KineCAM: An Instant Camera for Animated Photographs

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Fig. 1. *KineCAM* is an instant camera-inspired device that allows users to capture and fabricate animated photographs, in the form of kinegrams, on the spot. (© Ticha Sethapakdi. Photo: Thanh Nguyen, 2021)

The kinegram is a classic animation technique that involves sliding a striped overlay across an interlaced image to create the effect of frame-by-frame motion. While there are known tools for generating kinegrams from pre-existing videos and images, there exists no system for capturing and fabricating kinegrams in situ. To bridge this gap, we created *KineCAM*, an open source[1] instant camera that captures and prints animated photographs in the form of kinegrams. We present our experience using *KineCAM* to create a portrait series, and discuss how this type of customizable instant camera platform can create new opportunities for experimental and social photography.

CCS Concepts: • **Human-centered computing → Interaction devices**.

Additional Key Words and Phrases: fabrication, capture, kinegrams

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[1] https://github.com/HCIELab/KineCAM

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1 BACKGROUND

KineCAM combines the form factor of instant cameras with the expressiveness of animated photographs to explore and extend creative applications for instant photography. As such, the design and use cases for *KineCAM* draw inspiration from ideas in instant photography and moving photos.

Here, we present a historical overview of instant photography and moving pictures and discuss the ways in which *KineCAM* supports and challenges these ideas.

1.1 Instant cameras in a digital world

Digital photography has experienced a surge in popularity, and advancements in camera technology have spurred exponential growth in the number of photos captured [14]. Digital photographs are easy to manipulate, reproduce, and share—features that are valued in our increasingly connected world. While digital and smartphone cameras have become increasingly powerful photography tools, instant cameras, such as Polaroids, have kept their nostalgic appeal. Although instant cameras are more limited in their use and image quality than digital cameras, surprisingly there is growing interest in instant photography as new-old cameras enter the market [16, 27].

Today's instant cameras have many of the same properties as those from previous generations. They print one-of-a-kind photographs, which cannot be easily re-printed like other forms of film photography, rapidly on-the-spot [2, 4, 5, 8, 28]. Instant cameras have historically been promoted as social tools—such as by passing the camera around the room at a party—a practice that continues [28]. The popular image sharing platform Instagram makes several nods to the history of instant photography through its name, which is reminiscent of Kodak's Instamatic camera, and the emphasis on sharing square images [8]. Even "fauxlaroid" features which mimic the appearance of Polaroids, such as the iPhone *ShakeItPhoto* and image filters, continue to be used [2]. Thus, the cultural influence of the Polaroid camera body and its photographic process remain strong today. In its design, *KineCAM* also draws inspiration from the instant cameras of decades past, from its simple form factor to its bold red-and-black color scheme reminiscent of the *Polaroid Cool Cam 600*.

Some of the features that made standard instant cameras so popular, including their ease of use and fully self-contained processing, pose challenges to users who want to "hack" or customize the interface or output. The computational photography community has long argued that both hardware and software must be considered together in order to support a wide range of photographic outputs [1, 19]. While instant cameras are typically "black boxes" which prevent users from modifying the hardware or software, there is a growing interest in creating "hackable" instant cameras that perform specialized tasks within the maker community [6, 9]. In the same vein, we designed the hardware and software of *KineCAM* to be open source and modifiable, and we encourage users to experiment with changes to both of these components.

1.2 Making photographs move

While photographs are typically considered to be static, new forms of photography have challenged this convention to produce imagery that is more dynamic: blurring the lines between photos, videos, and animations [3, 21]. Whereas moving photographs were once somewhat niche, major smartphone manufacturers such as Apple and Google have devised ways to integrate them into their products [12, 20, 26].

Although the aforementioned examples focus on digital moving photographs, there are a number of alternative animation techniques which precede the digital age. The *kinegram* (also known as *barrier-grid animations* or *scanimations*) is one such animation technique that was developed prior to the 1900's. They have appeared in books [23, 29], cards [24], and even tattoos [17]. While kinegrams may not offer the high resolution and frame rate of their digital successors, they come with unique affordances. Unlike (digital) moving photographs, which viewers passively experience through a screen, kinegrams require viewers to physically engage with the printed image in order to "activate" the motion. Interacting with the image in this way gives the user control over the speed and direction of motion, lending to a more intimate and hands-on experience that is absent from standard digital pictures.

