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EXPLOITING INSTABILITY

Reconfiguring digital systems

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Abstract. The transmission technologies of digital environments propagated by the Internet, specifically the ubiquitous webcam system, present new material to mediate people's engagement with civic space and simultaneously offer new ways to materialize its three-dimensional form. Recent research shows that the technical functionality of the webcam can be extended through deliberate intervention within the performance of contemporary camera optics. This suggests the development of new techniques for design intervention that operate in direct relationship to the evolution of the very technologies they exploit. With specific focus on the optical and chromatic translational capacities of the camera, the paper will discuss how the manipulation of its colour receptor mechanism not only provides the designer with an opportunity to exceed the constraints of commonly available colour palettes, but also it will show how this digital disruption actively capitalises upon the discrepancies that govern design strategies applied to formal production within coexistent virtual and real-time space. Through the deployment of colour filter array patterns, this new technique is able to extend the working gamut of RGB colour space in a way that that allows chromatic selection for exterior and interior urban space to be linked to programmatic distribution across duplicate environments.

Keywords. CCTV; webcam; virtual; array; discrepancy.

1. Introduction

In his essay 'Scopic Regimes of Modernity', Martin Jay (1988) argues that rather than being defined by any single visual space, the contemporary visuality model comprises several simultaneously occurring and highly competitive visual subcultures. For Jay, the coexistence of conflicting methodologies for mediating the view of habitable space to the observer is a highly productive and rewarding condition which offers a superlative platform for the generation of future visual modalities. With this in mind, a significant component of any visuality paradigm is the method according to which colour is delineated and assembled into imagistic representations of life contextualised by environment. In a contemporary frame, this chromatic delineation occurs when colour is mapped onto a discrete virtual colour space by a digital system. In accordance with Jay's observations, multiple coexistent colour spaces, working in conjunction with specific aspects of transmission technology, currently define our understanding of colour and determine its use within the public domain.

This paper will argue, despite the seeming diversity of these mechanisms for colour dissemination, that the instrumentality of chroma within the digitally transmitted image is achieved by reliance upon predetermined and stable structures. Furthermore, it will discuss how these structures exclusively support the interest of proprietary groups and marginalize individual experience. In response to this, the paper will demonstrate through a series of design-based tests that the deliberate manipulation of these digital transmission technologies allows the designer to exceed and contest any imposed viewing condition. With specific focus on the chromatic translational capacities of the webcam propagated by Internet Protocol, the paper will reveal how the manipulation of its colour receptor mechanism provides the designer with an opportunity to exceed the constraints of traditional colour palettes. Thus, through the exploitation and disruption of its own internal architecture, this digital system is able to offer the designer new opportunities for the reinterpretation and assembly of chromatic palettes that work to compose a dynamic and diverse urban space.

2. Colour space

2.1 FIXED COLOUR SPACE: PROPRIETARY COLOUR AND THE NOTION OF 'COLOUR HARMONY'

Colour software and its complementary hardware are inextricably bound into prescriptive and pre-determined relationships exemplified by the sRGB colour space, or standard RGB, created cooperatively by Hewlett-Packard and Microsoft for Internet use along with the ubiquitous Adobe RGB colour space. In these scenarios, colour palettes are accorded themes based on fixed 'harmonious' assumptions made by the software producer on behalf of designers who work with contextual themes to achieve a particular user response to either a location or a product. An example of this is the Adobe Creative Suite and its sister site Kuler, which provide the designer with literally hundreds of thousands of predetermined Adobe colour palettes via an internal link. However, Kuler is only one of many applications that facilitate and propagate stable colour solutions to designers. Both ColorSchemer Studio and ColorImpact identify colour harmonies for the web creating palettes from photos using over a million pre-existing color schemes.

Furthermore, specific aspects of translational camera hardware such as the colour sensor mechanism also guarantee a stable and unchanging viewing experience. This mechanism acts in conjunction with software to produce design outcomes where the relationship between interior and exterior urban space becomes synthesised into an undifferentiated experience: one where design choice is imposed from without rather than being the product of autonomous decisions made by the designer in response to location, program and materiality.

2.2 UNSTABLE COLOUR SPACE

2.2.1 Colour hardware

The principal research strategies employed in this paper investigate the potential of the IP webcam system to facilitate the disruption of the stable and proprietary urban view that it traditionally propagates within the public domain. The strategies that arise from this investigation will therefore contribute to a broader series of productive tactics that allow the designer, through the manipulation of viewing conditions, to extend the application of working colour space in formal interventions within urban space.

