

Camera Caeca: On the Construction of Images Beyond Vision

Signal Camera as a Non-Optical Imaging System

Yixuan Xiao

OCAD University, yixuan.xiao@ocadu.ca

ABSTRACT

This paper presents Camera Caeca, a speculative imaging system that challenges the assumption of photography as a direct capture of visual reality. Unlike conventional digital cameras that rely on optical input, the proposed device replaces light with non-visual environmental signals and translates them into images through algorithmic processing. By maintaining the familiar interaction of a camera—pressing a shutter to produce an image—while fundamentally altering its sensing mechanism, the project exposes the constructed nature of digital imagery.

KEYWORDS

machine vision, non-optical imaging, signal-based imaging, generative systems

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Introduction

Photography is commonly understood as a process of capturing visible reality through optical means. From early camera obscura models to contemporary digital cameras, images are typically treated as representations of what is seen. However, this assumption obscures an important fact: digital images are not direct recordings of the world, but the result of computational processes that translate physical input into data and reconstruct it into visual form. As Joanna Zylińska in *The Perception Machine: Our Photographic Future between the Eye and AI* suggests that contemporary images increasingly operate in the space between human perception and machine processing, where seeing is no longer a purely human act but a distributed process between biological and computational systems [1].

Camera Caeca proposes a speculative imaging system that abandons optical capture. Instead of recording light, it uses a set of sensors (ultrasonic, light, and sound) to detect conditions associated with the photographed subject. Here, the subject is not a visually framed entity but a set of environmental relations. These signals are not treated as supplementary metadata, but as the primary source of image generation. Captured data is transmitted to a Python-based system, where it is translated through algorithms into information that can be encoded and manipulated, and ultimately rendered as a visual output. The resulting image no longer corresponds to a visible scene, but emerges from the interpretation of data.

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In this sense, the project deliberately departs from the conditions of traditional images. This framework aligns with Flusser's concept of technical images, which are not representations but realizations from a field of possibilities—a "blind" process through which the invisible becomes visible [2]. Camera Caeca operates as an apparatus that produces images from non-visual inputs, foregrounding the generative nature of machine vision.

A Processed Entity

In Trevor Paglen's work *Machine Readable Hito*, the characteristics of images under computational vision are made visible. Hundreds of portrait images of Hito Steyerl and Holly Herndon are analyzed through facial recognition algorithms, with each image accompanied by machine-generated labels such as age, gender, and emotional state (Figure 1). Rather than presenting images as objects for human interpretation, the work emphasizes how images are processed, categorized, and interpreted by computational systems. The image here is not an endpoint, but an input into a larger analytical system.



Figure 1: Trevor Paglen, *Machine Readable Hito*, 2017. Adhesive wall material. Image courtesy of the artist's website [3].

Through this comparison, it becomes clear that images are not stable representations, but sites of transformation. In *Machine Readable Hito*, the image is decomposed into attributes that can be classified and quantified, revealing a gap between visual appearance and machine

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interpretation. In Camera Caeca, this gap is further extended: the image no longer originates from a visible scene, but from signals that do not possess an inherent visual form. The question is no longer how an image is interpreted, but what qualifies as an image in the first place.

This also raises a broader question about visibility. If Paglen's work suggests that images are already shaped by algorithmic interpretation, then Camera Caeca suggests that visibility itself may be constructed. By generating images from non-visual data, the system does not attempt to represent reality, but instead makes visible the conditions of image production. What appears as an image is not necessarily what has been seen, but what has been processed.

Data Acquisition and Processing

The system is designed as a non-optical imaging pipeline that translates environmental signals into visual output. It consists of three primary sensing components: a light sensor, a sound sensor, and an ultrasonic sensor, all connected to an Arduino-based microcontroller. These sensors do not capture images in a conventional sense, but instead detect variations in environmental conditions associated with a subject.

When the system is triggered, each sensor records a set of values corresponding to different dimensions of the environment. The light sensor measures intensity, the sound sensor captures amplitude variations, and the ultrasonic sensor detects distance. These values are transmitted from the Arduino to a Python-based system via serial communication.

Rather than treating this data as metadata, the system interprets it as the primary source of image construction. The incoming values are parsed and mapped into a minimal visual structure.

Algorithm 1: Camera Caeca Runtime Loop

Input: Serial sensor stream (light, sound, ultrasonic)

Output: Encoded image file

- 1: Initialize serial connection
- 2: while True do
- 3: Read sensor data from Arduino
- 4: if data is valid then
- 5: Parse environmental values
- 6: Map values to image parameters

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- 7: Generate image representation
- 8: Save image to local storage
- 9: end if
- 10: end while

Implementation (Python Core Loop)

The incoming values are parsed and mapped into a minimal visual structure, where each capture is programmatically written and saved as an image file on the local machine. This process is implemented through a real-time Python execution loop that continuously listens to sensor input and triggers image generation:

```
ser = serial.Serial('/dev/tty.usbmodem143101', 9600)

while True:

    data = get_capture(ser)

    if data:

        path = generate_image(data)
```

Within this structure, the system remains idle until sensor data is received. Once triggered, `get_capture()` retrieves structured environmental values from the Arduino stream, which are then passed to `generate_image()` for visual encoding and local file output. At this stage, the system has already produced an image in a technical sense: the data has been encoded into a visual format and stored through standard image-writing processes.