While there are tools that allow users to create kinegrams from pre-existing videos or images [7, 10], they are typically made post hoc, i.e., there is a delay between capturing the motion, processing the image, and printing the output. Researchers have explored making digital kinegrams from live videos [13], though they do not provide a method for fabricating them on-the-spot. *KineCAM* bridges this gap by merging live capture and fabrication into a single, portable device.

2 *KINECAM* DESIGN

KineCAM is a custom-built camera device (Fig. 2) with kinegram processing software written in Python. It retains many of the key qualities of instant photos and moving photos but differs in several ways. Similar to instant cameras, *KineCAM* offers a fast and portable way to create physical photos. Rather than capturing static images, however, *KineCAM* is able to capture dynamic movements, which expands the artistic potential for instant photography. Unlike the "black box" of a Polaroid camera, *KineCAM* also provides access to the internal hardware and software systems, which enables users to customize their cameras and produce a wider range of visual outputs.

In the following sections, we provide the technical details on how *KineCAM* was built and programmed.

2.1 Components and workflow

KineCAM's workflow uses a three-tiered approach that encompasses capture, processing, and fabrication. When the photographer presses the shutter button, the indicator LED lights up for 1 second to show that *KineCAM* is capturing a video and turns off when it is finished. After extracting frames from the video and processing them into a kinegram, the Raspberry Pi prints the output on the thermal printer. The striped overlays are printed separately on transparency film using a regular inkjet printer.

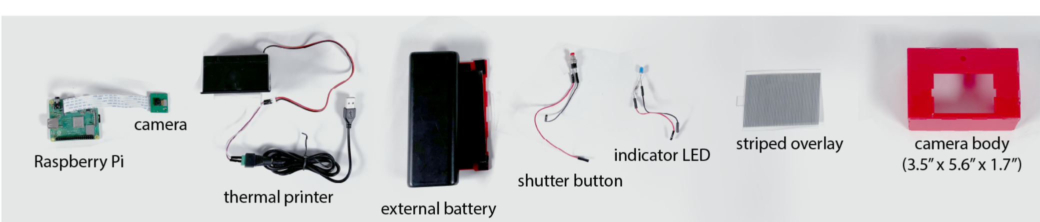

Fig. 2. The core components of *KineCAM* are the Raspberry Pi 3+, Arducam 5MP Camera, and a small thermal receipt printer. These are off-the-shelf components that can be acquired through most electronics retailers and together cost less than $100. (© Ticha Sethapakdi. Photo: Thanh Nguyen, 2021)

2.2 Software implementation

To create the kinegram, our system records the video for a fixed unit of time and selects n frames from it. It then decomposes the frames into strips of width w pixels, interlaces them, and composites them into a single image. For an n-frame kinegram, its striped overlay comprises alternating transparent stripes of width w and opaque stripes of width $(n-1)w$. Constructing the overlay in this way ensures that only one frame is visible at a time (Fig. 3a).

