

The qualitative image: urban analytics, hybridity and digital representation

Abstract

High-precision analytical software, such as that used for medical imaging, can be also applied productively to the assessment of urban conditions such as pedestrian and vehicular flow. A prominent feature of this tool is its ability to offer a new and more abstract understanding of the material nature of the city. Drawing upon a range of scaled-up software procedures to illustrate capability, the chapter reveals how an analytical medical software tool can be adapted for use in alternative interdisciplinary contexts such as urban design. Using imagery captured from public domain webcams, it demonstrates how the upscaling and transferal of this digital tool from its original disciplinary role provides a new way of assessing the appropriateness of a proposed built intervention. It also reveals that the extension of this tool's fine-grain, image-based analysis capabilities into a broader, more complex urban scale allows the more ambiguous and often-disregarded properties of city life to form part of a comprehensive and wholistic data set. The chapter concludes with the proposal that the synthesis of quantitative and qualitative data facilitated by this analytical platform exceeds the capability of urban assessment tools currently used by the discipline.

Introduction

To engage with the contemporary city is now to engage with the relationship between its built surface and the visioning technology that presides over it. Urban space has been transformed by new modes of navigation and perception that are amplified by the camera's ability to traverse the urban landscape in an unprecedented way. While the effect of the zoom lens extends the opportunity to correlate camera focal increments with the effects of a vast range of physical conditions, the streaming image-making process delivers this urban data to a global audience as an uninterrupted video stream, with a frame-rate capture indistinguishable from the perception of real time. As a consequence, both technology and the image assume a highly instrumental role in relation to the assessment and determination of conditions that arise from this new type of engagement with urban space.

With digital camera protocols mimicking many of the functions of the human visual system (HVS), optical cues based upon colour, brightness and shape become the principal determinants of image assembly and perceptual hierarchy. This means that the pixel not only radically shifts the rules by which representation is constructed and perceived, but these properties set new criteria according to which the city's operation and physical properties are able to be indexed and quantified. In this new digital frame, it is therefore the data array of the pixel grid that serves as a supplementary portal for the admission of new modes of urban information gathering and assessment.

Visual analytics play an important role in analysing the phenomena and processes that evolve in contemporary physical space and, by extension, the diverse decisions that are made based upon this data. Through an overview of current methods, tools and procedures, Andrienko et al (2012) identify variations of movement data as the main focus of urban analytics, speculating that the answer to overcoming the representational shortcomings of these tools lies in cross-disciplinary cooperation (Andrienko and Andrienko, 2012). Many recent software developments in visual analytics are concerned with overcoming problems associated with visualization complexity and clutter (Andrienko et al, Scheepens et al; Wongsuphasawat and Gotz; Zeng et al), with the express purpose of rapid commercialization (Scheepens et al, 2016). However, as an alternative approach to these types of proprietary software tools, many independent freely available open-source platforms also offer highly

efficient, targeted data analysis capabilities to produce an index of reality. Diagnostic or medical imaging software, currently the principal mode of scientific image-based analysis, demands a high degree of data precision to track and map the progression or remission of disease. Using image-based analysis, these independent, high-performance tools are specifically configured to analyse images in ways that resist the deliberate intervention of manufacturers' promotional strategies.

However, the transposition of this software from a medical to a design application calls for a new understanding of what types of disciplinary contribution the image might now be able to make. If the specific problem-set addressed by medical imaging is the representation and analysis of change over time, then the adaptation of similar criteria to the assessment of urban conditions, understood as color, luminosity/contrast and density, is simply an increase in the scale of analysis. Furthermore, the digital translation of these properties into digital data releases their potential to incorporate highly qualitative and affective data in the information-gathering processes of the contemporary city.

This chapter will discuss the interdisciplinary adaptation of software to the assessment of urban conditions. It will reveal how the precision of an open-source medical imaging toolset can be applied productively, not only to the assessment of pedestrian and vehicular flow, but to a new and more abstract understanding of the material nature of the city. Using a range of scaled-up interdisciplinary software procedures, it will reveal how this approach can set a new standard for the assessment of complex urban conditions that, through the synthesis of quantitative and qualitative data, exceeds the disciplinary capabilities of urban assessment tools currently available.

1. The distributed city

The diverse urban data-gathering capabilities of the Internet webcam network currently remain largely unexplored. As John Macarthur (Macarthur 2000) observes, while Modern painting transposed the relation of pictorial depths into a relation of surfaces, then so too does the aerial vantage point transpose the variation of landscape contours into a relation of patterns and textures that awaits further release. Traces of ownership of public space are clearly demonstrated by the textural patterns of images produced from these new aerial viewpoints. As one example of many, Google Earth views of politically sensitive zones are heavily edited and pixelated below a certain elevation, producing a *specific* pattern recognizable by its association with a *specific* type of activity and located in a *specific* place. Conversely, less sensitive zones are neither pixelated nor traceable through any particular pattern type at corresponding elevations. (Figure 1.1).



Fig. 1.1. Google Earth images of Haifa Airport Israel (left) and Heathrow airport United Kingdom (right) at identical altitudes, showing Google intervention in image definition of Haifa airport. Image: Google Earth.

The types of patterns that emerge at certain elevations also bear an historical trace of the impact of different political regimes and cultural mores upon individual land ownership. The diversity of patterns that appears at corresponding aerial elevations in different locations thus sets up an indexical relationship between the vertical representation of space and the material nature and scale of its content. Figure 1.2 reveals a correspondence between the physical occupation of the landscape and the magnification index of the camera. In both cases, the left-hand image was taken from exactly the same altitude above the earth as the right-hand image, revealing an observable relationship between the image patterning and the camera's vertical viewpoint.



Fig. 1.2. Google Earth images of India (left) and Israel (right) showing relative variations in patterns at identical altitudes. Image: Google Earth.

