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UNSEEN IMAGES

Gigapixel photography and its viewers

Photographs have long been recognized as providing a surfeit of information. This article takes up the recent emergence of gigapixel photography in its various forms as a technology in which the appeal of maximum image density is taken for granted. The article considers the "snapshot" mode of gigapixel photography as it reconfigures the conventional relationship of the viewer of a photograph to the place depicted. By providing an extraordinary quantity of photographic information for a viewer within every single frame, gigapixel "snapshots" produce images that anticipate the active participation of a future viewer, expect multiple reconfigurations of framing edges, and rely on unanticipated content for value and meaning.

Photographs have long been recognized as providing a surfeit of information. Cameras and printing processes capable of producing ever-higher resolution images have been desirable for a seemingly simple and straightforward reason: the more finely resolved a photograph, the more information is captured. Indeed, the routine excess of photographic information, even within what one may think of as a "typical" photograph in size and recording capability, has from the start caused not only a perceptual overload but, at times, a crisis of plenitude. Echoing a sentiment that has been expressed frequently since photography's invention, we are living in a time of an extraordinary abundance of photographic imagery.[1] Like generations before grappling with the emergence of amateur snapshot photography or the rise of the picture press, it is again commonly heard today that one can be swept away by the ever-rising tide of circulating photographs (Albers, Campbell, Heiferman). And, indeed, digital technology and, in particular, the rise of social media, has enabled and fostered both a love of and an obligation among many to not only make tremendous quantities of images but also to share and distribute them widely.

But aside and apart from copious quantities of discrete images — or even discrete images multiplied across digital platforms — there is also, in photography, the question of an abundance *within* any particular photographic frame, a kind of internal abundance. Photography is thus plentiful in multiple ways: in the number of discrete images made, again in the reproduction and distribution of those images, and also — perhaps most fundamentally — within the discrete image itself. This essay will take up the recent emergence of gigapixel photography in its various forms as a technology that takes the appeal of maximum image density for granted. In particular, I will consider the "snapshot" mode of gigapixel photography as it reconfigures the conventional relationship of the viewer of a photograph to the place depicted. By providing an extraordinary quantity of photographic information for a viewer within every single frame, gigapixel "snapshots" produce images that anticipate the active participation of a

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future viewer, expect multiple reconfigurations of framing edges, and rely on unanticipated content for value and meaning.

While it may be true that all photographs rely on future viewers, are subject to cropping or editing, and produce unintended meaning as a matter of course, the volume of data contained within the frame of each Gigapixel snapshot sets these conditions up as a requirement for viewing: in order to literally see the entirety of the captured image, viewers must produce their own subjective — if not arbitrary — compositional frames of previously unseen information. This engagement makes evident and unavoidable the photographic medium's historically ambivalent relationship to chance recordings and reconfigures them into the status quo of gigapixel snapshot viewing. And, though the camera has numerous potential commercial applications, these features make it particularly apt for surveillance and, indeed, its configuration of features produce an impulse to surveil, whatever the subject matter.

In his recent book, *What Photography Is*, James Elkins dwelled on the ubiquitous internal abundance of information in photographs: what he calls the "surround." Removing the ostensible subject of a photograph — usually a person or a distinct place or thing — as well as the aesthetic formulations of "foreground" and "background," Elkins seeks a word to describe the unintended aspect of photography. Elkins asks what photography would be, what it would record, if it did not record ourselves, our memories, subjects we can name, date, identify and classify. He writes, "If the figures and intended subjects of photographs were cut away, the mass of photography — the acreage of prints and slides and screens and posters and digital frames — would be comprised of overlooked, un-needed, and unwanted details" (116). But what if, as is the case in surveillance, capturing the "surround" is indeed the central point? I will return to Elkins's consideration of the surround below as it plays out in the realm of gigapixel imaging, an arena in which the presence of the surround is magnified exponentially.