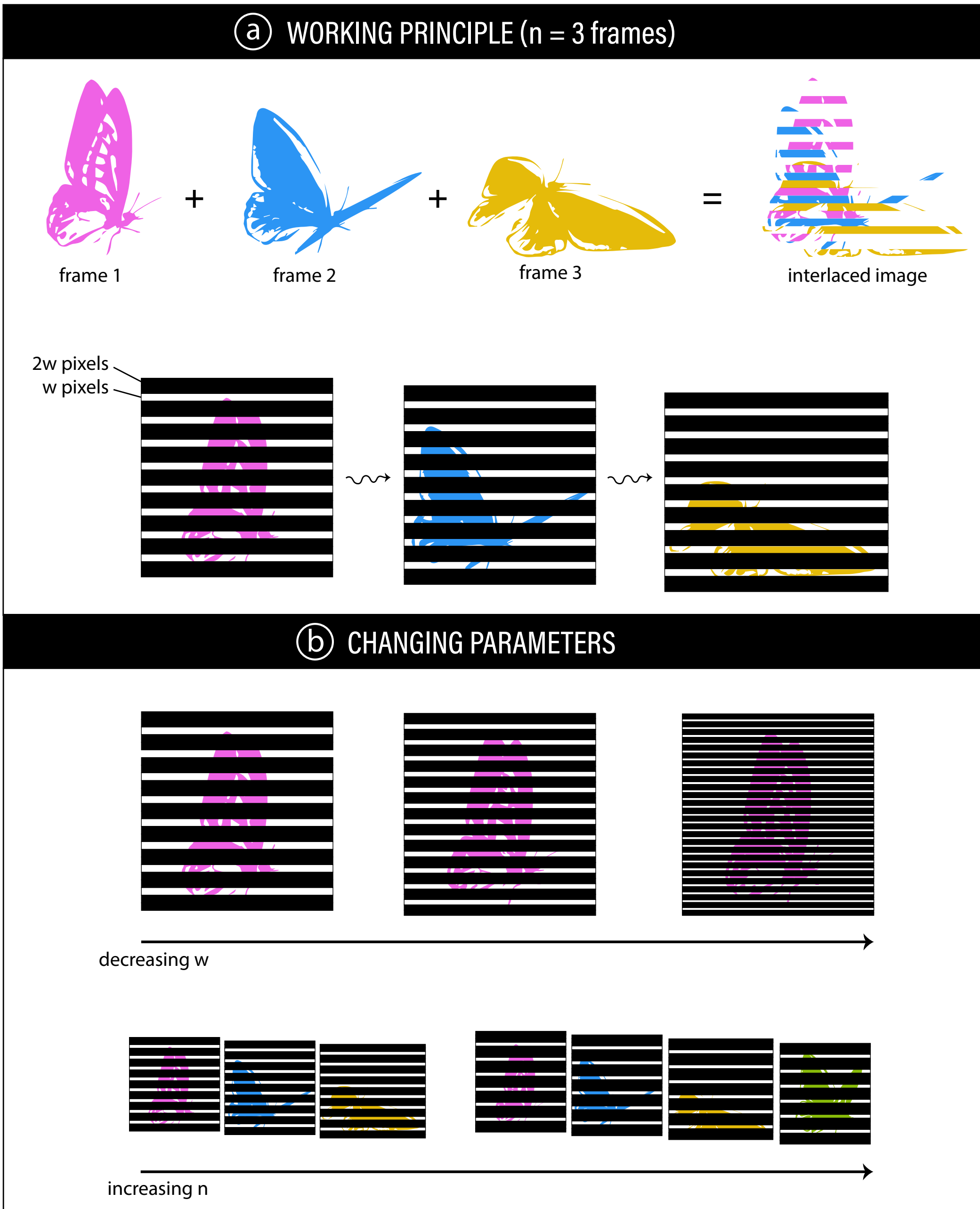

Fig. 3. A system diagram showing a) the working principle for *KineCAM* and b) the effect of changing certain parameters. (© Ticha Sethapakdi)

In our examples, we set the default video capture length to 1 second (32 frames total), create strips that are 3 pixels wide, and select frames near the beginning (frame 9), middle (frame 19), and end (frame 29). We picked these values because they produced subjectively good results for our purposes, but these parameters can be adjusted.

3 RESULTS AND DISCUSSION

We used *KineCAM* to create a portrait series that captures an afternoon social gathering (Fig. 4). Subjects were invited to have their picture taken while we observed how they interacted with the camera. We use our experiences from this activity to discuss how *KineCAM* creates opportunities for experimental, low-stakes, social photography.

