED. Because they give off their own light, the eye reads them as lit displays, with the glare and glow of a television. They do not look like pigment on a surface. Where ambient light is sensed at all, it is used only to dim the panel, never to bring out the relief and texture that give a real painting its life.

One rectangle for everything. Portrait, landscape and square works are forced onto a panel of fixed shape, or rotated only in software so that black bars surround the piece. The proportions the artist composed for are lost.

Ownership without presence. Products that do show wallet art often ask the owner to hand assets, or signing authority, to a platform. Convenience is traded for custody.

Closed gardens. Hardware tends to be proprietary and hard to repair, and content is locked to one vendor's catalogue and subscription. There is little room for makers or communities to build on it.

Being seen, and being paid for it. Artists rarely get the chance to have work shown in real homes and to earn when people actually look at it. The streaming art services that exist curate from the top down. They are not an open market of works contributed by owners.

The privacy cost of attention. Measuring whether anyone looks at a display is routine in advertising, but the usual methods point a camera at people and send the footage to a server. In a home, that is not acceptable.

> *Across all of these the pattern is the same. Digital art is held in wallets, shown on glass that still looks like glass, kept inside closed platforms, and given no fair or private way to be seen and valued.*

2. The solution

Graeae responds to each of these problems. The frame behaves like an object rather than a screen, the network around it behaves like a commons, and the owner stays in control of both assets and privacy.

2.1 A frame you build, not a black box

The device ships as a kit. It lists commonly available components, namely a single-board computer, a microcontroller, a colour e-ink panel, light sensors, a small camera, a near-field communication (NFC) contact and a rotation motor, and it includes assembly instructions, hosting instructions and software from a public repository. Anyone can build it, repair it, read how it works and extend it.

2.2 Art that looks like art

The display is a reflective, non-emissive colour e-ink panel, run with no backlight. Like paper or canvas, it builds its image from the light already present in the room. There is no glow and no glare, and in a dim room the work is dim, as a real painting would be. This one choice does most of the work of making a file feel like an object.

2.3 Light-responsive rendered relief

A flat image has no brushstrokes, so Graeae adds them by rendering rather than by any physical change to the panel. Four light sensors, one at each corner, work out the direction from which the frame is lit. Software studies the artwork, separates its edges from its areas of solid colour, and infers a plausible map of surface relief. It then draws directional shadows along the edges and fine, canvas-like striations across the solid areas, all lit from the measured direction. As the light in the room moves, whether a lamp is switched on or the sun crosses the sky, the highlights and shadows move with it, the way the raised ridges of real impasto would. The owner can switch the effect on or off for each work.

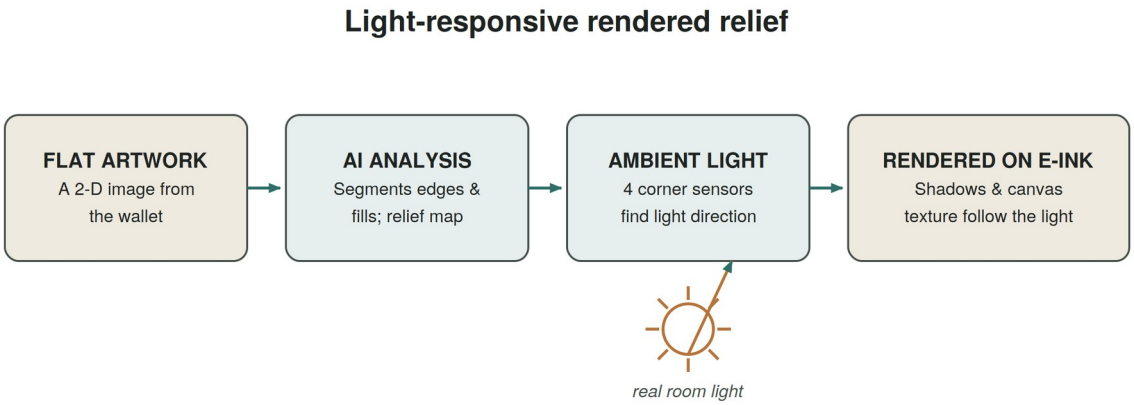

Figure 1. A flat file is given the look of painted relief that responds to the light in the room.