Similarly, the *guerilla* tactics of urban groups like the New York-based Institute of Applied Autonomy indicate how the webcam platform might contribute to the formation of new landscape usage patterns. As Laura Kurgan observes, thanks to the Internet platform interdisciplinary mechanisms of digital data manipulation are now broadly accessible across global digital space. ‘Many military technologies have gone from classified to omnipresent, from expensive to free, and from centralized to distributed, downloadable on our desktops anywhere on earth with access to the Internet.’ (Kurgan 2013, 24).

This group's *i-SEE* program is a web-based application (21st Century Digital Art) which maps the locations of CCTV cameras in urban environments with the express purpose of providing a hidden route for the user that avoids Internet camera surveillance. The software reveals that there is a strong correlation between areas with the highest incidence of cameras and the presence of politically, morally or economically sensitive property. (Figure 1.3)



Fig. 1.3. Top left to right: i-See software map of lower Manhattan showing area of concentrated surveillance cameras; corresponding Google Street View of this area showing Morgan Chase Bank; Goldman Sachs. Image: Google Earth. Bottom left to right: i-See software map of lower Manhattan showing route avoiding surveillance cameras; Google Street View of this area showing currently degraded zone and sparse inhabitation. Image: Google Earth.

By avoiding detection and reversing the idea of personal visibility promoted by urban Internet camera networks, the individual *i-See* user therefore subverts the original intent of the system. The selection of a *path of least resistance* that uses unorthodox routes across the urban landscape thus potentially not only eventually aligns the inhabitation of these spaces with non-conforming citizens but links the image-making platform to the material evolution of the city. In this respect, it is both the data in the image in combination with the network system that simultaneously influence urban growth patterns and bear witness to their evolution.

1.1 The open-source digital imaging platform and new opportunities for data analysis

The replication by camera manufacturers of the cues of the human eye within camera technology re-presents similar optical conditions and vulnerabilities to which the HVS is subject. In both personal camera and public webcam terms, image-processing malfunctions associated with environmental conditions such as reflection, refraction and diffraction are all targeted for removal by camera manufacturers to ensure that the individual snapshot and the public capturing of urban space are smooth and flawless. An example of this are the camera's shape-sensitivity patterns, which are extrapolated algorithms of HVS saliency factors relating directly to coarse or low-resolution peripheral vision (Kruegle 2011). This mimicked scanning process is engineered specifically to use shape-scanning algorithms that can enhance pre-selected areas of an image (Foley et al. 2014). In a context of urban space, this inevitably produces a predetermined image of the city aligned with the politics of site ownership. It also excludes peripheral data relating to what are classified as *aberrations* from the city image that could potentially add enormous insight and value for data-gathering. The precise strategies hardware and software manufacturers employ for camera applications are therefore predictably difficult to access (Klette and Rosenfeld 2004). Not only are they concealed from the viewer, but they do not disclose the history of the processes to which image data has been subject.

However, the fundamental image properties of the HVS and the digital image, colour, luminosity and shape, can be released from the constraints of embedded proprietary hardware and software through the availability of open-source code, which is free to users as well as to developers. Many of these software programs enable the image to be captured directly from the Internet in *.raw* file format before it is subject to reductive optimisation and culling processes and then re-cycled as an *authentic* and comprehensive basis for urban analysis. Also most open-source software has associated collaborative communities for development support and therefore the benefit of future enhancements that are not dependent on a single organisation (Chen 2005). Many open-source software programs have availed themselves of the open-source GNU/Linux code to either avoid or correct the numerous image enhancement decisions embedded within commercial software. *GIMP* (GNU Image Manipulation Program), is a freely distributed program that is expandable and extendable, allowing the user to undertake image manipulation at all levels of complexity, including photo retouching, image composition and image authoring. Other programs like *Color Blender* (Color Blender) and *Pipette* (Charcoal Design) operate exclusively to override any default hardware colour choices, allowing the user to access the internal colour geometries of the image, and thus to have control of the predictive assemblies of multiple colour palettes (Figure 1.4). The use of this type of code, in combination with the relentless generative capacity of the Internet camera, therefore means that the ability to produce a reductive, stable image of urban space is severely diminished



Fig. 1.4. Color Blender software showing its predictive hex mixing capacity.

However, it is the hidden choices embedded in the more inaccessible aspects of both the image processing pipeline and its final contextual location that pose the greatest obstacle to the opening up of the image-making process. Proprietary software manufacturers have been able to discourage intervention because the colour demosaicing or interpolation process involves the interaction between software and camera hardware, both of which are tied to the copyright of the product and also automated. 'In practice, it is extremely rare to have access to any history of the processes to which image data has been subject, so no systematic approach to enhancement is possible' (Poynton 2012, 383). However, another cross-platform image-processing program, *Raw Therapee* (Raw Therapee), intervenes in this process at its origin, allowing *raw* or untampered files to be read by the computer. This program gives the user advanced control over the colour-demosaicing process, enabling use of a variety of different algorithms rather than being subject to the camera's built-in code.

The assignment of highly specific and layered integer values to the basic image unit, the pixel, means that the primary compositional and structural elements of the image are color, contrast and brightness data. In the case of colour images, pixel values are represented by

triples of scalar values such as red, blue, green or hue, saturation and intensity, and these values alone determine the relationships that each pixel can have with another. Circumventing the concealed manoeuvres of commercial image-processing pipelines, open-source imaging toolsets such as *PixelMath* (PixelMath Software), *ImageJ* (ImageJ: Image Processing and Analysis in Java) and *Fiji* (ImageJ) instead provide high-precision insights into this type of image geometry. *PixelMath* is able to perform a series of pixel-level arithmetic and logical operations between images. *ImageJ* is a Java-script software that allows custom acquisition, analysis and processing plug-ins to be developed using its internal editor and Java compiler. A public domain open-source software, *ImageJ* delivers Richard Stallman's four essential software freedoms to the user¹. *Fiji* is a distribution of *ImageJ* focused on biological image analysis. *Fiji* is *open* not only in respect to its source code but its inter-connectivity to other platforms. The ambition of its developers is to integrate with other bioimage analysis software that outperforms it in particular tasks, seen in its integration with MATLAB and ITK (Shindelin et al, 2012). *Fiji* facilitates the transformation of novel algorithms into *ImageJ* plugins that can be shared with end users through an integrated update system.