The focus of this research, therefore, is the camera's colour receptor mechanism: the CCD sensor, and the colour filter array pattern located within it. The colour array is located above the pixel sensors to capture colour information and convert it to a full-colour image. The most common array is the Bayer filter with a pattern of 50% green, 25% red and 25% blue, which is used because it produces both a stable and predictable outcome and it is compatible with the numerous software applications made available for image translation. However, there are multiple alternative array assembly options within the context of an additive colour environment that have the potential to produce diverse chromatic outcomes. These patterns can be deliberately manipulated to produce both unexpected and highly strategic results that are directly linked to the visibility of anything captured within the camera's field of view. (Figure 1)

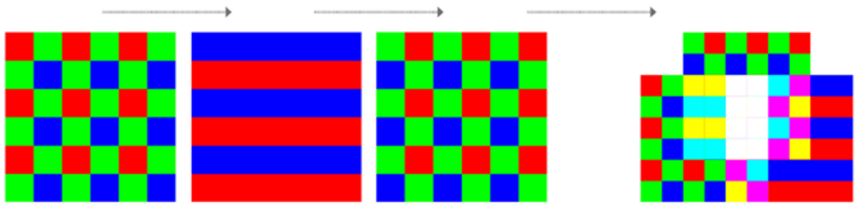

Figure 1: Bayer array pattern (left) with variations combining to produce new colour options.

2.2.2 Interference

Because the camera lens focuses the light from a single point within the image frame onto each pixel which then generates a charge proportional to that light, it follows that there is a direct relationship between the patterning within the received image and the patterning within the camera filter array. Put simply, because the charges created by the pixel array are a faithful and exact reproduction of the pattern of the transmitted image, then consequently any manipulation of pattern regardless of scale within the actual physical view will affect or disrupt its virtual counterpart.

An example of this would be the incorporation of the two complementary colours within the RGB additive colour model to the third colour at each location within the traditional Bayer pattern. In this case, the addition of red and green to blue at any location of the physical representation of the pattern [such as a building façade] would theoretically produce white or invisibility i.e. no chrominance, simply luminance when it is captured by the image sensor. (Figure 2) Similarly, the random addition of complementary colours to a third colour within the locative constraints of a specific patterning would also produce unexpected chromatic results. Thus by embedding an array pattern within the formal view, both a building's visibility and its effect are able to be strategically controlled by manipulating the relationship between its materiality and the technology that mediates it to the public. This discrepancy that is then established between the building's operation within the virtual and real environments begins not only to subvert the traditional, predictable experience of colour, but its effect also can potentially engage the viewer in a new and diverse experience of urban space.

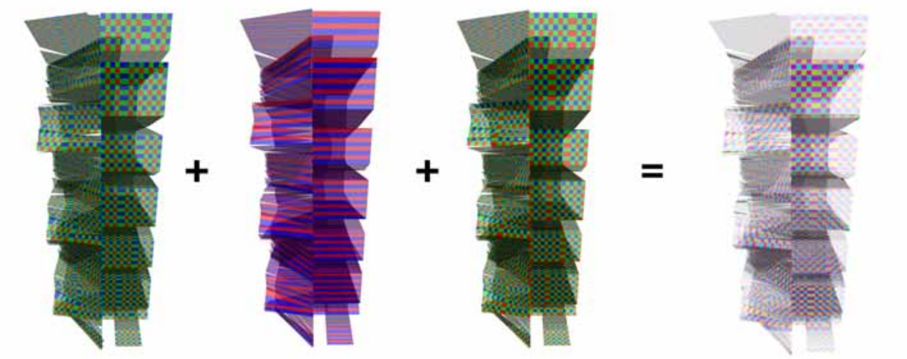

Figure 2. The strategic incorporation of complementary variants of the Bayer filter array pattern into building facades can produce both unexpected chromatic results and diminished visibility when viewed over the Internet.

3. Colour filter array tests

3.1 CONDITIONS, CONSTRAINTS AND OBJECTIVES

3.1.1 Hardware specifications and comparisons

The colour filter array tests were conducted using a Sony SX43E Handycam Digital Video Recorder. The operation of this technology is identical to that of the Sony SNC-RZ50N network camera with the exception of specific operational capacities which are detailed as follows and which were taken into account when calculating results.

Table 1. Comparative camera specifications.

