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Pixels, bits and urban space: Observing the intersection of the space of information with urban space in augmented reality smartphone applications and peripheral vision displays

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Abstract

Today the urban environment can be seen as a mix of technically mediated elements and actual physical locations — the city is techno–synthetically composed. The method of observing the production of space, as asserted by Lefebvre, must take into account physical and non–physical spaces, produced out of the coexistence of everyday life and activities with the space of information. This paper explores the merging of bits and bytes with the urban environment and uses augmented reality applications for the smartphone and peripheral vision displays as case studies to illustrate how the method of visually layering digital graphics on to the image of actual space produces a new kind of spatial commodification.

Contents

Introduction: The urban environment as techno–synthetically composed

Today, the merging of physical space with the digital world of information creates a new urban environment that is techno–synthetically composed. The smartphone makes use of a combination of networks, radio frequencies, stationary data processors, fixed antennas, satellites and software. All these technologies combined allow the smartphone and its applications to deliver and transmit data. Therefore, the urban environment can be thought to coexist with digital data sent and received between people, devices and systems. The world of data and its technical infrastructures (physical and non–physical) can be thought of as a space in which communication between devices and data takes place. Places are enriched with electronic information because data are now accessible at anytime and anywhere, given a portable data processing device. Furthermore, QR codes are placed in numerous places in the city creating 'hot spots' that offer information about specific locations. The urban environment is redefined — the urban environment is changing not only in its appearance but in the way it is used, accessed and lived by its inhabitants.

During the '00s, and in literature of locative media and location–based games, Lefebvre's triad appears as a relevant theme in the discussion of spatial perception through the use of locative and wireless technologies [1]. Lefebvre's theory of the production of space becomes relevant during this time precisely because it sets out a method with which to investigate the production of space within the urban environment, as the use of the space of information increases and becomes part of the rhythms of everyday life. It offers the framework in which to investigate the newly found relationship between the urban environment and the space of electronic information, and thus investigate how space itself is changing. The space of information intersects with everyday rhythms and becomes an integral part of the lived experience. Just as Lefebvre asserts that we must study rhythm as laid bare by the dynamics of representation, in the same manner this paper is concerned with the way the lived experience is

formulated by representations of space on the smartphone screen.

For Lefebvre, "technology plays a mediating role in the production of space" [2]. Lefebvre asserts that representational spaces overlay with physical space [3] and that the bodily lived experience [4] eludes the perceived physical space. In the spatial analysis of the urban environment we must include the non–physical spaces; what Lefebvre calls mental spaces, which are associated with the abstract: that is the space of power and capital [5]. As the rhythms of the city change and are intertwined with network and communication technologies and smart devices, Lefebvre's method in observing social space — via the study of rhythms and representation practices founded within urban space — needs to be modified to include: representations such as graphics that direct and inform; dynamic surfaces and interactive building facades; and other interactive spaces created by network and communication technologies. This paper uses augmented reality smartphone applications and peripheral vision displays (PVDs) as case studies that illustrate the merger of the space of information with the urban environment. As will be shown, whereas locative media projects and games of the '00s portray a potential to escape the monumentality and the narrative representations of abstract space [6], in AR applications and PVDs of 2010s these are reaffirmed and augmented.

Section 1: Lefebvre's triad

In *The production of space*, Lefebvre presents "the historical processes of the social production of space" [7] and offers analytical tools for its investigation, especially in relation to the way "a living body produces space by deploying its energies" in society [8]. Social space for Lefebvre is defined by his now famous triad of the "three moments of social space" [9]. In brief; spatial practice is perceived (physical spaces), representations of space are conceived (mental imaginary spaces), and representational spaces are a lived experience (sensory and mental appropriations of space). Lefebvre's elusive writing style and reoccurring definitions of the triad, explain the slight differences in its interpretation by Lefebvrian scholars [10]. A spatial practice can be thought of as the practice of linking separate places together. For example, it is through the linking of actual networks, roads, routes and intersections that spatial practice is perceived. "Spatial practice it is observed, described and analysed on a wide range of levels: in architecture, in city planning or 'urbanism', in the actual design of routes and localities, in the organisation of everyday life, and, naturally in urban reality" [11]. Spatial practice is the spatial articulation of civic control expressed in the geographical distribution of city planning, joining cities, agricultural land and the periphery and their connection to centres of production. A representation of space can be conceived through the understanding and acceptance of the relative oppositions between the real and the imaginary. For example, in Renaissance painting perspective is employed to represent depth and volume in a two dimensional surface. In representations of space, space is conceived through an order of signs, codes and "frontal relations" [12]. Maps and all kinds of "graphic representation or projection" [13] are representations of space, which can be seen as communicational and information systems, "conveyed by images and signs" [14]. Representations of space can be thought of as expressions of social practices carrying in them relative relations between knowledge, understanding and ideology [15]. For Lefebvre we move towards representational spaces, where historic change and socio–economic relationships are abstracted within the realm of imaginary and symbolic meaning used in representations of space. Representations of space and representational spaces have a close relationship, as the latter employs the former in its signification in order to create meaning; they "reference from the one to the other and back again" and this oscillation "plays an ideological role but replaces any clear–cut ideology" [16].

