# Chapter 6: Computing Photographs and Maps

## Datascapes

Qualities of maps and landscapes have somewhat interchanged. Previously uncoded, landscapes have also become coded, carrying various types of information, not belonging to the realistic view, as landmarks, name-tags and various measures. Both landscapes and maps are today carrying a growing amount of data, in different layers. One could say that the landscape and map when placed together has become a datascape, in terms both of machine vision and data visualization. None of them are concrete but can also be just a set of data. Some of these Arjun Appadurai defined as ‘five dimensions of global cultural flows that can be termed (a) ethnoscapes, (b) mediascapes, (c) technoscapes, (d) financescapes, and (e) ideoscapes’.[[1]](#footnote-1) Each of them refers to a different type of the abstract landscape forming a context of life; habits, media, finances and ideology. Contemporary studies of such datascapes underline that data is not that distinct from the vision, although there is a substantial difference between processes of visualization and vision. As Steve F. Anderson notes, there is no longer a great difference between data and vision, capturing and looking.[[2]](#footnote-2)

Like with the mappae mundi of medieval Europe described before, today’s imaging technologies are used to compute, assemble, and overlap a variety of information into a single image. Consisting of many layers, they do not have any fixed visual layout, but are an abstract dataset, adapting to the user. Some of these layers, indeed, may be visually descriptive, as landscapes once were, especially when photography is being applied onto maps. Yet, new spatial data is not fully, but only partially visible. While being complex and inclusive, new total images of maps are merely possibly visible by the act of using of the map, or the act by which the map automatically maps the user, even without their knowledge. And moreover, the part of the set appears as invisible, thus counting more precise placement of the person in terms of relative distance to satellites, or by using GPS technologies, there is no need for visualization of the abstract space of the map. Thus, contrary to previous conceptions, today it is the general sense of the space that is lost, as the space becomes an aggregation of geographical or conceptual data.

## Montaging Techniques

The combining of various materials in order to make a photo-like image is not a post-digital invention. Indeed, photomontage techniques, where the photographer combined several photographs into one, are as old as photographic technology itself. At first, the reason to produce such montages lay in the limitations of the photographic medium. The problem of slow exposure time, for example, made it impossible to simultaneously produce images of the land and accompanying sky. In the late 19th century, photographers such as Oscar Rejlander and Henry Peach Robinson would combine several photographic negatives in order to produce one compact visual artefact in positive.[[3]](#footnote-3) Results, overall, were consistent. Aside from combining negatives, photographers also used a number of post-production methods, such as retouch, shading, and tinting. Nevertheless, the merits of photomontage were often debated and criticized for distorting the truth claim of the photographic medium. And an idealistic duel between Realists and Pictorialists, who denied the obligatory realism of photography, marked the 19th century discussion about photography.[[4]](#footnote-4) Photomontage was thus seen by many historians as a pictorial tool which destroyed the epistemic nature of photography, and made out of it yet another device for rhetoric and other literary figurations.

Geographic photomontage was used for the epistemic purpose of describing space. This contrasted with the deliberate use of photomontage for either rhetoric argument or poetical parable, as with the Pictorialists, or the use of this technique for political activism, as with Modernists such as John Hartfield, Hannah Höch, and others.[[5]](#footnote-5) Such spatial descriptions were also amplified, as Rudolf Arnheim writes: ‘The simple example of this innovation is the photomontage, which juxtaposes fragments of totally different spatial systems. The sizes of various pictorial objects can no longer be compared within the represented space’.[[6]](#footnote-6) Yet not all photomontages led to impossible or unnatural descriptions of space. Some afforded great accuracy. And in the geographic information science of today, photomontage served the purpose of acquiring knowledge, not necessarily about reality itself, but rather about data and its many potential re-interpretations.