2.4 Physical reorientation and polaroid composition

Instead of rotating the image in software, the frame physically turns. It looks ahead to the next work in the running order, reads that work's orientation from its metadata and proportions, and, during a short transition that announces the upcoming piece, turns a two-position mechanism so the panel is already correct when the work appears. Square works shown in portrait are set automatically inside a polaroid style border. The viewer sees a considered, gallery-like change rather than letterboxing.

2.5 Tap to know more

An NFC contact lets any visitor tap a phone to the frame and open a light web application that shows the current work's details. The same entry point, once an owner signs in, becomes the administrator console for managing wallet connections, the running order (sequential, shuffled or grouped) and sharing. There is no public sign-up. The first administrator sets a private credential the first time they use it.

2.6 Context, curated

Descriptions and background for each work can be drafted by a language model and then reviewed and approved by the owner, so that visitors read accurate, considered text rather than unchecked output. Works can be grouped automatically by features taken from on-chain metadata, such as the artist or membership of a collection, and by a dominant colour read from the image itself, with no manual tagging.

2.7 Custody you keep

Every wallet connection is view-only. It is enough to read works and their metadata for display, and never enough to move them. The frame and its software hold no private keys. Owners show, share and earn without giving up control of their assets.

3. Under the hood

3.1 Hardware architecture

A single-board computer handles image processing, rendering and networking, while a microcontroller drives the rotation motor and reads the light sensors. The reflective e-ink panel,

the four corner light sensors, the camera, the NFC contact, two concealed preference controls and the two-position motor make up the rest of the device. Because only two rotational states are needed, orientation is handled without an accelerometer. Every part is off the shelf.

3.2 The relief pipeline

The rendering pipeline takes the two-dimensional artwork, segments it into boundary and solid-fill regions with a trained model, and estimates a depth or surface-normal map that stands in for relief. A relighting stage combines that map with the measured light direction to produce directional shading along the boundaries and shaded striations within the fills. The composited result is written to the panel. When the light direction changes, the system re-renders; on a bistable e-ink panel this happens in steps, which suits the slow changes of daylight.

3.3 The orientation engine

Because the running order is known ahead of time, the system can look ahead. Before a work is shown, its orientation is worked out and the panel is turned during the transition, with a card naming the next piece. Square works bound for portrait are set into the polaroid layout in the same step.

3.4 Software and self-hosting

Each owner runs their own copy of the control software, on the device itself, on a home server, or in a cloud account they control. That copy serves two progressive web applications, one for visitors and one for the administrator, manages the view-only wallet connections by ordinary means, and runs the rendering, curation and, where enabled, metering functions. Nothing about showing the owner's own collection depends on a central server.

4. The ecosystem

Beyond a single frame, Graeae can connect a community. Taking part is optional and additive, and a frame works fully on its own.