Representational spaces are monumental but they also include a combination of bodily senses and lived experiences. A representational space can be lived as a mental and bodily experience but with the parameter that within a lived experience 'culture intervenes' [17] in its interpretation. The lived representational space, therefore, is an all–consuming process of feeling, seeing and apprehending reality, and hence social space. The relational opposition and unity of representations of space and representational spaces create a calamitous tendency to narrate and abstract space. All three are always in relative opposition but entangled.

Taking Lefebvre's theory, this information space [18] is perceived as a network of interconnected infrastructural components, such as satellites, cells, base stations, devices and people. It is conceived through representations of space in the form of the screens of smart devices and interfaces such as maps and other graphical representations, and it is lived as an everyday experience by using it to regulate daily activities such as family life, rendezvous and work related tasks. Looking at the urban environment as techno–synthetically composed illustrates the now established coexistence of the information space as a technical infrastructure that transmits data; the multiple spaces of communication between people; and the interaction of dynamic objects in the city (*i.e.*, building façades, urban screens) with the rhythms of everyday life and activities. In this newly composed urban environment, information, data and media are intertwined. Urban space, in other words the lived experience of the city, is now produced in conjunction with the space of information that is used in everyday life and the technical infrastructures that support this.

Section 2: Spatial theories, ’90s and ’00s

The locational qualities of the space of information, and the way that it is overlaid onto the actual physical space of the city, make it different to cyberspace. The difference today is that content is generated ‘on the fly’ — whilst people are going about their everyday lives. Instantaneous, mobile and wireless technologies are reforming the spatial experience of the urban environment and changing the assumptions of global connectivity. It has been said that, “By the early 2000s, bits had returned from cyberspace. They had gone on location in the material world” [19]. In the cyberpunk culture of the ’80s and ’90s, the mind’s full immersion into the virtual world of information was achieved by depriving external sensory stimulations and using virtual reality components such as gloves and helmets [20]. The body remains in physical space whereas the mind navigates cyberspace. Today, using the smartphone, the once disembodied experience of communicating with others online has transgressed and is now coupled with mobility and location specific interaction. Mobile access to instantaneous reception and transmission of data changes the way urban space is articulated.

During the ’00s, literature in mobile phone culture identified the existence of an additional space. This concept arose from the observation of mobile phone users who negotiate between the private space of their conversation and the public space they are situated in [21]. For Castells, capital and networks work together to create an all–consuming plane of production with no apparent centre, “The space of flows links up electronically separate locations in an interactive network that connects activities and people in distinct geographical contexts” [22]. For Graham and Marvin the uneven distribution and access to networks and built infrastructure creates the effect of Splintering urbanism, when urban centres with well–established network technologies operate at the expense of less developed places [23]. For Manovich, Augmented Space includes data space, cell space and locative and mobile technologies that allow intersecting with the flow of information and data. “Cell space is physical space ‘filled’ with data, which can be retrieved by a user via a personal communication device” (Manovich, 2006). The emergence of this new space has also been thought conceptually as a hybrid city, where physical and digital spaces merge due to using mobile technologies as social devices [24].

Furthermore, the merger of data (bits) with the city concerns current research. Gordon and de Souza e Silva (2011) examine how localities become networked through location aware technologies [25]. Gordon (2010) sees Hollywood as a database city, not only because there is a vast array of information available online about this place but also because visitors and residents can relate to places by accessing information whilst being in that specific location. Equally, Frith (2012) argues that with the smartphone the world of digital information and space have merged; the digital has become part of the physical [26]. He asserts that with location services, “the experience of the city as a representation through the mobile screen” becomes personalised [27] and that with smartphone interfaces the city is transformed “into a new type of database city” [28].