## Proto-computational Methods

The oldest compositional method used to merge or, in a sense, compute photographs, is the panorama. Underlying the process of production of the panoramic image was the idea of seeing without being seen. In general, the object of ordinary panorama showed landscape and some portion of the sky. In the 19th century, the photographic imagination culminated with the innovation of the extended horizontal image of the panorama, which in the beginning were produced by painting and later photographically. The panorama evolved at the very moment that interest in landscape painting was slowly starting to fade away until finally, with the invention of the reproductive medium of photography, the landscape as an artistic and image genre was relegated to the amusements and crazes of the wealthy and elite.[[7]](#footnote-7) Across the 19th century, panoramas became extremely popular, and many different panoramic forms were invented.[[8]](#footnote-8) By 1870, the panorama and its variants were being mass produced and toured all over Europe. Audiences for the panorama, which at the time either remained largely in one place or had little experience travelling, even to nearby cities or to other places within their own home city, were fascinated by the way other places looked.[[9]](#footnote-9) Indeed, as Walter Benjamin wrote, ‘The interest of the panorama is in seeing the true city-the city indoors.’[[10]](#footnote-10) He also noted:

Just as architecture, with the first appearance of iron construction, begins to outgrow art, so does painting, in its turn, with the first appearance of the panoramas. The high point in the diffusion of panoramas coincides with the introduction of arcades. One sought tirelessly, through technical devices, to make panoramas the scenes of a perfect imitation of nature.[[11]](#footnote-11)

At this historical moment, the emancipated masses of emerging societies had started to appropriate and recycle image genres that had long been reserved for the upper classes, producing from them a new kind of culture, a culture today known as popular culture. Panoramic images would eventually become a form of mass entertainment. But in those cases in which the panorama represented historical and archeological sites, its topographical and geographical aesthetic is undeniable, and it served to educate a population which, at that time, was still predominantly stationary in their habitat.[[12]](#footnote-12)

With most early panoramic devices, a wide-angle view was achieved not by the audience moving their gaze in relation to the image, but by moving the image itself within the exhibition venue. Another type of moving panorama dates to the last few decades of the 18th century. Such a panorama was one of the first image genres to afford immersion within a total image. This immersion worked in one of several ways: either by moving the image mounted onto a panel around the audience, or by moving the audience standing on a stage inside the image.[[13]](#footnote-13) These immersive techniques from panoramic photography would have a profound influence on later visual culture. In fact, the panorama anticipated virtual reality in one key respect: enlarging what is visible but doing so at a cost to the depth of the image. Because panoramic photography followed from the painted panorama, the image was made in a certain way. Firstly, the photographer rotated the camera around, with their own self as the axis, like the center point of a circle or semicircle, while photographing the world not which they might see at first glance, but which they saw while pivoting. Secondly, the full size of the objects in view were recorded within the picture plane. Objects were not visually cut. Thus, multiple images could be merged together more easily. And thirdly, the panoramic photograph had no central focus, distinguishing it from landscape painting, which may be created from a single vantage point.

With a panorama, the photographer described the space through a fluxing perspective, in contrast to the fixed perspective of the Renaissance. This movement introduced a cinematic experience to the experience of the photographic image which, at the same time, maintaining its frozen reality. There are a number of ways for a photographer or photographers to create such an image. Of course, these are besides pivoting on one’s feet while taking the shot, as one might when using the ‘pano’ function of a smart phone camera today. According to Rob Towley, these panoramic techniques include: tiled constructions, planimetric, and diagrammatic, peripheral or rollout photography, and topological photography.[[14]](#footnote-14) And each of these served a different purpose. In addition to these various ways of recording a panorama, there are also several ways to create overlapping images, such as the stereographic overlap (in which images are set in proximity to each other in order to construct the illusion of dimensionality) and sidelap or lateral overlap (in which images are placed one next to another).[[15]](#footnote-15) While not yet computational, all of these techniques can be understood to be proto-computational method, advancing the consequential image scanning, as sectioning the image in equal sub-sections.[[16]](#footnote-16)