1.2 The numerical indexing of urban space

The application of image analysis software to the city means that image content, in this case an urban scene, is represented by an array of pixels, all distributed in a specific numeric relationship to each other. By extension, it also means that complex urban conditions captured by Internet webcam technology are assigned specific numeric values and locations on the picture-plane grid that are recognisable according to a unique array pattern of pixel values. Conditions relating to urban pedestrian and vehicular flow and material surfaces, mediated according to intrinsic pixel values of colour and brightness, thus become a primary mechanism for urban data gathering and assessment, while the temporal nature of this platform's content capture allows the shape-based evolution of urban conditions to be similarly quantified.

Using open-source software *PixelMath* to identify individual pixel values, the following example draws upon unique numeric arrays to identify particular urban conditions which can be distinguished according to the precise contextual distribution of pixel values. This can be seen in Figure. 1.5 where a portion of blurred image content is translated into a numeric matrix which then serves as the means by which the distribution of numbers that compose this particular represented condition, in this case atmospheric diffraction, can be readily identified.

Diffraction artefacts are another example of aberrant and normally disregarded images that represent the city in all of its variable conditions. While an image such as this would normally be rejected and not considered as part of this city's formal, curated *iconic* image library, the webcam's automatic capture of this event nevertheless presents it as just another of the city's many shifting conditions. By establishing a means whereby the complex conditions of urban space can be documented in numeric form, a reproducible platform is thus established that indexes the properties of the city according to a new range of user-determined qualitative criteria that in proprietary circumstances would have been otherwise discarded.

¹ '1) The freedom to run the program, for any purpose; 2) The freedom to study how the program works and change it to make it do what you wish; 3) The freedom to redistribute copies so you can help your neighbor; 4) The freedom to improve the program, and release your improvements to the public, so that the whole community benefits.' (Ferreira and Rasband 2011, 1).

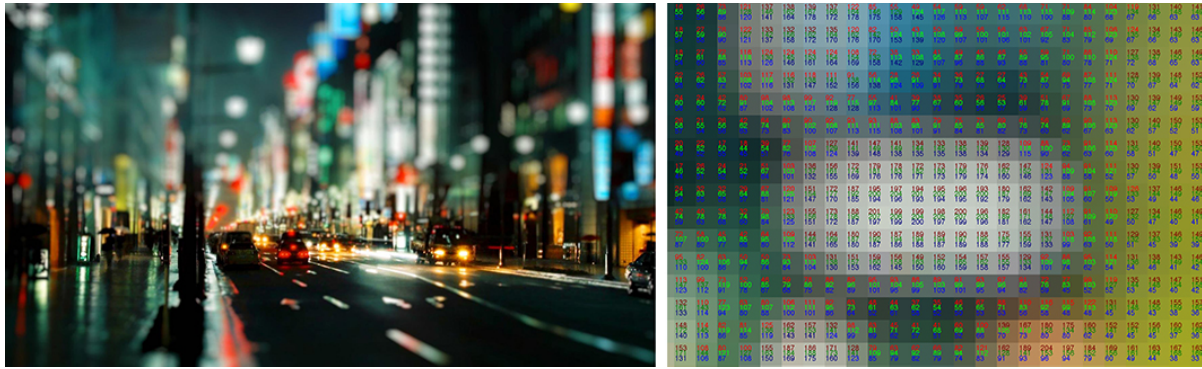


Fig. 1.5 Image of urban street scene, showing diffraction artefacts and areas of content selected for *PixelMath* analysis (left). Numeric distribution of RGB pixel values of a diffraction artefact from the same image produced using *PixelMath* software (right). Image: Creative Commons.

Another example of the type of inclusion made available through the proliferation of the Internet are webcam glitches, or transmission errors which are often highly abstracted, affective representations of urban conditions (Figure 1.6). The webcam's automatic inclusion of these images within the daily urban image portfolio further reveals the extraordinary potential diversity of translatable digital arrays into the city's material surfaces.



Fig. 1.6. Image of urban scene showing transmission or glitch error artefacts (left) and close-up of the artefact area in a *PixelMath* analysis showing numerical distribution of RGB pixel values (right). Left-hand image: Emilio Vavarelle. Google StreetView.

The incorporation of non-traditional representations of the city's many conditions as part of its visual documentation can also be understood within a broader disciplinary context. If the designer's role is to understand complex urban conditions through the mapping of urban space, then the inclusion of diversity, aberrant or otherwise, responds to this brief. Furthermore, at the forefront of urban representation and analysis, it is therefore the introduction of new mapping and data-gathering tools contesting the city as a singular, normative space that sets this process in motion.

2. The temporal city

The distributed nature of the city means that the formation of either a continuous or comprehensive image from any single vantage point is not possible. Unlike the traditional static images of the city, the webcam's progressive revealing of contemporary urban space can be extracted as a projective analytical tool to reveal the evolutionary pattern of diverse and yet simultaneously occurring urban conditions. The two key determining factors in this procedure are time and place.

ImageJ addresses the first of these factors. The adaptation of this software as an urban analysis tool calls for a reassessment of what types of information the image might provide. The specific problem set addressed by medical imaging is the analysis and representation of change over time, which can easily be transposed to the assessment of transformative urban conditions. *ImageJ* has the capacity to organise streaming video footage into manageable image sets or *stacks*. Image stacks are multiple, spatially and temporally related images or slices displayed in a single window that can be easily manipulated, rotated and reassembled according to user specifications. The three-dimensional visualisation of an image stack thus extends its functionality well beyond the realm of two-dimensional analysis into more projective analytical functions in which the evolution of environmental and material properties associated with colour and luminosity can be traced.

The proliferation of Internet webcams in Tokyo addresses the second factor owing to the ability to capture multiple readings of the same place over controlled intervals of time. The density of this urban space also presents an ideal opportunity to observe and assess simultaneously occurring complex activity.