All these arguments are examples of thinking about additional spaces created by networked technologies. They are spatially attributing because they depict and illustrate added spaces, and the transformation of existing ones, brought forth by the addition of networked technologies that are accessible in a particular locality. Places themselves become richer with electronic information, because of the intertwining of these spaces. These multiple spaces are physical, non–physical and mental spaces that exist as part of urban space. On a global scale, these are the imagined space of a mobile phone conversation, the splintering effect caused by the uneven development of city infrastructures and the space of flows in which capital and data circulate and alters sense of time (Castells, *et al.*, 2007). Within the urban environment, these are the database city (Gordon, 2010); the hybrid city (de Souza e Silva, 2006); augmented spaces (Manovich, 2006), in which specific locations, large surfaces and building facades become visually stimulating interactive surfaces embedded within the urban environment. The intersection of information space with actual space produces new ways of experiencing the urban environment and spatial practice. Urban space is observed today not only in its actual form; buildings, roads, intersections and the signification of representational practices in architecture and city planning, but also by the integration of physical with non-physical spaces (in which conversation takes place, data travel and all sorts of other digital information are displayed on building facades, LCD screens and billboards). Observing the impact that networked technologies have in the way urban space is produced must be fully articulated and examined to determine their impact on the formation of urban space.

Just as Harvey (2000) asserts that capitalism through fragmentation produces spaces of transportation, leisure etc. which facilitate capital accumulation (Fraser, 2007); and just as Castells (2004; Castells, *et al.*, 2007) suggests that the production and distribution of goods and services changes geographically due to network technologies, it can be said that the use of smart devices in the city produces new spaces and transforms existing places into a mix of physical and mental spaces within the space of information.

Section 3: Locative media, history, maps and urban screens

Locative media projects were systems that combined three elements: location as the physical space the user is situated in; the electronic world of information; and the system for interaction. For example, games were played in the city streets, interactive screens were placed in public space, and digital maps could be annotated by users. It was noted that locative media offer an alternative to conventional cartography and produce a fold between virtual and physical, data space and geographical space; they

do not "just mix realities but produce a reality of their own" [29]. The negotiation between actual physical space, with all of its dynamics and oppositions, and the access to a virtual space of information, in other words the mixing of virtual and actual elements- often called 'mixed reality' because of the mixing of heterogeneous elements — created new experimentations in media art. The possibility to re–appropriate the urban environment by an interventionist approach gave rise to experimentations such as urban screens [30], digital graffiti [31] and digital psycho–geographic maps [32].

Between 2001 and 2004, the artists collective Blast Theory led the field of experimentation in the U.K., and designed games that were played in city streets. Blast Theory employed a creative mix and a DIY approach to a combination of technologies. For instance, a physical board was used, onto which devices were literally pinned, such as a GPS tracker, a PDA and a mobile phone. Furthermore, they designed interfaces for the Web, PDA and mobile phone that created experimentation with mapmaking and tracing technologies. In 2002–2003, 'Amsterdam Realtime', by Esther Polak (NL), offered an alternative to conventional cartography (Hemment, 2006). Based on a Web interface and using GPS, it traced the participants' location and created a psychogeographical map of the city of Amsterdam. Between 2004 and 2008, 'Urban Tapestries', by Proboscis (U.K.), epitomised experimentation of this period as it combined a commercial venture with artistic intent. It incorporated an annotative map, and the content created was contributed and shared by its users. The Situationists, Debord's (1956) theory of the *dérive*, psychogeography, walking as an opposition to the established order of perceiving urban space (Solnit, 2001; Benjamin, 1999), and de Certeau's (1984) spatial wonder and spatial practice, are all relevant to locative media. The psycho–geographic approach of annotative maps and the re–contextualisation of familiar surroundings in location–based games, offer a view as to the potential of these new technologies and their application to create alternative spaces inside the urban environment. In locative media and location based games, by mixing virtual objects with elements from the real world, walking in the city can be seen as a model that can be modified and transuded into a narrative experience, therefore walking and location are re–contextualised and given an additional meaning (Drakopoulou, 2010).