Of these panoramic techniques, tiled constructions appear as complex panoramic images, while panoramas merge images in one row, tiled constructions do it in more. With a planimetric image, the image is recorded via the strategic movement of the camera from the left to the right side, much like as with a scanner for a computer. With a diagrammatic image, on the other hand, the image is recorded through multiple perspective views to construct a flat diagram, which can produce quite a confusing effect, similar to the paintings of Cubism in the early 20th century. Each of these techniques may be applied for different purposes or to various extents. Aerial photographs, for example, consist of organized tiles of joined images. Photogrammetric images, in contrast, consist of a complex system of images which are merged one to another to make a three-dimensional object. Such photographs do not necessarily need to be photographed systematically, using neutral settings, or the same lenses. Rather, with the aid of computational photography and even artificial intelligence, diverse photographs can also be merged from archived sources of varying age and quality. For example, Bundler, software program written by Noah Snavely, is a structure-from-motion (SfM) system for unordered image collections, such as images from the Internet. It ‘takes a set of images, image features, and image matches as input, and produces a 3D reconstruction of camera and scene geometry as output’.[[17]](#footnote-17)

|  | MAP | PHOTO |
| --- | --- | --- |
| MAP | Hypermap | Orthophoto |
| PHOTO | Photomap | ‘Deep photo’ |

Table 5: Provisory explanation of variants between photographs and maps

## Orthophotos

Another way of computing images is to correct photographs according to or along with another visual, non-photographic material. Among the most known of such corrective computational or pre-computational photographic techniques is the orthophoto. An orthophoto is a ‘planimetrically accurate photo image’, or an image which functions like a map. And it can be used to visually depict the planet Earth in a way similar to using a camera with a telephoto lens and images which have been taken from an altitude or distance from the surface of the Earth of 45,000 km.[[18]](#footnote-18) As such, it was not possible to record an orthophoto until the innovation of flying machines in the early 20th century.

In contrast to panoramic photographs, which are recorded as a series of horizontal images, orthophotos are correcting photograph via orthographic projection, where all of the projection lines are perpendicular to the projection plane, in order to represent three-dimensional objects in two-dimensional space. Because this photographic image aligns with a map projection, it may be utilized to measure the true distances between features.Orthophotos do not indicate a distance between the object and the subject as active perception, as there is no subject angle by which a distance can be metered, but depicts only distances on the surface of the image itself, standing for real place distances. Such an orthophotographic view is planimetric, in that it extracts only the horizontal position of features on the Earth’s surface, and reveals these geographic objects, natural and cultural physical features, and other entities independent of elevation. Thus, orthophotographic techniques are used to correct the curvature of the Earth on a flat map.

Since the earliest beginnings of aerial photography, as described in Chapter 2, various mechanisms and methods have been used to correct the subjective human view with objective computational views. Aside from early efforts by Nadar and Batut, the first endeavor to automate orthophotography was in the 1920s. This coincided with several key innovations in cartography, including the stereo comparator, auto-stereography, auto-cartography, and aero-cartography. The first orthophotographic images were produced by 1931 by Otto Lacman, the author of a treatise on orthophotography.[[19]](#footnote-19) But only after World War II was the orthophotoscope constructed, a ‘photomechanical or optical-electronic device that creates an orthophotograph by removing geometric and relief distortion’.[[20]](#footnote-20) Meanwhile, more and more photographic images were being geometrically corrected or ‘ortho-rectified’ so that the scale of the photograph would be uniform. Soon after, a matching projector, call an orthoprojector, was invented to assist in the production of accurate orthogonal projection. And the first such map to be converted from a photograph was taken in 1960, a map of the Union of Soviet Socialist Republics (USSR), which at that point presented a selection of the whole.[[21]](#footnote-21) Most orthophotos today are made by using large-size cameras.[[22]](#footnote-22)

## Photomaps and Photorealist Maps

Orthophotographs made from photographic images can reference the Earth with greater accuracy than maps based on graphic prints could in the past. Yet, due to the intervention of computational processes, digital orthophotos (DOP) mask their origins in photographs while still retaining this realistic effect. Photomaps, in contrast, are actual cartographic products made on the basis of a photographic preparation. Photomaps have been produced for a long time. In the 19th and even 20th centuries, with the beginning of experiments in combining maps and photographs, photographic images would be covered with a thin sheet of paper and geographical lines would be traced over them. Later, such lines were carved directly into the material upon which the photograph was mounted. Then, the entire construct, photograph, map, and all, would be re-photographed in order to produce a new image. Today, however, a special kind of film is required to make a photomap, a type of film which is having equal density, so that lines can gradually be separated out according to scale. Usually such film is combined with reversal film, which can be used for large projections, recording the same images on both.