A stack of webcam images extracted from streaming webcam video footage of Shibuya Crossing, Tokyo clearly shows the evolution of programmatic activity over a relatively brief time-frame (approximately 13 seconds) across multiple image axes (Figure 2.1). A development in different degrees of colour and luminosity can also be seen. The visual capture of the city across multiple, simultaneously evolving axes thus allows a specific temporal point within the image stack, not only to be identified, but assessed according to its qualitative properties of colour and brightness.



Fig. 2.1. Still from webcam footage (left) and rotated stack of webcam images (right) extracted from streaming webcam video footage of Shibuya Crossing, Tokyo, Japan. Left-hand image: Forrest Brown/Shutterstock.com.

ImageJ facilitates the type of visual journey that moves the viewer through a series of orthogonally intersecting x,y axes that progressively evolve along a third z axis to produce a complete reconfiguration of the formal content of the image stack (Figure 2.2). These new image *slices* are the synthesis of axial cuts that collectively form a new urban spatial map that interrogates the more traditional representations of the city's activities and its material surfaces. Reminiscent of the analytical model proposed by Ferreira et al (2011), in which access to a specific urban data set relating to taxi trips is facilitated by a visual query model that allows users to select data slices and explore them, here instead the slices record more qualitative data, foregrounding hitherto unseen variants of the city in terms of its colour and brightness properties. The capacity for the user to *step inside* the image stack releases the city's multiple viewpoints and its conditions in unprecedented ways that, on the one hand profoundly transform the understanding of the city as a complex condition, and on the other endow the designer with comprehensive analytical agency.

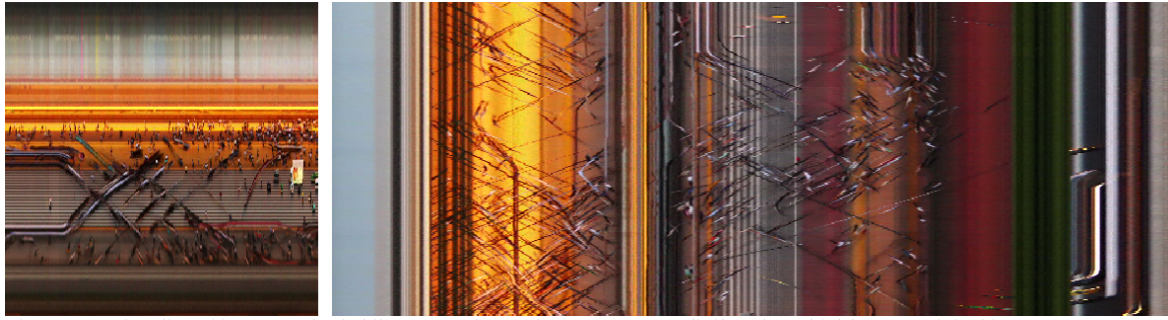


Fig. 2.2. Interior slice of image stack of Shibuya Crossing, Tokyo Japan on XZ (left) and ZY (right) axes. Original image: Forrest Brown/Shutterstock.com.

2.1 Urban Flow as Qualitative Brightness

A comprehensive solution for the visualisation of arbitrary origin–destination flows has long eluded researchers (Andrienko et al, 2012). Rejecting conventional visualisation methods such as flow maps because of their propensity to generate visual clutter, Zeng et al (2016) nevertheless concede that the aggregate movements of objects between different locations could have huge spatial and temporal variations. In addition to this, these authors observe that existing visual analytic methods generally focus on global OD flows across regions and ignore OD flows constrained along specific locations/paths. Proposing their waypoints-constrained OD visual analytics model as a partial, temporary solution, they identify the need for a way of visualizing OD flow volumes along with the movement paths of the OD flows.

Acting as a supplementary urban visualisation tool, *ImageP*'s capacity to transform activity into degrees of brightness presents a new analytical means by which the city can be understood. Using the *Z Project* function, the conflation of an image stack comprising thousands of single urban *snapshots* into a single image, means that traditional modes of representing the city's flow are relinquished in favour of the blurred trajectories of motion over time (Figure 2.3). Precise temporal readings are available for either single or comparative analysis in one or several locations respectively.



Fig. 2.3. Single still from webcam footage of Shibuya Crossing, Tokyo, Japan (left) and a conflated projection of same image stack along z axis according to maximum luminosity for a 13 second interval showing mainly pedestrian flow (right). Left-hand image: Forrest Brown/Shutterstock.com.

Depending upon the location, the compressed images can demonstrate different types of activity. While Figure 2.3 reveals distinct variations mostly relating to the volume of pedestrian traffic through the Shibuya Crossing location at different times of day, another Tokyo webcam seen in Figure 2.4 mainly discloses information about the density of vehicular traffic. This is just one instance of how this type of software application can add informative and comparative insights into specific locations and demographics, particularly if data extractions were conducted at key intervals throughout the day.

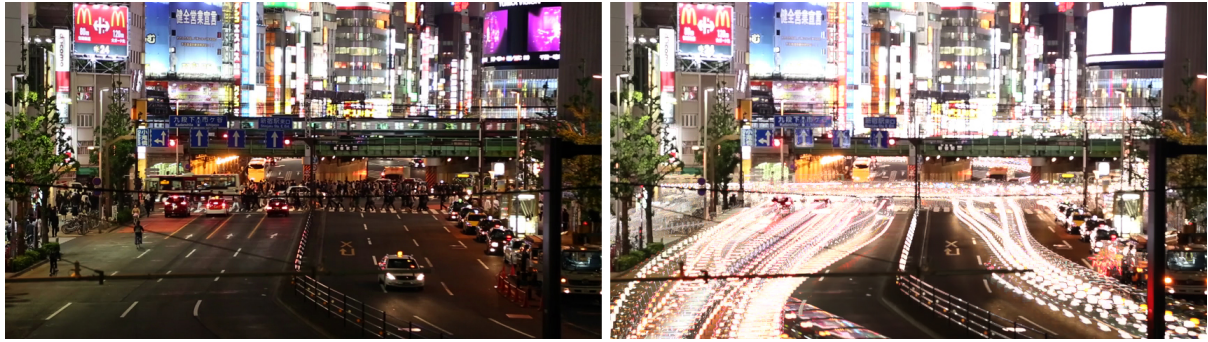


Fig. 2.4. Single still from webcam footage of Shinjuku district, Tokyo, Japan (left) and a conflation projection of same image stack along z axis according to maximum luminosity for a 13 second interval showing mainly vehicular traffic flow (right). Left-hand image: Tokyo Motion/Shutterstock.com.