Fig. 4. Selected scans of the portrait series made with *KineCAM*. (© Ticha Sethapakdi)

3.1 Encouraging experimentation

KineCAM is an unconventional photographic device that piques curiosity and encourages experimentation. Although it looks like an unassuming instant camera on the surface, *KineCAM* produces photos that are not typical of instant cameras. This subversion of expectations drew subjects to *KineCAM* and encouraged them to experiment with the outputs. In our photo sessions, subjects tested the expressiveness of *KineCAM* by performing actions ranging from subtle hand gestures to large full body movements (Fig. 4).

We also found that *KineCAM*'s short turnaround times and easy-to-obtain materials made it suitable for fast and carefree iteration. Historically, instant cameras provided the immediate gratification that film cameras could not, and artists have used this to their advantage to create more experimental artistic photography [2, 5]. Andy Warhol notably used Polaroids as preliminary "sketches" for portrait paintings, largely to experiment with different poses and expressions [11]. At the same time, the high cost of instant film often required photographers to think before snapping [2]. Like the instant cameras that inspired it, *KineCAM* has a short (roughly 16 second) turnaround time between capture and printing, but uses cheap and readily available materials. This lets *KineCAM* facilitate experimentation while increasing access. These characteristics are important since both photographers and their subjects rely on iteration to acquaint themselves with *KineCAM*'s unconventional photographic process: when prints did not turn out the way users expected, subjects could iterate and refine their poses until they achieved desirable outcomes.

3.2 Functioning as a social tool

Polaroids have been considered to be fun and playful tools, heavily marketed as devices to be passed around at parties and social gatherings [4, 28]. Peggy Sealfon notes in *The Magic of Instant Photography* that the presence of the camera encourages people to behave differently. She states that the camera can be a "helpful ice-breaker" and "will motivate people to do unexpected things, just to see the immediate record of their behavior" [22]. In *KineCAM* we notice similar behavior: subjects spontaneously gesture or move with the intention of seeing how their motions will be captured. In our photo shoots, people would call their friends over to do motions together or assist them with more ambitious poses, such as leaping into each other's arms or slapping each other's faces (Fig. 5). As none of the subjects knew what to expect from *KineCAM*, it offered an experience wherein subjects could discover and learn the camera's behaviors and affordances together. Even the act of waiting for the image to process and print had a social component to it: people huddled around *KineCAM* in anticipation as the printer created the kinegram and excitedly exchanged remarks when they saw desirable or surprising outputs.

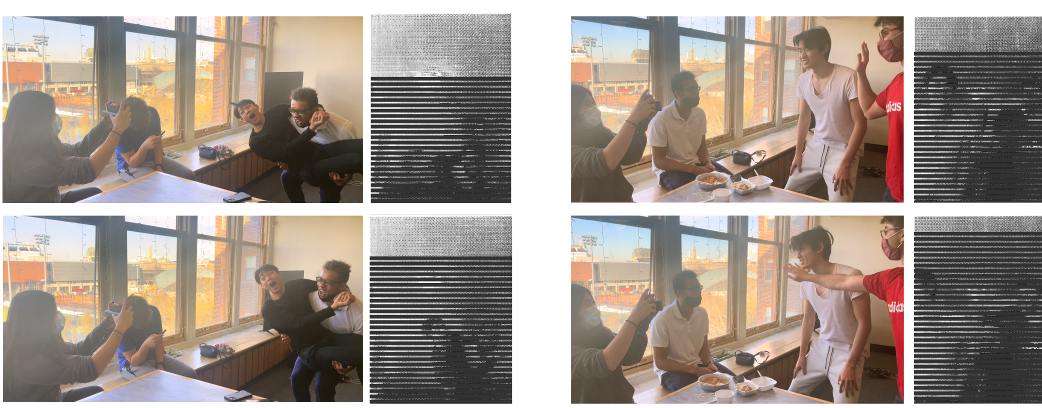

Fig. 5. *KineCAM* spurred playful interactions between participants. (© Ticha Sethapakdi)

3.3 Creating unique physical artifacts and surprises

Polaroid historian Peter Buse noted that the output image itself becomes a wonderful gift or even incentive for a person to appear in the photograph [4]. This is also true for the images produced by *KineCAM*, which were often described as "cool" by subjects and motivated them to have their picture taken just to see the results. Buse has also argued that one of the most relevant features of Polaroid photography to consider in today's digital world is the uniqueness of the output [5], as the lack of a digital negative makes it harder to reproduce these images mechanically. *KineCAM* preserves and extends this quality: the image is not stored in memory so it is not easily reproduced. The viewing of the image is also an experience that varies each time as the viewer moves the filter across the image. And while users may scan and reprint the kinegram later on, there can only be one true "receipt" of their experience. Although these outputs could be videotaped and uploaded to social media sharing sites, the full experience of moving the filter across the image is lost.