In addition to orthophotos and photomaps, there are also photographs which encompass some elements from map making, such as place or name tags, topographic borders or marks, or other geographic information. These photorealistic maps look more truthful and trustworthy than do photomaps, more objective, even like they are not coded, because of the seductive effect of the photographic image. However, here the photograph is also just a layer in a more complex system. And some photorealistic maps also have amplified elements, such as color or shape, which further distinguish them from photographs.

## Hypermaps

Beyond the orthophoto, photomap, and photorealist map, all of which to some extent de-photographise some photographically recorded reality by diminishing the indexical or realistic effect of the photograph, there are other ways of preserving the post-digital photograph as an authentic carrier of geographical information. One such way is the hypermap. Hypermaps are systems of images which include many layers of information, some or none of which may be photographic in nature.[[23]](#footnote-23) Viewers or users of a hypermap can therefore zoom into different areas of space or layers of information, which may connect to place-tags or other geo-information, a large amount of data which enhances the user’s search return through a ‘hypergeo model’.

Hypermaps are a hybrid between photograph and map which gain layers of information because of how they fuse these several kinds of mediation together. But hypermaps also loose information from these various media forms, including the indexicality of the photograph, as well as the precision of the map. This loss is most significant in relation to photography, because the photograph has to be corrected in order to simulate the flat, two-dimensional visual space of the map. Indeed, only the ‘realistic effect’ remains from the photograph in a hypermap which, according Rob Tovey, may be present in cartographic, scanned, diagrammatic, peripheral, and topological information.[[24]](#footnote-24) Here, the vision and mediation of the photographic eye is combined with the visualization and abstraction of the cartographic gaze. But this simultaneity between photographic techniques and map making contaminates the overall epistemic value of the hypermap.

One of the most important kinds of information that is lost in this process of hybridization is the subjectivity of the author. In a hypermap, photographs are computed and merged in order to achieve a non-subjective view.Hypermaps and their depiction of absolute space erase the presence of the subject by failing to provide the viewer with any immediate information about the point of view of the image author. Moreover, the hypermap describes everything but the subject, either by re-distributing the subject through the act of use, or by describing only the world around the subject, as if the total image is a donut and the subject is its absent hole.

Figure 23 - *Turgot map of Paris* (work in the public domain)

Figure 24 *- Mount Kilimanjaro Summit photomap* (work in the public domain)

Figure 25 – Geodaten Bayern, *Orthophoto of Augsburg*, 2012 (work in the public domain)

## ‘Deep Photo’

In addition to hypermaps, as well as other possible combinations of maps and photographs, there are systems which can be used to merge various layers of photographically-based imaging into a single view. These deep photographs are a kind of ‘complex image’, including more data than what is seen at the first place, to employ a concept by Oliver Grau.[[25]](#footnote-25) And while not as axiomatic or transparent as basic photography, deep photos can in fact be used to attain an even greater degree of veracity in the objective depiction of reality. This is because the very process which is involved in creating such a total image eliminates the role of the subjective and thus interpretative. These images are recorded systematically and with precision. In many cases, they describe reality by measuring it rather than interpreting it. And this, in turn, supports more objective meanings.