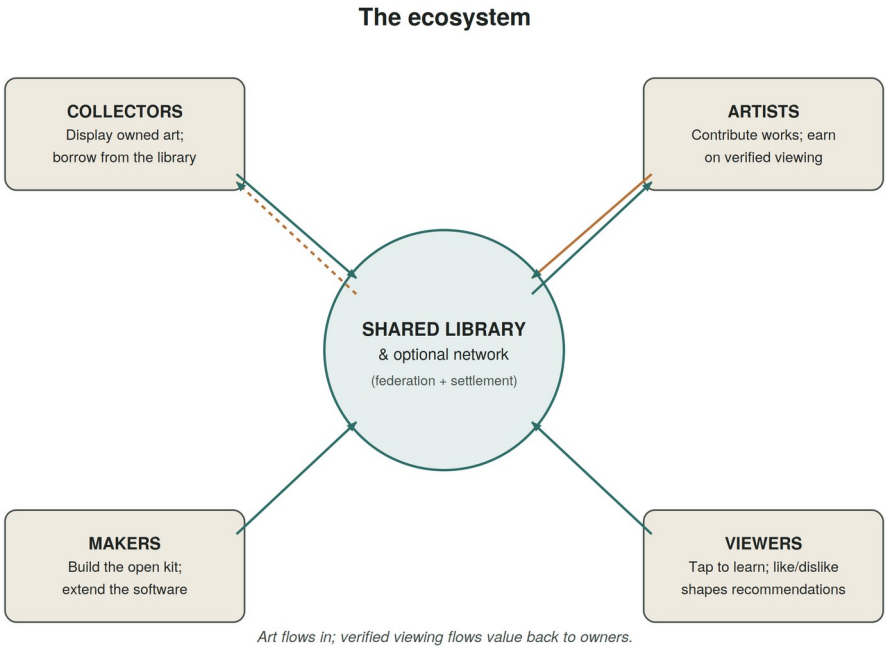

Figure 2. Collectors, artists, makers and viewers around a shared library. Art flows in, and value flows back to owners when works are actually viewed.

4.1 Roles

- Collectors show their own works and may borrow from the shared library to bring variety to their walls.
- Artists and owners lend works to the shared library and earn when those works are viewed.
- Makers build the open kit and extend the open software, hardware and finishes.
- Viewers tap to learn about a piece and signal taste through two concealed like and dislike controls.

4.2 The shared library and optional network

Independently hosted copies of the software can connect to an optional central service that keeps a shared library of works lent by owners and coordinates settlement. A subscriber, even one who owns no art, can draw works from the library onto their frame. Contributors keep their view-only connection, so the underlying assets never leave the owner's wallet.

4.3 Verified-display metering, in private

Any sharing economy depends on measuring real use. Graeae measures viewing without watching anyone. The camera's video is analysed entirely on the device to decide whether a person is present and whether their attention is on the artwork. Only an anonymous verified view signal is produced. The video frames are processed on the spot and discarded, never stored and never sent. The signal is reported to the settlement service, which passes value to the owner of the viewed work according to how often it is actually looked at.

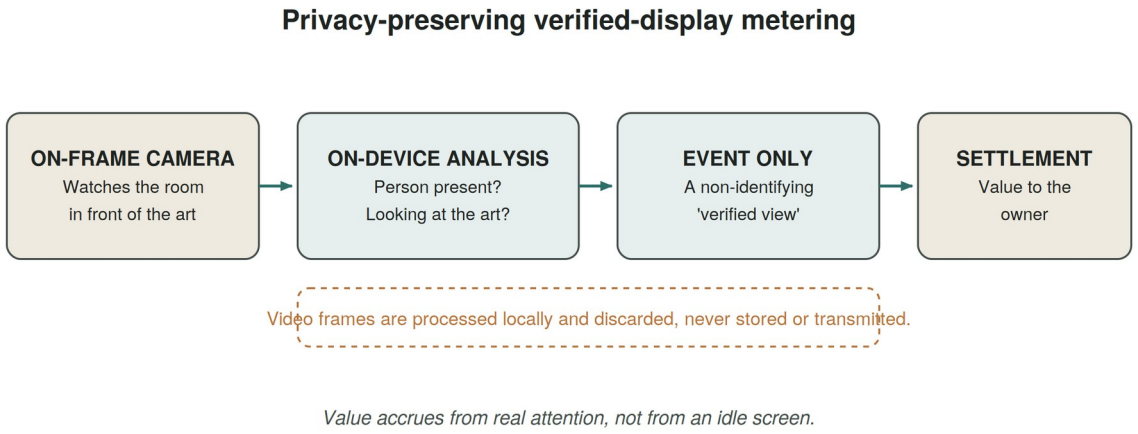

Figure 3. Attention is checked on the device. Only an anonymous signal leaves the frame, never any image.

4.4 How value flows

Subscribers pay to reach the shared library, and the resulting pool is shared among contributing owners in proportion to verified viewing of their works. Owners do not set a price per view; the share follows real attention. This rewards work that people choose to live with and look at. The exact economic settings are left open in this paper and will be described separately.

> *A note on forward-looking statements. The economic mechanisms described here illustrate intended design. They are not a commitment, not an offer of any security or token, and not financial advice. Final settings may change.*

4.5 Preference signals

The two concealed controls let a household express taste without putting buttons or overlays on the artwork. Likes and dislikes adjust which works, and which kinds of works, are recommended from the shared library, and how often they appear.