The snapshot within the gigapixel field

> Ubiquitous gigapixel cameras may transform the central challenge of photography from the question of where to point the camera to that of how to mine the data. (Brady et al. 386)

In June, 2012, a team of researchers from Duke University, the University of Arizona, and the Distant Focus Corporation made this claim on the public introduction of their work developing the AWARE-2 camera.[2] Funded in part by the United States government's Defense Advance Research Project Agency (DARPA), the AWARE-2 camera has the potential to create a 50-gigapixel image. The unprecedented resolution of the image and the detail in a distant subject presents an abundance of information that is in keeping with the medium's historical technological trajectory of valuing image density.

In its current stage of development, the AWARE camera records up to 2 gigapixels, though the team has published designs for digital capture up to 50 gigapixels. As a point of reference, 8–12 megapixel cameras are standard for consumers to purchase today: the recently released iPhone5 captures 8 megapixels, and many high-end professional digital cameras record about 12 megapixels.[3] The megapixel measurement simply tells how many pixels are recorded in an individual photograph. A photograph that measures 4000 × 3000 pixels contains 12,000,000 pixels, or 12 megapixels. 1 million pixels equal a megapixel while 1 billion pixels equal a gigapixel (1,000,000 × 1,000). A 50-gigapixel image would record 50 billion pixels, and include about 4,000 times the amount of information per image than current high-end 12-megapixel cameras. To create the AWARE camera images, a single shared lens gathers light and distributes it to a surrounding array of 98–226 (or more) micro-cameras. The design makes the overall camera scalable to greater numbers of micro-cameras that, in turn, each have individual focus and exposure and send their data to be compiled in a processor to be stitched together into one complete image.[4]

The camera is also designed ultimately to take still images at a near video rate. As one of the researchers commented, taken at that rate "The 50-gigapixel camera would generate a half a terabyte of data every second. You'd fill a terabyte hard drive in two seconds, you'd fill a data center in about a day, and you'd fill all of the data centers on the planet in about a year to a year and a half" (qtd. in Merrit and Stolte). Furthermore, to complement the challenges in storage, there are similar challenges in viewing the full image: the camera promises a resolution so high that no technology yet exists to display its images.

Unlike other modes of gigapixel photography, to be discussed below, the AWARE camera is specifically designed to create a multi-gigapixel photograph of a specific moment: a "snapshot" in the developers' parlance. The terminology is notable: one may think of a "snapshot" as a quick and casual photograph taken by an amateur or hobbyist photographer without a great deal of aesthetic intent.[5] Snapshots are the province of vacation pictures, birthday parties, and, in today's online and social media world, selfies and Instagram feeds. The images produced by the AWARE camera occupy a different photographic universe, yet the "snapshot" designation is a critical one, and distinguishes the AWARE camera from other methods of gigapixel imaging such as the GigaPan or Photosynth models, currently the two most prevalent and commercially available forms of gigapixel photography.[6]

GigaPan technology creates high-resolution panoramas that are not dependent on any particular camera, but employ robotic mounts that a user sets to automatically capture a panoramic scene. After the user specifies the locations of the upper left and lower right corners, the device creates a series of up to thousands of individual photographs taken sequentially covering the desired frame. The individual photographs are subsequently run through image stitching technology to create a single unified image (GigaPan). Originally developed by scientists at Carnegie Mellon University and NASA Ames Research Center to create panoramas by the Mars rovers Spirit and Opportunity (both launched in 2003 and landed in 2004), the technology is now widely available commercially and the focus of numerous community enthusiast groups.[7]

Photosynth can also create panoramas, but more uniquely creates "synths" which can run up to several hundred images taken by different cameras and from different points of view of the same general subject through a pattern recognition application to automatically match adjoining images and create an interactive model of a particular scene in an illusion of three dimensions. The most well-known synth, which also served to introduce the technology to a very wide audience, is CNN's orchestration of "The Moment", for which the broadcast network solicited participation from viewers attending Barack Obama's 20 January 2009 inauguration to share a photograph from "the moment" of his oath. CNN compiled 600 photographs to create a synth that, as the network put it, "truly captures the moment" of his inaugural oath.[8] Photosynth technology emerged from a research project at the University of Washington that was focused on compiling three-dimensional views of popular tourist locations with photographs from the online photo sharing site, Flickr.[9]