In design terms, this type of representation also offers the opportunity for a design intervention within this space to be contextualised according to the many urban properties made visible by viewing technology. In other words, the image stack serves as a mechanism for a new type of design decision that is, at once, qualitative and time-based. To position this within a global context, the *ImageJ* image stack establishes a new means and criteria by which both the properties of the city and any intervention within this space can be assessed. Because the stack is but one small part of an evolving continuum, it therefore produces a collective *montage* of the distributed global city, where new volumetric representations of qualitative urban space continually cross-pollinate and evolve. The ability of this software to foster new modes of observing the inhabitation of urban space thus raises the possibility of pre-testing a design intervention according to whether it is either complementary or antagonistic to existing site use. The deliberate and strategic activation of program-related brightness within a webcam-viewed urban context could therefore profoundly affect the experience of the city for a global audience.

2.2 Urban Flow as Quantitative Luminosity

However, the numeric basis of the conflated urban image also means that it can be subjected to comprehensive, traditional modes of analytical scrutiny. The visible trails of pedestrian meandering discussed previously, described within the image as colour and brightness levels, can also form the basis of a scaled-up PIV analysis, a block-based optic flow, used to cross-correlate between specific areas of diagnostic images. In this case, the pattern generated by particles is used to compute the velocity field based on what direction and to what extent a section of an image has moved between two successive instants.

In Figure 2.5, the optic flow analysis of the two different extremities of the image stack of Shibuya Crossing reveals highly specific visual data about the direction of traffic flow in this space. Although the images are extracted from opposite ends of the image stack, the overall displacement of traffic between the images is not significant. The PIV analysis nevertheless provides a detailed analysis of this displacement according to both motion direction and intensity. Extended into a design context, the application of this analytical process could provide invaluable insights into urban planning through the provision of highly nuanced and assessable data over any predetermined time interval.

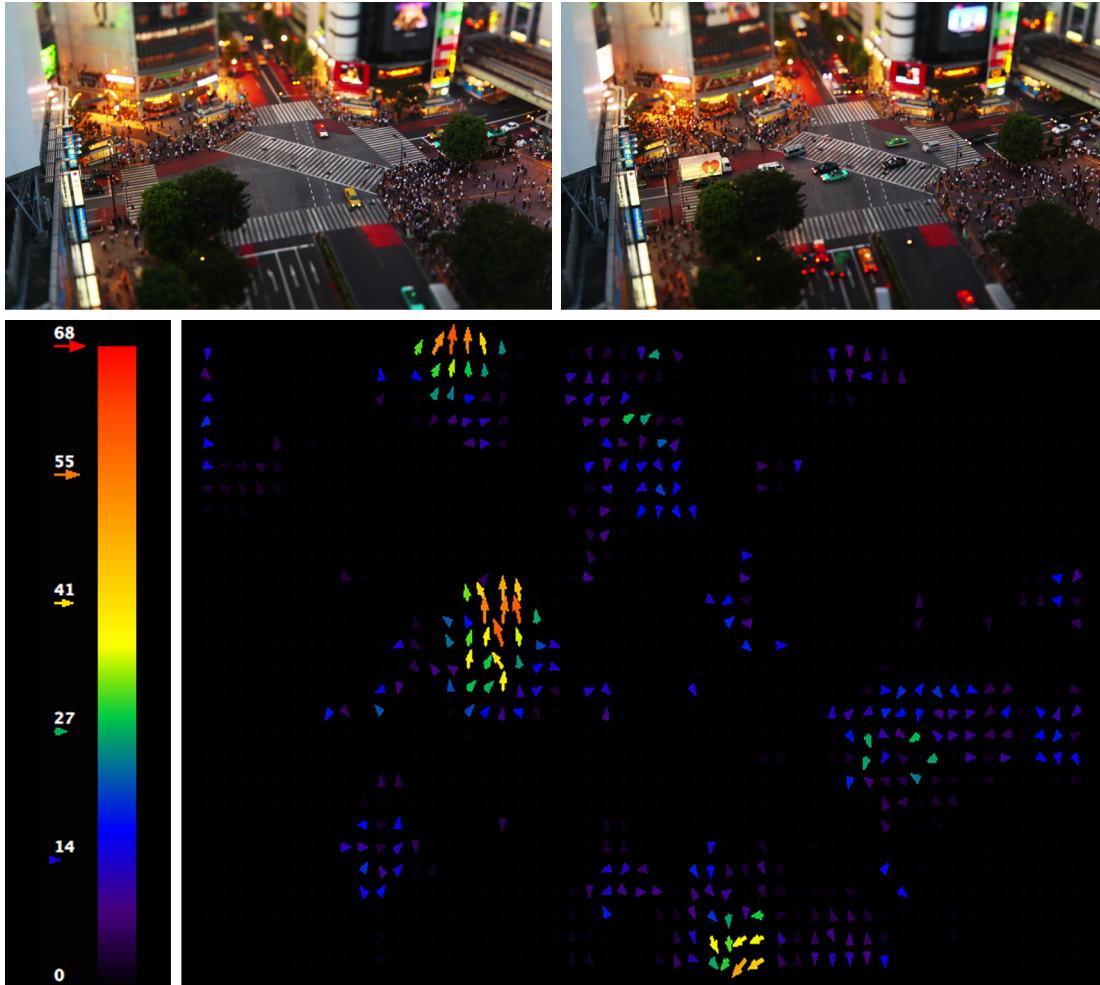


Fig. 2.5. Top: Single stills from webcam footage of Shibuya Crossing, Tokyo, Japan. Image: Forrest Brown/Shutterstock.com. Bottom: PIV analysis of optic flow between the same two images.