However, when these images are opened, they appear nearly empty or unreadable to the human eye (Figure 2). Due to their extremely low resolution or minimal pixel variation, they do not present recognizable forms and remain closer to signal traces than to photographs. What is produced is therefore an image that exists materially—as a file, as data, and as a visual encoding—but not yet perceptually.

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Figure 2: Signal images generated by Camera Caeca during data acquisition. The images are programmatically saved as a single-pixel or low-resolution file and remain largely imperceptible when viewed.

This approach resonates with Hito Steyerl's *In Defense of the Poor Image*, which emphasizes transformation, circulation, and degradation over visual fidelity [4]. The images produced here similarly depart from representational clarity, foregrounding process and transformation as primary conditions of the image.

Gradient Mapping

Following the initial stage of data acquisition, the system proceeds to translate encoded signals into perceptible visual forms. This stage introduces a set of mappings that expand these signals into a visible image space.

Sensor data is parsed and assigned to specific visual parameters. Light intensity is mapped to color temperature, shifting the image between warmer and cooler tones. Sound input is translated into variations in noise distribution, introducing granular textures across the image surface. Ultrasonic distance data influences spatial modulation, affecting the dispersion and density of visual elements. These mappings do not reconstruct a scene, but instead define a system in which environmental signals control the distribution of color and texture.

The resulting images take the form of abstract color fields, where variation emerges from the interaction of sensor inputs rather than from spatial representation. What becomes visible is not the subject itself, but the conditions detected by the system. In this sense, the image functions as a translation rather than a depiction.

This logic aligns with *Machine Vision: How Algorithms Are Changing the Way We See the World*, where it is noted that: "The 'operational images' that are generated and processed by ... any ... machines, are clearly not representational in the sense that the Mona Lisa or a movie are representations. But they are still constructed." [5] Within this framing, the images produced by Camera Caeca operate in a similar condition: they are not representations of a visible world, but constructed outputs of a computational system.

Imaginary Familiarity

This project reframes the camera not as a tool for capturing light, but as a device for sensing and interpreting the environment. It proposes a visual translation method in which invisible environmental data becomes perceptible through computational processes, producing images that are structured rather than representational. In this sense, images are treated less as reflections of a visible world, and more as outputs generated through specific sensing and interpretation systems.

At this stage, the system focuses on making this translation process visible and consistent, allowing the relationship between sensor input and visual output to remain legible. However, this clarity also introduces a limitation: the current visual language remains relatively direct in how it maps data into form, and does not yet fully explore how interpretation might shift when additional generative layers are introduced.

One direction that remains open is the integration of AI-generated imagery. While the current system focuses on making the translation process explicit and readable, future development could extend this framework through generative models. Environmental signals could then guide image synthesis toward more familiar visual forms, such as landscapes or atmospheric scenes, while still remaining grounded in non-visual inputs. This would introduce a stronger tension between recognition and abstraction, where perceived realism becomes a constructed effect rather than a direct reflection of a visible scene.

This shift introduces a condition in which visual familiarity is no longer dependent on direct correspondence with a specific scene. Instead, it emerges from learned statistical and structural relationships within both sensor data and generative models. As a result, the system may produce outputs that resemble known environments—such as streets, buildings, or urban spaces—without referring to any actual or previously seen location. Familiarity becomes an effect of structural similarity rather than perceptual memory.

If an image can feel recognisable without corresponding to anything visible, then what exactly is being recognised? What determines what becomes meaningful within such a system of translation? If images are only legible through a chain of inherited codes and prior images [2], what happens when that chain is displaced by non-visual sensing and computational translation? Does readability still depend on tradition, or is it reorganized through machine-based forms of recognition?

These questions remain open within the project. Rather than resolving them, Camera Caeca situates itself within this uncertainty, asking what it means for an image to be produced when the act of seeing is no longer anchored in light, but distributed across systems of sensing, translation, and inference.

REFERENCES

1. Joanna Zylińska. 2023. *The Perception Machine: Our Photographic Future between the Eye and AI*. The MIT Press. <https://doi.org/10.7551/mitpress/14471.001.0001>
2. Vilém Flusser. 2011. *Into the Universe of Technical Images*. University of Minnesota Press.
3. Trevor Paglen. 2017. *Machine Readable Hito*. Adhesive wall material. Retrieved April 9, 2026 from <https://paglen.studio/2020/04/09/machine-readable-hito-and-holly>
4. Hito Steyerl. 2009. *In Defense of the Poor Image*. e-flux journal.
5. Jill Walker Rettberg. 2023. *Machine Vision: How Algorithms Are Changing the Way We See the World*. Polity Press. Retrieved from <http://ebookcentral.proquest.com/lib/oculocad-ebooks/detail.action?docID=31036447>