Deep photography has many currently emerging subtypes. However, the categories for these are not yet stable enough for them to be distinguished as genres. In metrophotography and photogrammetry, however, various layers of information are embedded, such that they can be classified as a type of deep photography.[[26]](#footnote-26) Perhaps the most significant characteristic of the deep photo is that it has a resolution far beyond that which naked human vision can itself be capable of achieving. Deep photos are merged from big data which has a photographic origin. So they have far more detail and description than ordinary photographs. For example, the largest deep photograph made by a single artist to date is *Mont Blanc Under Snow* by Filippo Blengini.[[27]](#footnote-27) This 365-gigapixel assembly is made out of 70,000 individual photographs. The image offers the viewer a detailed close-up with better image quality than with those images taken by satellite.[[28]](#footnote-28) With the previous record holder for ‘largest image,’ a 360-degree panorama of the city of London recorded from BT Tower, it is possible to see almost every house within the line of sight, but from a low oblique view.[[29]](#footnote-29) For the low oblique, the camera has depression angle of about 60 degrees, showing only a relatively small area of the surface of the Earth, in perspective that is neither fully aerial nor landed human.

Among other methods of image computation and merging with non-photographic materials, deep photographs can also be made by overlapping the very same frame recorded across three or more different exposures. This process is usually known as bracketing. Through bracketing, the photographer repeatedly shoots the same visual scene, and with each shot alters the parameters of the exposure, such as white balance, or some other parameter. By so doing, the depth of field, exposure details, and contrast relationships may be manipulated. The recorded images, which are usually made with a camera fixed upon a tripod in order to stabilize the long exposure times which provide greater detail, are then superimposed over and under one another as layers within the same image. This produces an evenly sharp image that would otherwise be impossible to record. In addition, by taking multiple exposures, the photographer may choose those with the best quality, even without necessarily merging it with others. Such a practice was especially common in landscape and, most of all, architecture photography.

Today, this bracketing technique is an automated feature which is built into most if not all digital cameras, including the phone, tablet, and laptop cameras which are supported by high dynamic range (HDR) photography or Google Pixel. Bracketing can be used to alter more elements in an image than just the exposure and depth of field. Bracketing can be used to widen the field (such as in panoramic photography), change the image spectrum (multi-spectral images, a kind of hyper-photo), produce higher resolution (deep photography), create a parallax image (stereo-photography), and erase or generate objects (post-production). These are more or less the features of all so-called ‘cognitive cameras’, plenoptic cameras which through the programming of their functionality can be used to extract information out of an image sequence, rather than just conjoin images.[[30]](#footnote-30) A plenoptic or light-field camera is defined by several key features and functions. Most essentially, it captures the light which emanates from a scene, including the intensity of light as well as the direction in which these light rays are travelling. This contrasts with other types of cameras, such as the analogue or digital camera, which primarily are defined by the medium with which they record, such as through a chemical process or onto a memory chip, respectively. Beyond this essential feature of light detection and tracking, the plenoptic camera has the same functionalities as other photographic cameras in terms of automatically producing a frozen image or sequence of images. And because the mechanism of such a camera works largely independently from human intervention, as with the loading and reloading film or the changing of settings, the time between taking pictures is shortened, which in turn leads to greater image stabilization (IS) and reduced blurring or noise. With the aid of plenoptic photography, an amateur photographer can produce images which appear as though they have been created by a professional photographer. In most digital single lens reflex (DSLR) cameras, images are computed on the micro, or data level, beyond either the vision or control of the camera user. Therefore, an amateur photographer often remains unaware of this process.

Today, post-digital photographs include a vast amount of photographic as well as non-photographic information which has been synthesized into a single visual artefact. Such artefacts cannot be seen all at once, which is certainly how photographs used to be perceived, but rather is user-directed in terms of which layer is looked at. In fact, the user creates the image through the very act of use, zooming in to see the narrow details, and zooming out as well as moving in various planar directions to see a wider picture. Such images are also compressed. And they have to be decoded or processed otherwise. For this reason, these photographs do not have a single meaning or message but a multitude of possible meanings and messages which are created by each user. It may be concluded, therefore, that the total image is a post-digital photograph which contains more visual data about some place than any single one viewer could naturally perceive on their own, whether in terms of the view angle of the camera or cameras, the wave-length of the light, or additional information such as maps, tags, and geolocations. Indeed, with the total image, we have entered into what Hito Steyerl calls ‘the age of post-representation’ in which the world is simultaneously represented by many visual techniques.[[31]](#footnote-31)