Levels of image colour and luminosity therefore underpin this type of image-based analysis. The capacity to describe spatial luminance as height for a three-dimensional surface plot allows these values to be visualised and tested against those of another. The benefit of this function is that it allows the status of the individual colour channels to be observed well as the relative luminosity levels of different spaces to be easily compared. This function is, in turn, supported by a binary converter and a particle assessment function, the Floyd Steinberg Dithering Algorithm (Figure 2.6). Similar to a recent approach outlined by Scheepens et al (2016), in which directions of traffic flows are visualized using a particle system on top of the density map, here the image data is converted to binary form and subsequently counted and measured according to the maxima of luminance. In this case luminance is defined as weighted or unweighted average of the colours (Ferreira & Rasband, 2011). The advantage of this approach, however, is that the combining of processes adds high-level quantitative support data to other qualitative data, thus generating a new hybrid mode of urban analysis that draws upon a broad variety of complex and unedited urban conditions.

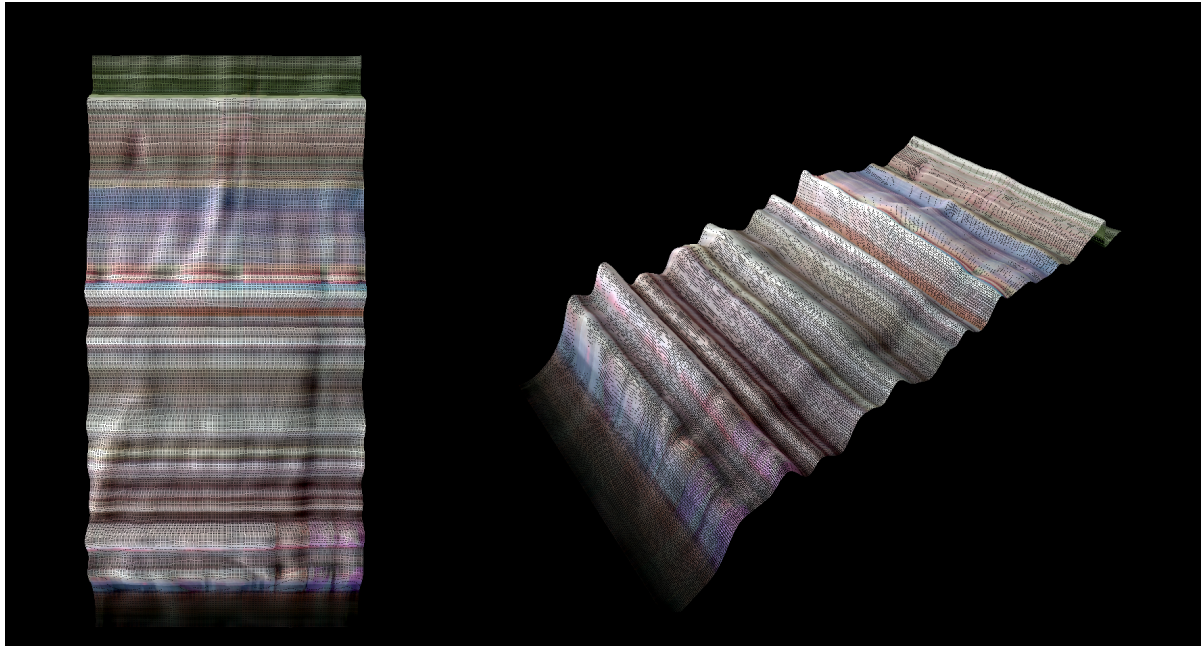


Fig. 2.6. Luminosity surface plot visualisations of the sum of images in a stack of Shinjuku district, Tokyo, Japan processed using *ImageJ's* Interactive 3D Surface Plot plugin. Original image: Tokyo Motion/Shutterstock.com.

3. The material city

In the essay *Too Blue*, Brian Massumi (2002) argues that colour cannot be quantified because its complex properties resist its reduction to a single idea. This is because the idea of a colour held in the memory exceeds the *testable* meaning of the word. He goes on to explain that, as a correlate of colour, brightness is an equally uncontrollable phenomenon, dismissing the exclusion of its aberrational forms, such as glare and diffraction, from current modes of representation as a reductive and normalising approach. “The ‘anomalies’ of vision can’t be brushed aside for the simple reason that they are what is *actually* being seen” (Massumi, 2002, p. 162). For Massumi, ambiguity within the perceptual field thus opens up the potentially limitless production of affective conditions in which urban dwellers reside and which are an indispensable part of any data-gathering process in this space.

With the city’s qualitative visual properties now readily translatable into data, a new approach to the design and manufacture of its material surfaces also becomes possible. The emergence of an indexical relationship between the digital image and the urban landscape now means that the image not only *informs* future form, but form can affect the numeric values within the image. However, for affect to be truly affective, in the sense that it is “*other than* conscious knowing” (Gregg & Seigworth, 2010, p. 1) and about multiplying the ambiguity and complexity of urban conditions, then it is only through a combination of the capacity of the material surface to involve the full spectrum of viewed conditions, including its aberrations, and the visioning technology that present these conditions to a global audience in an unedited form, that the data for a comprehensive picture of urban space for analysis is possible.

3.1 The Urban Surface as Qualitative Colour

The generative capacity of the *space-time* image stacks made visible by *ImageJ* as discrete sectional views is further extended by its ability to abstract image content as temporal patterns of colour and brightness. In a departure from conventional data-assessment visualisations, here complex urban conditions unfold as a single strip or a multi-tiered colour profile of the recomposed urban landscape (Figure 3.1).