5. In practice

The collector. Sarah connects her wallets read-only, sorts her pieces into groups by artist and colour, and lets the frame move through them. Each work shows in its true orientation, lit by her living room lamps, with brushwork that catches the light.

The visitor. A guest taps a phone to the frame and reads who made the current piece and why it matters, in text that Sarah reviewed and approved, then taps a hidden control to say they liked it.

The artist. Devin lends a series to the shared library. As people across the network choose to show the work and actually look at it, verified view signals add up, and Devin earns in proportion to that attention while keeping custody throughout.

The maker. Priya builds the kit over a weekend from parts she sources locally, installs the open software, hosts her copy on a small home server, and later contributes an improved rotation bracket back to the project.

6. Design principles

- Open and self-hosted: no lock-in, since the owner runs the software and can inspect, repair and extend the device.
- Custody and sovereignty: connections are view-only, and the system never holds keys or moves assets.
- Privacy by design: attention is measured on the device, no image is stored or sent, and only an anonymous signal ever leaves the frame.
- Art first: a reflective, non-emissive surface and rendered relief, so works read as objects, not screens.
- Honest about the landscape: streaming art and connected frames already exist. The contribution here is the specific combination of an open, light-aware device, physical reorientation, retained custody, and private, owner-fair metering.

7. How this differs

The table below sets common approaches today against the design described here. It aims to be fair rather than complete, and the features of other products vary.

Dimension	Common approaches today	Graeae
Display	Emissive screens, with glow and glare	Reflective colour e-ink, read by room light
Surface	Flat image	Rendered impasto that follows the light
Orientation	Fixed, or software rotation with bars	Physical two-position rotation by look-ahead, with polaroid for squares
Hardware	Proprietary, closed, hard to repair	Open kit of common parts, with open software
Ownership	Often platform-held or licensed	View-only, so keys and custody stay with the owner
Sharing and earning	Top-down curated catalogues	Owner-contributed library, with value set by verified viewing
Attention and privacy	Camera analytics may store or send footage	On-device only, with anonymous signals and discarded frames

8. Intellectual property and open source

The methods described in this paper, namely light-direction-responsive rendered relief on a reflective panel, look-ahead physical reorientation with polaroid composition, and privacy-preserving verified-display metering across independently hosted copies, are the subject of a patent application filed by Srinivas Kasturi. In keeping with the project's open approach, reference software will be published openly after filing, so that the community can build on, audit and extend the platform while the core inventions stay protected.

9. Roadmap

Phase 1, Foundations. A reference kit and open software, delivering the single-frame experience: e-ink display, rendered relief, physical reorientation, the NFC console and view-only wallets.

Phase 2, Community. A shared library and connection between self-hosted copies, owner contribution, and verified-display metering with settlement.

Phase 3, Ecosystem. Maker tooling, alternative enclosures and panels, richer curation and recommendation, and wider wallet and chain support.

Dates and scope are indicative and will be confirmed as the project develops.

10. Conclusion

Digital art deserves to be lived with, not merely held. By pairing a surface that behaves like a real material with software that lets the room's light bring out a painted texture, a frame that turns to meet each work, and a private, owner-fair way to share and reward viewing, all of it open and self-hosted, Graeae sets out to take art out of the wallet and put it back on the wall, on the owner's terms.

Appendix A: Glossary

NFT. A non-fungible token, a blockchain record that identifies and usually points to a digital work.

View-only connection. A link to a wallet that can read its contents for display but cannot move them.

Reflective, non-emissive display. A display, such as colour e-ink, that forms its image from reflected room light instead of giving off light.

Impasto. Paint laid on thickly, so that brush or knife marks stand up in relief and catch the light.

Verified-display signal. An anonymous signal, made on the device, showing that a person actually looked at a work on screen.

Self-hosted copy. An owner-run copy of the control software, on the device, a home server, or a personal cloud account.

Appendix B: Important notices

This document is for information only and describes intended design and direction. It is not an offer or solicitation to buy or sell any security, token or other instrument, nor a promise of future features, availability or returns, nor legal, financial or investment advice. Statements about future plans are forward-looking and may change. Trademarks and product names of third parties belong to their respective owners and appear here only for comparison. The methods described are the subject of a pending patent application, and nothing here grants any license.