Both systems create high-resolution images stitched together from multiple sources to form time-lapse composite images. Though they do not create "snapshots" of particular moments, they are redefining the subject–object relationship in photography. The scholar William Uricchio has focused on Photosynths in particular as a technology that, because it produces images that are joined together from multiple vantage points over time to create the illusion of entering three-dimensional space virtually, indicates "cracks in the façade of the subject–object relationship characteristic of the modern era" (25). Uricchio attributes these "cracks" (and he is rightly careful not to hail this technology as transformational in and of itself) to a new state of "algorithmically defined relations between the viewing subject and the world viewed" that is produced by computational imaging such as Photosynth.[10]

By design, Photosynths enable viewers to "wander" through photographic images and their typically collaborative authorship undermines any one point of view and thus a conventional photographic relationship predicated on a single authorizing view of any particular subject. Rather than a viewer simply *looking at* a still photograph, Photosynths encourage viewer participation. In "wandering" through an image, each viewer may create a unique individual experience from the data offered. Similarly, GigaPan technology has appealed to artists precisely for its possibilities as a photographic medium that takes place distinctly over time and thus resists the substantial history associating photographic images to the capture of a discrete moment.[11]

What Uricchio recognizes as a novel viewing experience, however, also limits, from another perspective, the recording capacity of Photosynth — or, indeed, of GigaPan. Volumes of visual data that are stitched together over time may contain a great deal of data, but that data is of limited value in tracking either specific places in time or specific places over time. Like the snapshot, the time-lapse composites capture more visual data than the human eye can discern via conventional display. Because they are created over time, however, they are better suited for stationary subjects. In the realm of surveillance, this limitation is a substantial one: an operator of a time-lapse gigapixel composite camera would necessarily forgo the ability to compare the same subject at different points in time. For any subject in which tracking motion or movement is important, the time-lapse composite (created by GigaPan or Photosynth) would be less desirable than the snapshot (created by AWARE).

Secondary viewing: from place to surveillance

The AWARE research team's 2012 publication of the current state of their camera in the journal *Nature* made evident the potential for "wandering" that Uricchio refers to. Each illustration, notably, provides two sets of views, which I will refer to as full and partial, or primary and secondary. To be clear, primary and secondary are temporal designations rather than value designations. The full or primary view is the full frame recorded by the camera, and provides the starting point for an initial viewer. The secondary view is selected as a portion of the primary view to demonstrate the density of visual information available beyond what is visible in the full frame, by zooming in. Journal readers are put in the position of tertiary viewers re-assessing the initial view through the eyes and the selections of the secondary views.

The first illustration of the AWARE camera's capabilities is a black and white gigapixel "snapshot" of swans in the tundra on Pungo Lake in the Pocosin Lakes National Wildlife Refuge (Figure 1). Located relatively near the AWARE team's home base at Duke University in North Carolina, Pungo Lake offers expansive vistas populated by distant swans: a nearly ideal subject for demonstrating the extraordinary informational capacity of the camera and the remarkable clarity of distant swans that, without magnification, are barely visible. The primary image displays a scenic panoramic expanse of marshy foreground giving way to the lake and horizon under a cloudy sky. A distant bit of land emerging at the left side of the composition is balanced by a few prominent trees on the right, and viewers are even provided a small inlet of water that leads the eye through the marsh and into the middle ground of the lake. In many ways, then, this sample image conforms to the conventions of traditional landscape imaging. It has clearly been made with an unusual camera, however: the array of cameras produces, at the edges, a scalloped effect that, visually, serves to soften the image and make it feel even somewhat handmade.