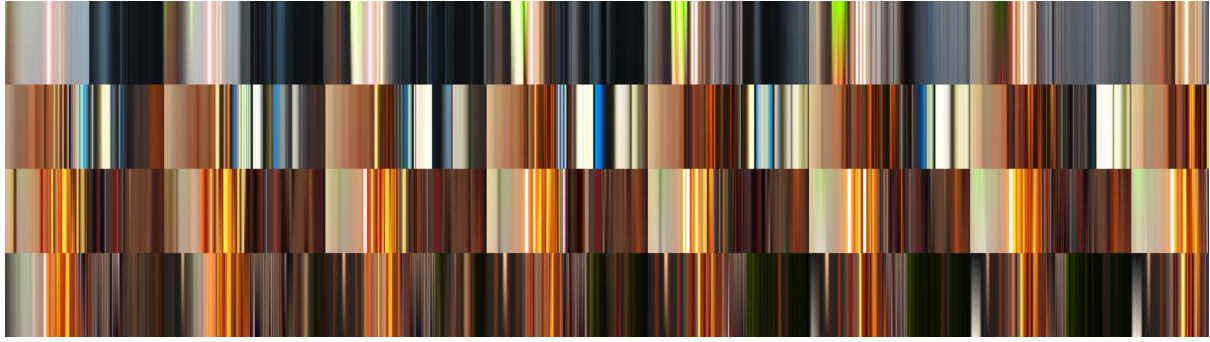


Fig. 3.1. Montage of image stack slices of Shibuya Crossing, Tokyo, reconfigured according to properties of colour and luminosity. Original image: Forrest Brown/Shutterstock.com.

Just as they offer a high degree of scrutiny in a medical context, so can individual *slices* or images from the different axes of any image stack be extracted for design-related analysis using the *Re-slice* tool design. Therefore, broadly speaking, given the quantum of activated flow in Shibuya Crossing, the progression of colour and brightness in a stack of images can, in the same way, also be individually extracted and understood in this case as shifts in urban materiality and traffic flow. This type of mapping tool thus represents programmatic changes of all kinds; human and vehicular circulation patterns, as well as the effects of urban activation outside and inside buildings.

For the designer, this type of reconfigured image content also gives a precise insight into the more complex urban conditions to which an intervention might respond. These might include conditions associated with its visibility, such as its materiality (colour and texture) and its visibility over controlled intervals of time (brightness). As an example of this, a building might be required to stand in high contrast to its surrounding context, in which case a choice of materials and surface activation would be selected to function in opposition to that of its neighbours within a specific temporal frame. Similarly, a requirement for low visibility would mean a selection of materials and surface activation that is indistinguishable from the building's immediate context. The same process can be used to understand different time spans and therefore can provide either a more detailed and specific level of information, such as an extended time span of twenty-four hours. Applying this process according to the camera angle and location, the designer can identify precise temporal shifts in the city's material surfaces and how they interact progressively.

The extended capacity to explore the content of the various axes of an image stack axes is also offered by this software's previously mentioned *Z Project* function. The synthesis of the colour and brightness properties of the city are here presented in a single conflated and highly affective image that bears *ghostly* traces of the transitions in material and human activity which occurred in this particular space over a specified time span (Figure 3.2). While on one hand the images offer a new insight into the continually evolving material character of the city, on the other they present composite data that can be readily quantified to support projective engagement in its future design functionality.

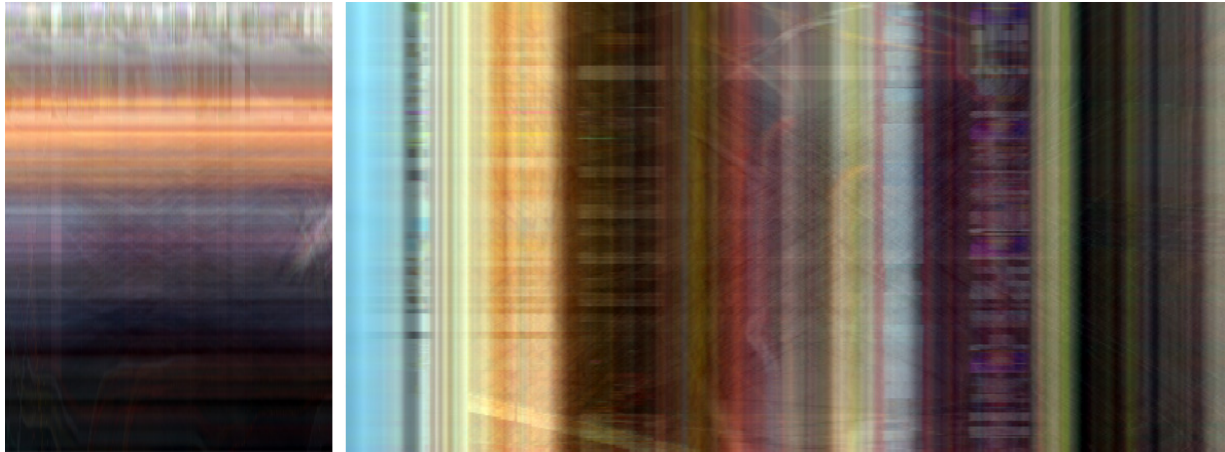


Fig. 3.2. Conflated projection of image stack along ZY (left) and XZ (right) axes of an image stack of Shibuya Crossing, Tokyo, Japan. Original image: Forrest Brown/Shutterstock.com.

Furthermore, the global distribution of the Internet webcam network is such that this process can also be used to compare the conditions of one location with those of different locations at an international level. This facilitates the comparative assessment of urban space to be made within an identical temporal frame. This type of process would thus be able to deliver the means to make projective design decisions based upon this data. The capacity of the webcam's image-making network to support the ready cross-referencing of different urban conditions, both at a local and global level, thus provides the means whereby the complex conditions of modern life in one location can readily index and cross-pollinate those of another.