## Dangerous Places and Comfortable Spaces

Commonly, images of the Earth or of the layers of its atmosphere which are taken from planes in the air can be photorealistic. But such images become more and more abstract when taken by satellites in space. As Bruno Latour notes: ‘By looking at the satellite image we extract ourselves from our particular point of view, yet without, bouncing up to the bird's eye view; we have no access to the divine view, the view from nowhere’.[[32]](#footnote-32) Different systems of coding and transmission are used with new technologies from radar to infra-vision. And the more the aerial view is coded, the less realistic is the image. Indeed, these new kinds of images do not at first sight appear to be as substantially coded as maps, because to one degree or another they still represent the Earth indexically, or at least with some factual connection, such as by incorporating aerial photographs. Even so, the overall lack of realism in such a total image, because it encompasses a view extended beyond that which the naked human eye could naturally perceive by using technology, in turn minimizes the viewers’ obligatory relationship to the subject of the image. In erasing the place of the subject in the view, and thereby any possibility for the audience to relate to that subject, whether through abjectification or empathy, the total image becomes a symptom of the pathological forces in contemporary culture.[[33]](#footnote-33) With everyday experience which is increasingly abstracted from the Earth through using and interaction with such images, whether you ‘Choose Destination’ or ‘Explore Nearby’ with Google Maps, or if you share where you are ‘Traveling To’ on Facebook, it becomes that much more difficult to connect with the concreteness of life. And this is the tragedy of such technological innovations as the deep photograph and computational methods.

With the innovation of aerial photography, it is the map that become real. But in turn, such photography also introduced an abstract vision, as abstracting from a human position. Reality, when perceived through several mapping tools, also becomes digital, James Bridle notes.[[34]](#footnote-34) Today, the augmented or virtual space of maps which provides the user with an experience other than reality, in turn separates the user from the once-necessary process of verifying for themselves the reality which they perceive and navigate.[[35]](#footnote-35)

The space in which we live today is a space which is computed, assembled, and multi-perspectival. Maps are no longer necessarily objective, because they are based on data, and at the moment in which a user views or interacts with the map, they are viewing or interacting with data this data that has already in some way gone through a process of selection and interpretation. As computed photographs and maps, once being closely tied to physical reality, have become yet another tool of visualisation, we have dived into virtual space. Neither landscapes nor maps do necessarily mean a real place. They are not settled on one side while reality on the other anymore, but everything is fully integrated inside the map, from cars driving, over taxi services and apartment rentals, restaurant working hours. Both are combining a part of material reality with the abstracted one. In many cases it is impossible to split the cartographic reality from the geographical one.[[36]](#footnote-36)

In parallel to a great precision of the place, a new generation of fully places that emancipated from physical reality, such as virtual places are expanding our perception of the real space, and overlapping with the real ones in many cases, changing their (also spatial) meanings, as in augmented reality.[[37]](#footnote-37) The world of today is a super-networked self-organizing datascape, rather than a fixed reality. There are many interpretations of reality co-existing, each presented as a total and unique one. So, all images of it are distorted and our visual conception of reality, by mapping it.