Since the full resolution of the image can only be seen with magnification, the researchers highlighted four small areas of the full image capture on which to zoom in, marked *a*–*e* in rectangular boxes (Figure 2). Below the primary image, these secondary

Fig. 1 Duke University/University of Arizona, Pungo Lake as captured using AWARE-2, 2011/2012. Copyright Nature Publishing Group.

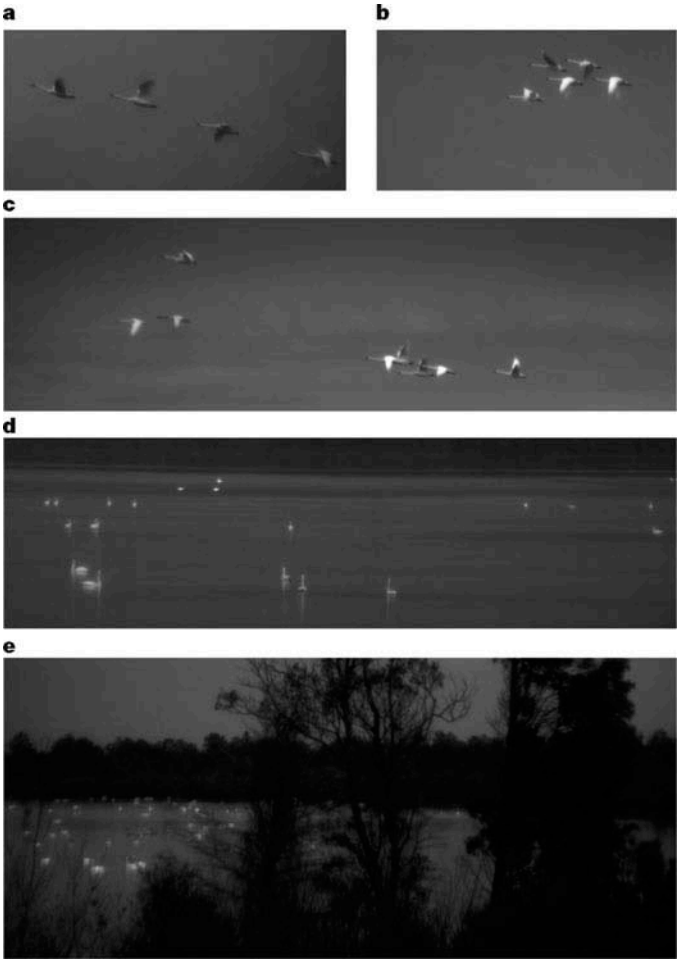

Fig. 2 Details of Figure 1. Copyright Nature Publishing Group.

images in the enlarged boxes feature swans in flight (demonstrating the snapshot capabilities of the camera) and at rest on the water. As the swans emerge for inspection from visual obscurity, the viewer's attention is redirected from the whole to the part, from the general aesthetic appreciation of a lake view to the analysis of individual swans in specific locations around and above the lake. In this case, readers of the journal are relying on the choices of the research team to direct our attention, but with access to the original file any area of the full-frame panorama could be enlarged by a viewer, thereby shifting the role of the viewer from passive observer of a place to active participant in locating and defining points of interest. Indeed, the only way to actually see the breadth of photographic information captured is to engage with the image in this active way.

The second illustration captures a relatively more urban scene: a quiet traffic circle at Duke University populated with pedestrians, a car, and trees, against a backdrop of mid-rise university buildings (Figure 3). Again, to show the camera's capabilities, a