Annotative maps of locative media projects, and the maps of location–based games, act as mediations between actual physical space and the space of information. Equally, with urban screens the use of interactive screens (as a form of agency) mediates between actual physical space and the space of information. Using interactive public screens and intervening on buildings' façades is an established field of experimentation. As opposed to commercial electronic billboards, "the genre of the 'urban screen' has come to refer to those intended for cultural content" (Wright, 2008). Urban screens are installation environments that are representational spaces specifically created for situated participatory interaction within a specific locality. These techno–synthetically composed environments can be seen as new forms of expression within public and urban space. In location–based games [33] the notional game world can be thought of as a layer that is superimposed onto the city surface. Maps depict the location of objects, and other players as icons and virtual avatars. These graphical representations are key narrative features for the game play, used to provide and illustrate the game's social world and help to sustain the 'mixed reality gaming' model as players negotiate between actions in the physical world and the digital game world (Flintham, *et al.*, 2003). As Lefebvre points out, the representations of space are based on the knowledge and understanding of a conceived balance between the imaginary and the real [34]. In these games, representations of space, in the form of maps, portray the coexistence between actual physical space and the imaginary game world. These maps bind together physical space with the artificially added elements of the game–world.

In the same manner, AR applications and PVDs make use of representations of space and employ the model of visual layering (photomontage of digital graphics with the camera image) to mediate between the actual physical space the user is situated in and the vast space of electronic information. Because smart devices and their interfaces require the mixing of different technological components, formats and platforms, visual layering is necessary in order to represent these spatially different entities. Visual layering as spatial annotation is an inevitable method when constructing interfaces that include network infrastructures; communication between people; infrastructural agents (satellites, antennas, base relays), and physical space. Manovich (2002) gives particular emphasis on layers both in the process of creating digital images and in architecture that should take into account "the fact that virtual layers of contextual information will overlay the built space" (Manovich, 2006). Most recently, geographic information systems (GIS) have made use of graphical layers to produce electronic maps that assist historians to visualise a particular time in the past (Cohen, 2011).

Locative media, urban screens, annotative maps and games played in the city; all combined the experience of walking and being in the urban environment with access to the space of information. These mediations observed the merging of the space of information in its totality (infrastructural networks, systems, software, devices, interfaces, stationary processors, antennas satellites) with actual physical space and utilized it — visually and contextually — to create alternative appropriations of the urban environment. Today many of the services and the combination of technologies once employed in locative media are now built–in components on the smartphone. The smartphone's introduction in 2007 (iPhone 2007, Android 2008), saw the total integration of the mobile phone with the Web, mapping and location services, and marks both the end of locative media experimentations, and the beginning of the commercialized application of location–based technologies [35]. In AR applications and PVDs, the use of visual layering in the form of digital graphics superimposed onto the image of actual space, is an illustrative example of the merging of the space of information with the urban environment. As will be shown, these interfaces, in their representations, use significations particular to the branding experience they offer, and mix commercial information with everyday life and activities such as walking, utilizing this merger with a consumerist approach to create a convoluted experience that produces a new kind of spatial commodification.

Section 4: Augmented reality applications

Augmented reality applications on the smartphone, superimpose graphic information onto the camera image, creating a photomontage of digital graphics with the image of actual space. AR applications display the user's proximity to objects, people and places, and reveal encyclopaedic and commercial information about these. For example, they display information about objects and places of interest as well as the distance to and location of amenities, such as shops, restaurants, bars, ATM machines, museums, garages, parking spaces, etc. In augmented reality browsers such as Layar (Layar, 2009, iPhone and Android), Junaio (metaio GmbH, 2010, iPhone and Android) and Wikitude (Wikitude GmbH, 2008, iPhone and Android) different 'filters' or 'layers' can be used to display a specific group of information. There are different kinds of functions that AR applications can perform. For instance; to observe the world around us (*i.e.*, watch the night sky, display encyclopaedic information about nearby places); to locate places, objects, people and things (*i.e.*, point towards the location of bars and restaurants); play games; educate; or provide access to art and community–based projects. These functions can also be combined, for example Wikitude displays both places of interest and encyclopaedic information about these, as well as the location of commercial outlets and amenities such as bars, restaurants and ATM machines. AR applications which are used to locate things, include Tesco Store Finder (on Junaio, Tesco, 2011, iPhone and Android) used to find the nearest outlet of Tesco supermarkets in the U.K. The AR application displays the location of Tesco stores in the vicinity, and is fully focused on guiding the consumer to the nearest outlet. Applications used to observe the world around us include Google Goggles (Google Inc., 2011, iPhone and Android) which, by pointing the camera at an object such as an art painting, a bottle of wine, or a building, displays relevant information on the screen. In the U.K., the Spot Crime AR application (on Layar, Emerging Technology Center in Baltimore, 2009, iPhone and Android) depicts crime incidents in the vicinity of the user, reported by the Metropolitan police, without giving any detailed information or precise location about these crimes. Rather than displaying an accurate map of crime, this AR application serves an audience, and reflects a current anxiety, of modern society.