The abstract image or series of *colour profiles* of the city means that it is no longer recognisable in its traditional form. The new dominance of its qualitative aspects, in which the internal arrangement and hierarchy of image content is redistributed as colour and brightness, therefore also means that this process dismantles the capacity of pixel grouping to support any traditional urban narrative. This, and the deliberate inclusion of image artefacts such as blurring and colour aberrations, distance this type of urban picture from the highly curated properties of the promotional image, bringing a new type of urban visualisation into the design arena whereby the city's diverse conditions are made visible. Importantly, the unique assemblies and compositions that make up this new qualitative urban landscape also connect the designer to correspondingly new and unique types of formal and material assemblies that reveal these previously hidden qualities. The ability to see the temporal evolution of this data further transforms the ways in which design intervention within urban space can therefore be addressed and understood.

3.2 The Urban Surface as Quantitative Chroma

In the same way that this software synthesises and presents a hybrid qualitative and quantitative data set of urban flow, so does it enable the same to be undertaken for urban materiality. The assessment of colour intensity and emission of any *viewed* urban space can be undertaken to a high degree of accuracy using traditional modes of colour weighting assessment that quantify the individual RGB colour channels in the image. If image colour content is traceable to the various differentiations in materiality throughout the captured space, then this is an accurate means of assessing and quantifying the contextual behaviour of physical surfaces located within that space.

The modelling of the colour content of urban space as a three-dimensional interactive made available by *ImageJ's* Colour Inspector plugin allows the colour distribution of a space to be

understood as an interactive model according to a variety of optional colour spaces. (Figure 3.3). In design terms, this means that progressive material shifts in the city can be identified through a highly articulated temporal model, which further enables an intervention to be tested contextually.

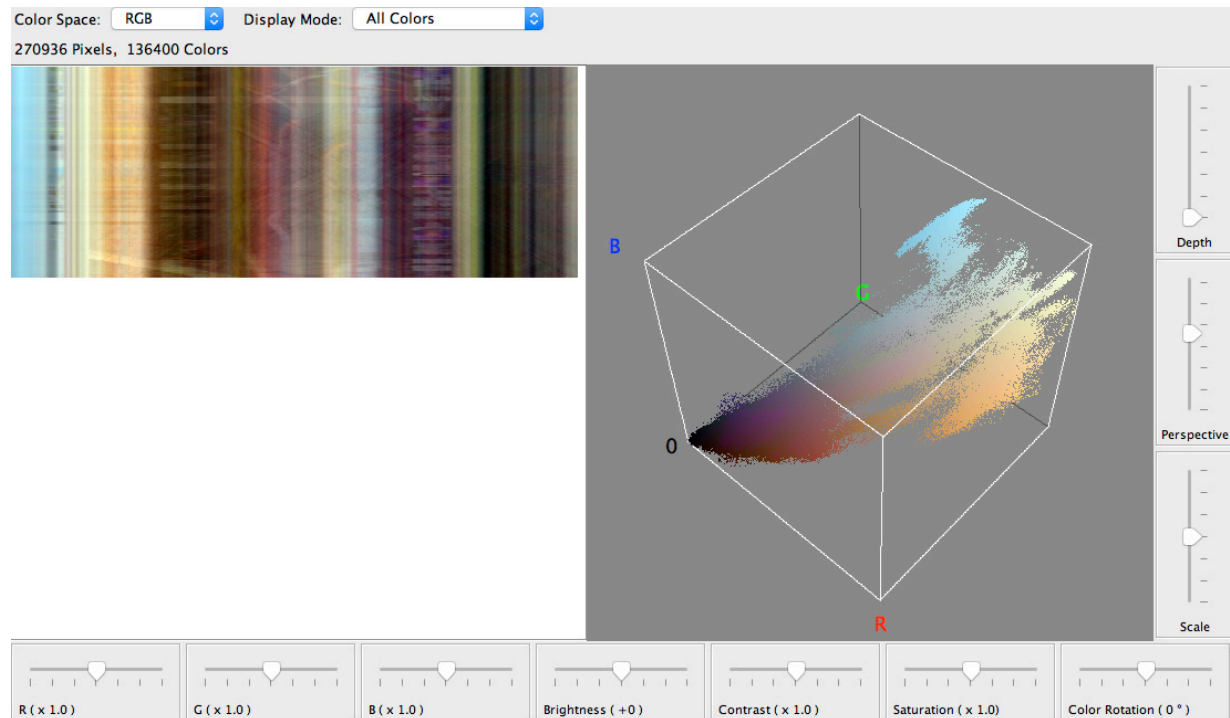


Fig. 3.3. *ImageJ's* 3D Colour Inspector function showing progressive shifts in urban materiality over a prescribed interval of time.

4. Conclusion

The generative capacities of the image are made possible by two key aspects of digital image-making: the pixel-based structure of the image and the image-making technology of the webcam. The ability to assign a numeric value to all types of urban conditions captured by the Internet webcam means that the image is a highly adaptable interface for the quantification and assessment of its real physical counterpart. In this respect, the *scaled-up* application of medical imaging software as an urban analytical tool not only provides the designer with a temporal platform that can scrutinise the appropriateness of a proposed intervention in a constantly evolving and complex range of urban conditions, but the extension of its fine-grain, image-based analysis capabilities means that more ambiguous and often-disregarded properties of urban life are able to contribute to form part of a more comprehensive and holistic data set.

Assessing the city terms of its more qualitative aspects of colour and light also transforms the ways in which design intervention within urban space can be approached. The inclusion of data about the evolution of a city's more qualitative aspects, of its programmatic activity and its material surfaces, radically shifts the type of design intervention that can be made here. The digital multiplication of urban space thus produces entirely new conditions for the data-gathering procedures used by those who design it. It also presents a completely new formal language to the discipline. Drawing upon the properties of the HVS as the terms of reference for formal discussion is a radical departure from traditional linear-based design language. Instead it is now the data associated with the relationship between an object's colour,

brightness and shape that informs design decisions and the synthesis of quantitative and qualitative data that sets a new benchmark for the assessment of complex urban conditions.

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