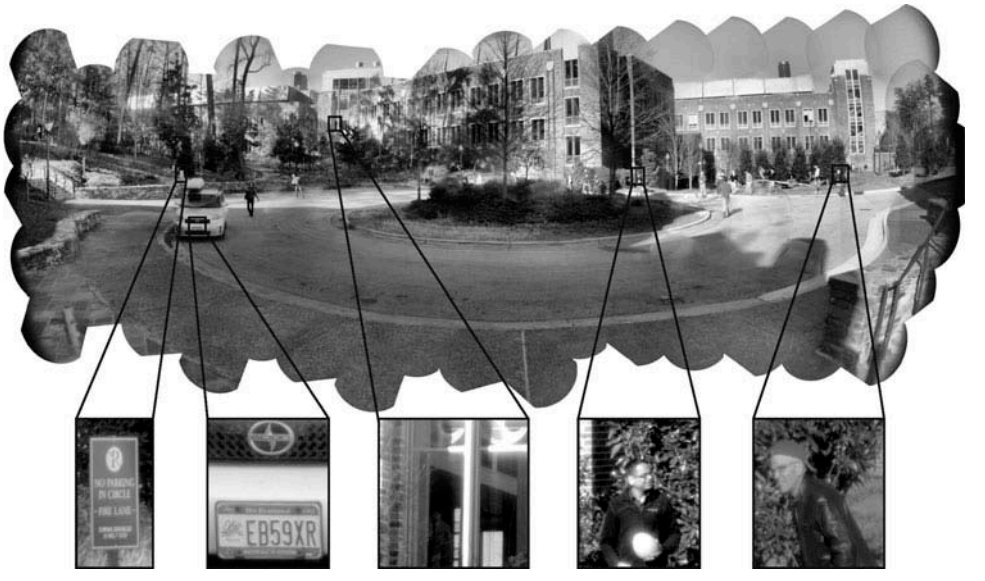

Fig. 3 Duke University/University of Arizona, Traffic circle captured using AWARE-2, 2012. Copyright Nature Publishing Group.

primary viewer has provided for journal readers five segments of the larger image at magnification. The excerpted images for a viewer's closer analysis include close-ups of a distant sign, the car's license plate, what appears to be either a reflection or a male figure just barely visible through a distant second story window, and two young men on the far side of the traffic circle, one of whom appears to be holding a large egg-shaped object and the other wearing a backwards baseball cap, glasses, and leather jacket, walking in a hunched posture. Compared to the photographs of the swans on Pungo Lake, the stakes of this level of image capture are immediately shifted to the human realm. Through the selection of the initial viewer, journal readers are set up not as biologists assessing migratory birds, but as investigators of human activity. The shift in expectation is striking: a previously quiet traffic circle now teems with potential clues and gestures. Will I need that license plate number? What is that distant, barely visible figure in the second story window doing? Why is the man in the leather coat walking in that odd posture? In the human realm, the camera's capabilities in the realm of surveillance come to the fore, as the possibility of zooming in to find a previously unseen figure situates viewers as potentially discovering unknown information.

A frightful amount of detail

Photographic surveillance, when intentional, is designed precisely to record activity and events that would otherwise have gone either without witness or the possibility of verification. Gigapixel photography, particularly in snapshot form, presents an expanded field of potential discovery within not only the visible frame but in the thousands of other potential "secondary" frames waiting to be mined. Though it is a

technology that will only be efficiently mined by non-human data recognition software, the basic perceptual challenge photographic imagery offers in terms of adequately understanding the breadth of information offered within a frame is not new.

Different photographic surfaces are designed to absorb more or less information within a particular period of time, but whether digital or analog, once the exposure begins the space of the photograph is populated, with more or less intensity, to the extent of the sensitized surface. This aspect of photography, which comes to the fore in current technology, also occupied inventors of the medium. The necessary abundance of visual information *within* any particular photographic frame struck one of the inventors of photography, William Henry Fox Talbot, as both a conundrum and charm of plenitude. His 1844 publication, *The Pencil of Nature*, in which Talbot alternately shares practical and philosophic musings about the possibilities of this new medium prompted by the photographs he includes, considers the fact that the camera may record details unintended by the operator. This is a predecessor to Elkins's "surround," which, for Elkins as for Talbot, is one of the defining hallmarks of the medium, distinguishing photographs from paintings or other methods of representation.