AR game applications include genres such as treasure hunting, massively multiplayer and first–person shooters. For example, Parallel Kingdom (PerBlue, 2008, Android and iPhone via Google Earth) is a massively multiplayer online role playing game (MMORPG) that uses Google Maps to represent the game terrain, although the photomontage of the camera phone image with digital graphics is not used as part of the game play. SpecTrek Light (Games4All, 2001, Android) utilizes the photomontage of the camera phone image to display virtual ghosts that players must chase and catch to earn points. In March 2012, the Resident Evil AR Application (Capcom, 2012, iPhone and Android) was launched in the U.K., as part of the promotion for a new game title *Operation Raccoon City*. In this game, players could shoot zombies at stations on the London Underground transport system. These games are often called 'trans–reality' games, as they mix the virtual game world with locating real objects. Location–based games in locative media offered an opportunity to reinterpret the familiar and re–appropriate places in the Situationist sense. In AR game applications the blending of the physical world with the world of information is not contextually utilized as part of the game play. In the Blast Theory games, for example, online players were chased by actual street players, allowing them to experience familiar surroundings under a different context. Within the discourse of locative media, projects such as Urban Tapestries and the Blast Theory games are seen as an intervention in the immediate surrounding environment that can bring variations to established ways of perceiving public space. Annotative maps bring spatial awareness and urban screens create a locality of congruent interaction. These techno–synthetically composed spaces temporarily interrupted and reinterpreted the character of a locality, as their context is based on creating new and alternative meanings to places, therefore utilizing this merger visually and contextually.

Most art–based AR applications simply use the gyroscope to produce kaleidoscopic images. An exception is the Virtual Public Art Project (on Layar, Christopher Manzione, 2010, iPhone and Android) that places sculptures, virtually, in public space and invites users to view them by being at that location. There are only a few AR applications that cater for a group of people and are designed to service the needs of a community. For example, the Free Wi–Fi Finder (on Layar, Niobium Labs Ltd., 2011, iPhone and Android) displays available free Wi–Fi spots in major cities of Greece. Contributions are provided by users via Twitter as they discover free Wi–Fi spots in the city, including: hotel lounges, shops, cafés, and university networks. There are even fewer AR applications that attempt to contextualize walking. In the Ph.D.–based work; AR application Audision Holbeck Audiowalk (on Layar, Simon Bradley, 2010, University of Huddersfield), users contribute and share audio narratives about specific places and routes in the village of Holbeck in the U.K. Also, with the Clio AR application (on Layar, Ringas, *et al.*, 2011, Android), that is based on the concept of collective memory, users create, share and hear audio files as they walk around the cities of Oulu in Finland and Corfu in Greece.

AR applications that aim for an educational concept include 'Star Walk' (VITO Technology, 2008, multiplatform) and 'Pocket Universe' (John Kennedy and Craic Design, 2011, iPhone and Android) that utilise this visual layering to display the position of stars and planets that are not visible to the human eye, and allow users that have limited knowledge of astronomy to observe the night sky. By pointing the smartphone above the horizon, the screen's graphics show the exact position of stars, planets and satellites. There is growing research, both in the sciences and humanities, on using AR applications for educational purposes (Li, 2010; Liestøl, *et al.*, 2011). Situated Simulation, Sitsim for short, are AR applications that display buildings, places and ancient monuments as they were at a specific time in the

past and use images, text and audio to provide information about these, making use of Web resources as well as other libraries and databases. For example, when one is located in the Acropolis in Athens, the AR application displays the Parthenon monument as it was in antiquity — colourful and vibrant and also explains each statue and characters in the Parthenon Frieze. Julius Caesar's Funeral on the iPhone (Project leader: Prof. Gunnar Liestøl, 2010, Department of Media & Communication, University of Oslo, Norway) simulates the ancient city of Rome and uses audio and text. It aims to assist archaeologists in visualising the area at a precise year in the past and therefore understand Rome's city planning (Liestøl, *et al.*, 2011).