1. Arjun Appadurai, *Modernity at Large: Cultural Dimensions of Globalization* (Public Worlds, Vol. 1), Minneapolis: University of Minnesota Press, 1996, 33. [↑](#footnote-ref-1)
2. Steve F. Anderson, *Technologies of Vision: The War between Data and Images*, Cambridge, MA: MIT Press, 2017. [↑](#footnote-ref-2)
3. See for example Henry Peach Robinson’s *Figures in Landscape*, Gelligynan Series (photomontages), 1880. [↑](#footnote-ref-3)
4. See: Dawn Ades, *Photomontage*, London: Thames and Hudson, 1976; Robert Sobieszek, ‘Composite Imagery and the Origins of Photomontage, Part I: The Naturalistic Strain’, *Artforum* 17.1 (1978): 58-65; Robert Sobieszek, ‘Composite Imagery and the Origins of Photomontage, Part I: The Formalist Strain’, *Artforum* 16.2 (1978), 41-43; Richard Hiepe and C. A. Haenlein, *Dada: Photographie und Photocollage,* Hannover: Kestner-Gesellschaft, 1979. [↑](#footnote-ref-4)
5. See: Kristin Makholm, ‘Strange Beauty: Hannah Höch and the Photomontage’, *MOMA* 24 (1997): 19-23; John Heartfield, ‘Photomontages of the Nazi Period’, London: Gordon Fraser Gallery & Universe Books, 1977; Magdalena Dabrowski, ‘Photomonteur: John Heartfield’, *MOMA* 13 (1993): 12-15; Ades, *Photomontage.* [↑](#footnote-ref-5)
6. Rudolf Arnheim, ‘Inverted Perspective in Art: Display and Expression’, *Leonardo* 5.2 (1972): 125-135. [↑](#footnote-ref-6)
7. As Walter Benjamin described and categorized: ‘There were panoramas, dioramas, cosmoramas, diaphanoramas, navaloramas, pleoramas, fantoscope, fantasma-parastases, phantasmagorical and fantasmaparastatic experiences, picturesque journeys in a room, georamas; optical picturesques, cineoramas, phanoramas, stereoramas, cycloramas, panorama dramatique’. Walter Benjamin, *The* *Arcades Project,* trans. Howard Eliand, Cambridge: Harvard University, Belknap Press, 2002, 527. [↑](#footnote-ref-7)
8. There were also a great number of more or less successful products which had to do with the original wide-scene view, such as the diorama, neoreama, cyclorama, eidophisikon, cosmorama, nahrama, phosporama, kineorama, myorama, sensorama, pleorama, mareorama, and more. [↑](#footnote-ref-8)
9. See Paul Mellon Sawyer, ‘Panorama as a Global Landscape’*,* *YouTube,* https://www.youtube.com/watch?v=ldLvpyoby-g. [↑](#footnote-ref-9)
10. Benjamin, Arcades Project, 532. [↑](#footnote-ref-10)
11. Benjamin, *The* *Arcades Project,* 5. Moreover, one of Parisian arcades is actually called the Panorama. [↑](#footnote-ref-11)
12. More on history of panorama: see Erkki Huhtamo, *Illusions in Motion*: *Media archaeology of the moving panorama and related spectacles*, Cambridge, MA: MIT Press, 2018; Oliver Grau, *Virtual Art: From illusion to immersion,* Cambridge, MA:MIT Press, 2003. See also: Wurzer, *Panorama*. [↑](#footnote-ref-12)
13. Type of latter panorama in which the public is freely moving is quite near the effect of the virtual reality. As Grau notes, distances are assumed rather than experienced, blurring the relationship between the image and real space, as naturally filling the observer’s field of vision. Grau, *Virtual Art.* [↑](#footnote-ref-13)
14. Rob Tovey, ‘Photomaps: A Visual Taxonomy’, *Visual Communication*, 17.2 (2018): 209-220. [↑](#footnote-ref-14)
15. When using stereographic, the parallax is 5-10 degrees, while with lateral overlap it must be larger, up to 30%. [↑](#footnote-ref-15)
16. Similarly, photogrammetric techniques may also be used to produce an objective viewpoint and obtain reliable information about physical objects and the environment. In photogrammetry, the photographer or photographic system fuses images together in order to produce a third dimension by employing several movements of recording: from up to down, meander (from outer to inner, in order not to step in), snake-shape (left-right and then righst-left), and from distant to close. The recorded data is then assembled in alignment with how its author may choose to visualize the object, rather than how the object appears to vision. [↑](#footnote-ref-16)