	Sony SX43 Handycam	Sony SNC-RZ50N Network Camera
Sensor	CCD 1/8”	CCD ¼”
F range	1.8 – 6.0	1.6 – 3.8
Zoom	60 x optical / 2000 digital	26 x optical / 312 digital

The camera features critical to specific tests are the zoom factor, in this case, the physical movement of the lens mechanism; the f-stop range which determines the quantity of light that can pass through the lens; and the sensor size which determines both the number and size of the pixels. For the purpose of these tests, the network camera's lower capacity for depth of field and therefore ability to resolve image definition is offset by its larger sensor size and lower f-range which increases its ability to absorb light. Put simply, the network camera is designed for low light conditions with fewer light aberrations because of security issues, however its ability to resolve images and colours is broadly equivalent to that of the Handycam.

3.1.2 Test constraints

- Zoom factor - the test results of interest are between 1x and 26x which is the area of operational parity between the two camera mechanisms.
- Light source/aperture plane distance is at a relative scale of 1:10. i.e. a 3 metre light source/aperture plane distance in the test correlates with a 30 metre distance in an exterior environment. Likewise, the colour array patterns used are 150 x 150mm to correlate with a typical building façade element of 1.5 metres height at the same relative scale.
- The lighting source are three American DJ FS-1000 Followspots with ZB-HX600, 120V 300W Halogen Lamp.
- The tests are conducted in low ambient light conditions to simulate urban night conditions.

3.1.3 Test Objectives

Two types of tests were conducted using the Bayer array pattern and two variations of it applied as a highly translucent material to 3mm acrylic base, much the same as a theatre light gel. One of the strategies behind this selection of patterns was that when all three patterns are assembled in a direct line before a light-emitting source, each pixel component, when superimposed over its corresponding location in the successive patterns, adds to produce white light or extreme luminance. (see Figure 2) In the tests, this meant that not only could potential aberrations be observed within the performance of the individual patterns acting in conjunction with the camera lens, but when all were assembled at a specific focal length, the effect of their combined light emission should theoretically be white or zero visibility. Further to this, the addition or subtraction of one or more of these patterns then opens up the possibility of manipulating any combination to suit particular design requirements, such as the linking of programmatic arrangement with colour and its subsequent variable Internet visibility.

The second test involved the strategic location of the individual arrays in response to both camera location and angle. In this test, the patterns were each placed at a 30° angle to the camera and their collective light emission patterns were recorded on a white board at a standard three metre distance over a range of zoom factors. The board was then replaced by the camera at precisely the point where the collective emissions of the patterns at those angles produced white. The intention was to see the result of the combination of the illuminated array patterns in relation to a range of zoom factors and also in relation to their angle of incidence to the camera lens. All test results were assembled into montages of progressive still frames using *ImageJ* non-proprietary medical imaging software.

3.2 TEST 1 – INDIVIDUAL AND ASSEMBLED ARRAY PATTERNS

3.2.1 *Results*

- In the individual pattern tests, in the 1-26x zoom zone, blue dominates over red in patterns 2 and 3 even though there are equal amounts of blue and red.
- This is reversed when these patterns are observed by the naked eye where red dominates over blue.
- In both the individual arrays (Figure 3) and the assembled arrays (Figure 4) an aberrant chromatic transition occurs from blue to green. This feature occurs within the zoom zone that is common to both cameras.
- This transition only occurs on the inward zoom: the phenomenon does not appear during the reverse action on the outward zoom. (Figure 4)

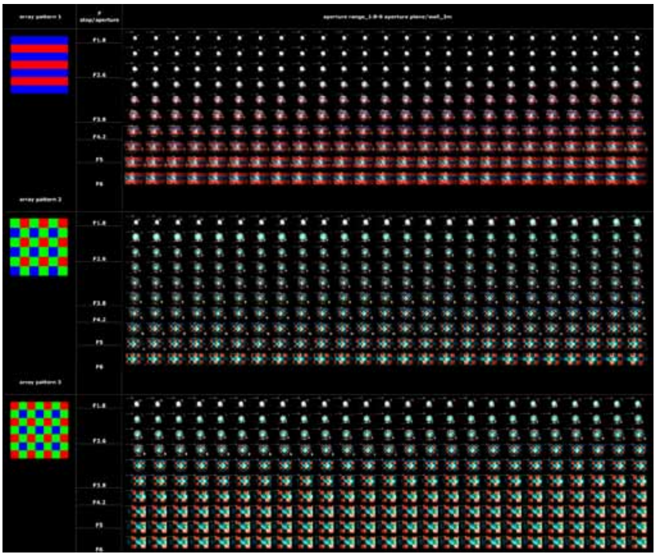

Figure 3: Individual array pattern recordings showing dominance of blue between F1.8 and F2.6 in patterns 2 and 3. Results above F3.8 lie outside the range of the network camera.