Lefebvre asserts that in the modern world representations of space, such as maps, convey in images and signs representational spaces such as transportation and communication systems [36]. In the first instance, AR applications can be seen as representations of space; as maps, cinemas and other representational practices asserted by Lefebvre. On a second level they simulate representational spaces as the montage of the camera image, together with digital graphics, is used as a viewfinder to observe and navigate actual space. Digital graphics superimposed onto the image of actual space offer a mediated view of the immediate surroundings, as well as 'go back in time' to observe a representational space as it was in antiquity. On the one hand, these applications visualise elements of the immediate vicinity and facilitate the navigation of actual space. On the other, they offer a mediated view of the world and immediate urban surroundings, making them subject to all kinds of manipulation. This visual layering of digital graphics on the image of actual space, in other words the spatial representation of objects and places in actual space via graphical elements, can be said to create a representational space. In these applications the interface used is a representation of space, whereas what is depicted is a representational space. Observing the city and the sky through the smartphone brings implications to the way in which the city environment is perceived through these interfaces.

In locative media and urban screens discourse, creating representational spaces that involve audience participation allows for the creation of a space within urban space, which manages to escape abstract space as it momentarily reinterprets the character of a specific place by altering its use. The visual representations of commercial AR applications are populated by advertising banners and have a consumer–based logic in the way they display information. These interfaces mediate between the vast information space and actual physical space, as they are made by putting together information that is retrieved by technical components such as GPS satellites, the Internet and other data sources. 'Abstract space [is] the space of post–war capitalism' [37]. Representational spaces serve as abstract space as conceived through the relation of ideology, power and knowledge [38]. Lefebvre inserts that the predicament of space and that of the lived experience is that it gets "crushed" and "vanquished" by abstract space [39]. As representations of space and representational spaces feed off each other to create an abstract space — an all–consuming homogeneous space experienced both physically and mentally — it can be said that AR applications commodify the spatial experience of the urban environment as they mix commercial information displayed on screen with the experience of walking and being at a specific location. By displaying pre–selected types of information and by customizing the vicinity of the user into a consumerist representation, these interfaces employ a user–centred and personalized experience (Tuters, 2012; Chester, 2012). AR applications construct a personalized space of spatial commodification; they become vehicles for the capitalist spatialisation of the urban environment as they combine sensual, visual, physical and non–physical spaces serving the purpose of space fragmentation and space abstraction.

Section 5: Peripheral vision displays

Apple and Google are experimenting with head mounted displays and, more specifically, glasses that layer digital graphics with the user's eyesight (Bilton, 2011). In 2012 Apple patented the "Peripheral treatment for head–mounted displays" for its iGlass device, which is not available to the market yet (Apple, 2012). This system tracks eye movements and, using LCD lights, it projects images to the areas of the user's peripheral vision. It can engage direct vision too, offering both a 'walk around' and an 'immersive experience'. The Google project was launched in June 2012 (Temple, 2012). It has been said that the two major features of the glasses is location information and face recognition (Bilton, 2012). The latter is synced with social media applications such as Facebook and has already raised concerns in the U.S., where an advocacy group for Internet privacy asked the Federal Trade Commission to suspend the project, until the government provides clear guidelines about privacy (Bilton, 2012). A promotional video titled: 'Project Glass, One day' showcases a day in the life of a young male wearing the glasses. Seen from the first–person perspective, as he wakes up the glasses display weather information, news, important emails and other notifications. As he walks the streets, smooth grey and white graphic arrows show which direction to take. A countdown clock shows time to destination. Red exclamation marks indicate social media notifications, reminders of nearby friends, new text messages and e–mail messages. He encounters a poster for a music concert that he scans with the glasses and sets a reminder to buy tickets. He meets a friend for coffee, after having reviewed the comments on a social media site about the coffee, and also pins his location on a social media site. He walks into a bookshop, asks the glasses to direct him to the music section, where he picks up the book 'Ukulele in a day'. The video ends at sunset as he performs a song on his ukulele for his girlfriend via a video call, and then invites her to the concert. All this in one day without taking the glasses off. The time spent to learn to play the Ukulele instrument is not shown on the video.

With peripheral vision displays (PVD), being in the urban environment is mediated through the interface.