It is a partially obscured clock dial on a tower at Queen's College in London that launches Talbot's observation in line with his evident wonder, seen elsewhere in *The Pencil of Nature*, that the medium records its subject (and surround) apart from the consciousness of the operator (n.p.). As the photo historian Robin Kelsey put it, "the chance effects of the world fill the gap between the incomplete attention of the photographer and the uniform attention of his or her apparatus" (23). Depending on the camera's operator, this may or may not be a positive result: for an artist seeking to control every aspect of the frame, the "chance effects of the world" might be an unwelcome interruption, while for a surveillance operator it is the very point of a camera's existence.

Notably, Talbot headed that way himself, concluding his brief discussion around magnification, a point that bears direct relation to the magnifying zoom used as a matter of course in gigapixel photography. Talbot wrote: "In examining photographic pictures of a certain degree of perfection, the use of a large lens is recommended, such as elderly persons frequently employ in reading. This magnifies the objects two or three times, and often discloses a multitude of minute details, which were previously unobserved and unsuspected" (n.p.). In Talbot's photograph of the clock tower, the clock dial is perfectly visible to the unaided eye, but the concept of magnification is taken up fifteen years later by Oliver Wendell Holmes, in his celebration of the stereoscopic viewer.

Holmes, too, speaks rapturously of the notion of the "perfect" photograph, but in the context of the three-dimensional illusion created by the stereoscope:

> Theoretically, a perfect photograph is absolutely inexhaustible. In a [painting] you can find nothing which the artist has not seen before you; but in a perfect photograph there will be as many beauties lurking, unobserved, as there are flowers that blush unseen in forests and meadows. (n.p.)

In both cases, "perfection" is taken for granted to mean containing a high quantity of legible visual information. Whether or not Talbot or Holmes would have found

gigapixel photography to be an obvious expression of perfection in photography today, Holmes is clearly captivated by the possibilities of discovery, particularly of unexpected beauty "lurking" in a natural landscape. Immediately, though, the enticement of the renewed possibility to experience something initially unseen is tempered by human presence and a degree of suspicion. Writing of two tiny figures captured in a larger landscape, Holmes casts this directive: "Look at the two faces with a strong magnifier, and you could identify their owners, if you met them in a court of law" (n.p.).

Linking quickly to the evidentiary expectation of the photograph (about which Talbot had, for his part, also speculated), where the unseen blushing flower suggests luscious possibility, the magnified revelation of a barely-seen human presence connotes caution and restriction. Holmes's choice of language is distinct. Consider if he had written, instead, "you could recognize them if you met them at a dinner party," replacing the impulse to "identify" in the charged location of a court of law with a softer hypothetical scenario. As such Holmes articulates the experience of finding or discovering human presence where it was not otherwise expected or known as one of fundamental mistrust. As with the gigapixel snapshot of the traffic circle, unease — of various stripes — is the flipside to the wonder at the "chance effects of the world" both Talbot and Holmes articulate.

Activating the surround

There is a romance to the notion, expressed by Talbot and Holmes, that these overlooked details may yield a point of interest in some future observer.[12] But Elkins is interested in "the surround" for the opposite reason; his goals in understanding photography, and the photographic surround, are specifically un-romantic. In considering what the medium records without anyone consciously asking it to, Elkins rejects any optimism for future interest and matter-of-factly quantifies the simple majority of visual information recorded photographically as uninteresting and, frankly, boring. Because the information is boring, it resists interpretation.

Yet the gigapixel snapshot also upends a conventional understanding of the role of the viewer vis-à-vis the role of the creator. Any "subject" is presented as only one option amidst an abundance of potential other subjects. The volume of information in an AWARE camera image exponentially increases the prevalence of the "surround." This does not discount the possibility that an AWARE photograph could direct a viewer's attention and revolve around a subject of interest. But if we take Elkins's dismal assessment of the majority of photographic content seriously, the sea of data that will be produced by a single frame, equivalent to 50,000 standard high-resolution frames, will be primarily significant as an accumulation of "surround." In effect, the captured image positions the viewer in the space normally occupied by the photographer, and the photograph offers the viewer a chance to start over, albeit within the framework of the primary view.