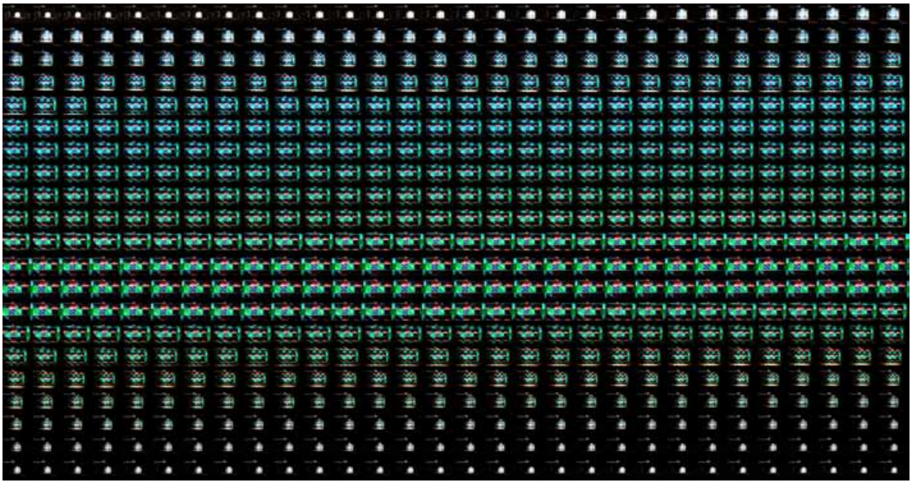

Figure 4: Assembled filter array patterns showing aberrant transition from blue to green.

3.2.2 *Observations*

The dominance of blue over red seen on the progressive camera images, which is the reversal of the view seen by the naked eye, opens an opportunity to control surface colour/visibility within a virtual environment and therefore to produce vast differences between the virtual and the real views. The aberrant chromatic transition which occurs in the individually recorded pattern test, and to a greater degree in the assembled pattern test, provides similar opportunities to link visibility and colour within the view to the camera's zoom function.

3. 3 TEST 2 - ARRAY PATTERN LOCATION AND ANGLE

3.3.1 *Results*

- When the patterns were illuminated separately on the board the pattern produced a strong effect (Figure 5).

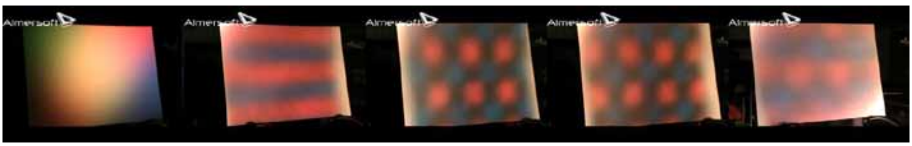

Figure 5: Far left: RGB colour emission without pattern; Centre: 3 individual pattern colour emissions; Far right: combined pattern emission showing diminished strength of colour.

- When the patterns were collectively illuminated on the board their strength began to diminish severely and approached white.
- This same effect was repeated when the camera was placed in the same location as the board. (Figure 6)

Figure 6: From left to right: zoom camera view of patterns when placed in same location as board. The image on the far left shows diminished colour to correspond with the reduced level of colour in the image on the far right of Figure 5.

- This effect this does not occur when viewed by the naked eye
- This effect only occurs at specific distance from the camera/zoom factor.

3.3.2 *Observations*

The combination of selected array patterns placed at a specific angle to and distance from the camera lens can produce zero chroma. This means that visibility/colour can be controlled by the deliberate selection of array patterns to interfere with the camera's receptor mechanism at pre-determined angles and distances.

4. Conclusion

The chromatic performance of the received virtual image can be controlled by strategically aligning material aspects of elements within the camera view to the camera's colour filter array pattern. This opens the possibility of linking the programmatic distribution of these elements within the image to a materiality that is determined by the designer rather than one determined by the pre-determined constraints of software and hardware. This potential orchestration of mutually informing spaces, by drawing attention to the variations and inconsistencies between the virtual and physical environments, not only extends the repertoire of design opportunities for urban intervention, but it also contributes to the experience of a contemporary habitable space that is constantly evolving and complex.

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