Researchers have shown that creative tools that incorporate some degree of unexpectedness can be beneficial to the creative process [15, 18, 25]. Since *KineCAM* does not allow users to preview or edit their kinegram before printing, users do not know what to expect until the photos are printed. While this takes control away from the user, it also increases the likelihood of producing serendipitous results. For example, one subject in our photo shoot wanted to record a gesture in which he forms a heart with his arms, but because he did not time the gesture to fit within the 1 second capture window, the resulting kinegram looked like he was flapping his arms. Instead of redoing the pose, the subject was amused by the outcome and appreciated the unexpected results. In another session one subject was trying to lift a friend off of the ground, but, to their amusement, the resulting kinegram made it look like he was falling or "glitching" in midair. These examples show that even "failure" cases can have charm.

3.4 DIY culture

KineCAM has been influenced by maker culture and the DIY movement by taking inspiration from a highly commercial product and making tools for creating this device from scratch with highly customizable features. This allows users to tailor the camera's specifications to the way that they operate it. Some attributes, such as video capture length and number of frames, are easy to adjust through setting parameters in the *KineCAM* source code. Changing parameters affects how the kinegram is processed, yet there sometimes remains an element of surprise in how a particular gesture is recorded. Making the captured frames closer together, for instance, would intuitively work well for recording fast gestures—however, how well this gesture is represented depends on the combination of the selected representative keyframes and the subject's motion. To capture gestures in a more controlled way, users would have to experiment with adjusting the subject's motion to fit the code or adjusting the code to fit the motion.

Adjusting certain parameters may create some interesting visual trade-offs. For example, shortening the strip width (while keeping the frame count equal) increases the image resolution because its overlay would have more transparent strips that reveal more parts of the image. However, it would also cause the resulting kinegram to appear darker because its overlay would distribute more opaque stripes across the entire image (Fig. 3b).

The hackability of *KineCAM* also allows users to repurpose the device with custom hardware. In our examples, image quality was constrained by the thermal printer, which is only capable of printing halftone images. While we used a thermal printer because it was the most portable printing option that was compatible with the Raspberry Pi, future makers could experiment with using a color printer. This would allow *KineCAM* to express not only motion but also color change.

3.5 Future work

In our photo sessions, we primarily focused on the experience of using and interacting with *KineCAM* in a social context. However, we believe that *KineCAM* has the potential to be more broadly applied to other situations that can benefit from on-the-go fabrication of kinegrams. One practical application for *KineCAM* could be to use it as a tool for rotoscoping in traditional animation. Although the image-manipulation techniques that *KineCAM* utilizes are relatively simple, such methods are highly relevant to a wide range of applications in computer graphics, such as video compression. As with many new artistic tools, we envision that *KineCAM* will be used in clever and creative ways that we cannot currently imagine. We believe that the hackability of *KineCAM* will not only offer new artistic opportunities for experimental photography, but also give makers the chance to more freely explore the use cases and limitations of the kinegram medium.

4 CONCLUSION

While there is tremendous value in approaching technology with a forward-looking perspective, it can also be inspirational to look back and revisit technologies with a sense of nostalgia. By drawing inspiration from the instant cameras of decades past and the longstanding fascination with adding motion to photos, *KineCAM* creates new photography experiences that encourage play and experimentation. We hope that open-sourcing *KineCAM* can enable future artists, makers, and engineers to reappropriate *KineCAM* for other use cases and contexts that make it greater than the sum of its parts.

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