The examples above underscore a reliance, in the AWARE camera images, on the chance indexicality of the photographic moment while also advancing or underscoring the inevitable role of the future, unknown observer who may, for a multitude of reasons, have opportunity to ascribe "unintended" meanings to the photograph in

question. The AWARE cameras operate as an exaggeration of this effect, present throughout the medium. Yet its exaggeration is significant: instead of simply the same effect writ large, the camera serves as an indicator of a tipping point past which the phenomenological experience of the viewer is necessarily transposed from one of relative stability to one of endless choice. Though theoretically a viewer may subdivide any photograph into smaller and more limited areas of difference, this camera sets that secondary act up as an organizing principle. Where this used to be the "chance" of photography, it is now the central purpose. The camera *expects* its viewers to have "missed" the content of any given moment and offers a later inspection of that moment as a matter of course, giving them the future to mine the past. The edges of the frame are the boundaries, but from any frame another 50,000 frames are not only possible, but expected.

In effect, though its chief technological hallmark in what is sure to be an increasingly crowded field of gigapixel photography is its ability to take a "snapshot," the multi-gigapixel snapshot image suspends and defers the conventional photographic moment, offering its creation to any viewer at any point in the future. Thus we return to the initial claim made by the camera's creator that: "ubiquitous gigapixel cameras may transform the central challenge of photography from the question of where to point the camera to that of how to mine the data." With the role of the viewer reconfigured with regard to the image, it also reconfigures the viewer's relationship to place in a manner not unlike other data-driven realms in which the process of finding, navigating, and choosing digital content is the central artistic act.[13]

Where Uricchio's dissolution of subject–object relation (or, for the purposes of this essay, subject–place relation) seemed initially contingent on a technology such as Photosynth that, by design, allows for collaborative image construction and a mobile point of view, similarly with the AWARE images, viewers come to occupy an interstitial space between viewer and image creator, newly responsible for finding and navigating content in a field of "surround." Though information about a place typically grounds viewers, through its plenitude of information the AWARE camera's advancements reconfigure the viewer again into an active selector deeming information in the visual field as important or irrelevant. Gigapixel snapshots magnify the effects of surveillance: despite the extraordinary density of recorded information, when the entire image is meant to be mined for unintended subjects or potential points of interest there can be no surround. Every viewer offers the possibility of uncovering meaning and every yet-unseen piece of the captured image represents potential.

Notes

1 Tracing back to the introduction of the hand camera by Kodak, I am thinking of Alfred Stieglitz, "The Hand Camera — Its Present Importance" (1897) and Sigfried Kracauer, "Photography" (1927) as precursors to the present concern with photographic abundance.

2 I am grateful to Michael Gehm for several conversations about the AWARE camera.

3 Pixel ratings do not take into account quality of lens, the size of digital sensors in the camera, and a host of other factors that ultimately affect overall quality of the final image.

4 This is a radically simplified distillation of the camera's technology. See the AWARE team's research page. The technology also has a "Live-View" mode that generates an image stream, allowing a real-time engagement with the scene. This article only deals with the still images created.

5 There is a rich literature on snapshot photography that more fully treats the complexity of the genre. Notably, snapshots have a history of association with a more "authentic" record due to their apparently less consciously mediated status. See, for example, Douglas Nickel, *Snapshots* and Catherine Zuromskis, "Ordinary Pictures and Accidental Masterpieces." This is to say nothing of the "snapshot aesthetic."

6 There are other methods of gigapixel imaging as well, notably telescopic solutions such as the Dark Energy Camera, located in Chile, which is currently surveying a large portion of the southern sky to learn more about dark matter and cosmic expansion. This camera records a much greater volume of visual information through a more conventional optic design; the camera is notably larger and not designed to adapt to other uses.

7 In 2008, GigaPan Systems became a commercial spinoff from the original technology development with the intent of bringing the high-resolution imaging to a broader audience. Currently, entry-level GigaPan robotic mounts cost about $300.