17. 'Bundler', https://www.cs.cornell.edu/~snavely/bundler/. [↑](#footnote-ref-17)
18. The minimal distance to record the full image of the Earth is 35,786 kilometers. [↑](#footnote-ref-18)
19. Otto Lacman, *Equalizer for non-flat terrain. Image measurement and aerial photography*, 1931, 10-12. [↑](#footnote-ref-19)
20. Definition of orthophotoscope from ESRI, https://support.esri.com/en/other-resources/gis-dictionary/term/d307b618-60b9-4efc-9afc-9c47918e54b4. Overlapping photographs scanned for the overlap, area is sequenced into smaller sections which are scaled. [↑](#footnote-ref-20)
21. Cartography in the USSR was so well developed as a field that they released maps of the entire world soon after the first orthophoto was taken. See: https://www.nationalgeographic.com/news/2017/10/maps-soviet-union-ussr-military-secret-mapping-spies/. [↑](#footnote-ref-21)
22. Cameras used today can record up to 450 megapixels in single shot. [↑](#footnote-ref-22)
23. Menno-Jan Kraak and Rico Van Driel, ‘Principles of Hypermaps’, *Computers & Geosciences* 23.4 (1997): 457-464. [↑](#footnote-ref-23)
24. Rob Tovey, ‘Photomaps: A visual Taxonomy’, *Visual Communication* 17.2 (2018): 1-12. [↑](#footnote-ref-24)
25. Oliver Grau, ‘Images (R)-Evolution: Media Arts Complex Imagery Challenging Humanities and Our Institutions of Cultural Memory’, *Leonardo Electronic Almanach* 20.2 (2014): 72-86. [↑](#footnote-ref-25)
26. Yet another form, which serves 3D construction metrophotography, or latter photogrammetry, being the latest of genres merging photographs with maps, are based on projective geometries, used in measurement of the architecture, while orthophoto merges analyses landscape in general. Rules for shooting images to be photogrammetrically. processed to have changed with the development of equipment, but in general they are recorded to be overlapped, in order of producing a higher precision. [↑](#footnote-ref-26)
27. Whereas the largest montaged image from multiple sources by this date is Pan Starrs, made out of 3 billion separate sources and in 2 petabyte size. See: https://www.ifa.hawaii.edu/info/press-releases/panstarrs\_release/. [↑](#footnote-ref-27)
28. Recorded using a Canon 70D DSLR, a Canon EF 400mm f/2.8 II IS, and a Canon Extender 2X III on a special robotic mount. [↑](#footnote-ref-28)
29. This image consists of more than 48,000 images. [↑](#footnote-ref-29)
30. Jin-Li Suo, Xiangyang Ji, and Qionghai Dai ‘An Overview of Computational Photography’, *Science China* *Information Sciences* 55.6 (2012): 1229. [↑](#footnote-ref-30)
31. Hito Steyerl, ‘Digital Debris: Spam and Scam’, *October* 138 (Fall, 2011): 70-80. [↑](#footnote-ref-31)
32. Bruno Latour and Emilie Hermant, ‘Paris: Invisible City’, Liz Carey-Libbrecht (trans.), 1998. http://www.bruno-latour.fr/sites/default/files/downloads/viii\_paris-city-gb.pdf, 9. Section published as: Bruno Latour, ‘Introduction: Paris – Invisible City: The Plasma’, *Culture and Society*, Elsevier, 3.2 (2012), 91-93. [↑](#footnote-ref-32)
33. Dorrian and Poussin, *Seeing from Above.*  [↑](#footnote-ref-33)
34. Bridle, *New Dark Age.*  [↑](#footnote-ref-34)
35. Tim Mehigan, *Frameworks, Artworks, Place: The Space of Perception in the Modern World,* Rotterdam: Rodopi, 2008. [↑](#footnote-ref-35)
36. Bridle, *New Dark Age.*  [↑](#footnote-ref-36)
37. Cosgrove, *Social Formation and Symbolic Landscape*, Cosgrove, *Geography and Vision.* [↑](#footnote-ref-37)