8 CNN combined 400 user-submitted photographs with 200 of their own to create this Photosynth. The language aligns the multiple points of view and increased quantity of information with a generalized sense of truthfulness.

9 PhotoTourism was developed by a team in the CSE Graphics and Imaging Lab at the University of Washington and debuted in 2006.

10 Uricchio's other example is location-based augmented reality applications.

11 The artists John Divola and Amir Zaki both use GigaPan technology precisely for its relationship to time and the altered relationship between subject and viewer that becomes possible.

12 This romance is principally taken up in a theoretical way by Roland Barthes with his theory of the punctum. While it does not align directly with the notion of an excess of information unintentionally recorded by a photographer, the punctum does rely on a future viewer seizing meaning from a detail of a photograph not necessarily initially intended to communicate a particular meaning.

13 I am thinking of contemporary projects that mine imagery from surveillance footage or that use imagery from Google Street View or Flickr, including work by Penelope Umbrico, Doug Rickard, Mishka Henner, Jon Rafman, and Michael Wolfe.

Works cited

Albers, Kate Palmer. "Abundant Images and the Collective Sublime." *Exposure* 46.2 (Fall 2013): 4–14. Print. Adapted from a talk at the Society for Education conference held in Chicago in March 2013.

"AWARE 2 Multiscale Gigapixel Camera." Duke Imaging and Spectroscopy Program. Duke University. 17 Dec. 2013. Web. 7 Jan. 2014.

Barthes, Roland. *Camera Lucida: Reflections of Photography*. Trans. Richard Howard. New York: Hill & Wang, 1981. Print.

Brady, D.J., et al. "Multiscale Gigapixel Photography." *Nature* 486 (June 2012): 386–89. Print.

Campbell, David. "Abundant Photography: The Misleading Metaphor of the Image Flood." *David Campbell*. 5 Sept. 2013. Web. 5 Nov. 2013.

Elkins, James. *What Photography Is*. New York: Routledge, 2011. Print.

GigaPan Systems. Home page. N.d. Web. 15 Sept. 2013.

Graphics and Imaging Laboratory, Department of Computer Science and Engineering. "Photo Tourism: Exploring photo collections in 3D." University of Washington. N. d. Web. 15 Sept. 2013.

Heiferman, Marvin. "The River." *Still Searching*. Fotomuseum Winterthur. 5 Nov. 2013. Web. 5 Nov. 2013.

Holmes, Oliver Wendell. "The Stereoscope and the Stereograph." *The Atlantic Monthly*. 1 June 1859. Web. 1 Nov. 2013

Kelsey, Robin. "Photography, Chance, and *The Pencil of Nature*. " *The Meaning of Photography*. Ed. Robin Kelsey and Blake Stimson. Williamstown, MA: Sterling and Francine Clark Art Institute, 2008. 15–33. Print.

Kracauer, Siegfried. "Photography." 1927. *The Mass Ornament: Weimar Essays*. Ed. and trans. Thomas Y. Levin. Cambridge, MA: Harvard University Press, 1995. Print.

Merrit, Richard, and Daniel Stolte, "Gigapixel Camera Captures Unprecedented Image Detail." *UANews*. University of Arizona. 20 June 2012. Web. 20 June 2012.

Nickel, Douglas. *Snapshots: The Photography of Everyday Life*. San Francisco: San Francisco Museum of Modern Art, 1998. Print.

Stieglitz, Alfred. "The Hand Camera — Its Present Importance." *American Annual of Photography* (1897):18–27. Print.

Talbot, William Henry Fox. *The Pencil of Nature*. London: Longman, Brown, Green, & Longmans, 1944. Print.

Uricchio, William. "The Algorithmic Turn: Photosynth, Augmented Reality and the Changing Implications of the Image." *Visual Studies* 26.1 (March 2011): 25–35. Print.

Zuromskis, Catherine. "Ordinary Pictures and Accidental Masterpieces: Snapshot Photography in the Modern Art Museum." *Art Journal* 67.2 (Summer 2008): 104–25. Print.

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