The added visual layer of informational graphics, text and social media elements and geo–location notifications — and the fact that, (like every other Google product) willingly or unwillingly, the user's movements and communication are traced and recorded — presents a rather dark future scenario. Experiencing the urban environment through representations that visualise brands and commercial interests creates even more problems in any attempt to distil some sort of autonomous experience of the urban environment. Benjamin (1999), the Situationists, Debord's (1956) theory of the *dérive*, and more recently de Certeau (1984) and Solnit (2001) have all identified the act of walking in the city as a practice that can offer alternative narratives to the given experience of the city. It seems, however, that by wearing PVDs and using AR applications the act of walking is populated by commercial interests — the urban environment now includes representations that visualise brands, and direct the consumer to the nearest outlet. With PVDs or by using AR applications as viewfinders to observe the world and to locate things, the user's eyesight and spatial field are fully populated by commercial graphics and advertising. This mode of representing the city is another way to commodify the spatial experience of the city and therefore of spatial practice. PVDs and AR applications are no different than the practices of commercialisation already enacted online, on smartphone screens and on the city streets in which space is populated by a mixture of consumer–based visual signs and advertising materials in the Baudrillardian sense (Baudrillard, 1983). What is more, they display information already existing on the Internet; they are merely a different computer interface for displaying this information. The visual layering in AR applications and PVDs highlights the fact that urban space is now infused with electronic information.

Spatiality is conceived both as mental and physical space — as defined by Lefebvre [40]. The urban environment is a mix of physical and mental spaces. From this viewpoint, AR applications and PVDs mix in their representations of physical and mental spaces: they represent physical space by displaying the distance and proximity to objects, places and people; and mental spaces by visualising commercial ventures that uphold the culture of consumption. They augment spatial branding [41] by digitally attaching graphics and text to objects and places. So, a production of space is observed in the sense of a lived experience that mixes heterogeneous elements, as well as representations, thus demonstrating the synthesis of the city as techno and physical. This reconfigured lived experience includes virtual objects and informational knowledge, but it also characterises the immediate vicinity, distance and places within a commercial and consumer–based logic. Rather than enriching places with electronic information, these new augmented reality applications do little to enrich but they rather visualise the hybridisation of space, of the urban environment, by visualising the commodification of all spaces, both mental and physical.

In this proposed model, and as per Lefebvre's guidelines, the conceived, perceived and lived are all mediated through the interface. This model proposes that the urban environment is perceived, conceived and lived with, and according to, the digital graphics and information displayed. In contrast, locative media projects and games utilized this merger of urban space with space of information for an almost subversive and re–appropriating context. AR applications and PVD represent the city space within a commodified context. Going beyond spatial branding, they represent the world through visual mediations that present fully the commodified space of the city. This mode of representing the city through the visual layering of digital information in the form of graphics and text, onto the image of actual space, mixed with the spatial practice (the experience of the city), creates a new space. From this point of view, spatial practice includes not only buildings, road intersections, commercial billboards and other visual sensors of capitalist spatialisation — but also information that derives from the virtual network of information.

Conclusion

Technologies of location and telecommunication will increasingly employ the model of visual layering, as representations of space are essential for the pictorial representation of the intersection of actual space with the space of information. AR applications and PVDs provide an insight to the future where visual layering (digital graphics with the image of actual space) will continue to produce spaces for consumption, communication, navigation, etc.

Currently, there are experimentations with GIS and in–car navigation. For example, the Toyota Diji concept car (Toyota, 2012) features a windshield screen on which layered digital graphics show navigation directions and feature virtual advertising boards along the streets. The product's Web site notes that messages can be displayed inside and outside the car's surface [42]. In South Korea, the Tesco virtual shopping wall has been installed on the underground and at train stations, the wall — a large poster — displays pictures of the most popular items sold in the supermarket, which users can scan with QR codes, and are then delivered to their home within a few hours (*Telegraph*, 2011). Gatwick airport in London has a similar wall installed (Neville, 2012). At the moment, Google Glasses are controversial since they pose challenges for privacy, policing, the unwilling recording of passers–by, and illicit tracing, storing and use of the data trail left by users. The insinuation and belief by Google that the future lays in an immersive process by which eyesight and peripheral vision are fully integrated into a consumerist space, poses questions as to the further development of PVDs and the accountability these interfaces have with regard to issues such as human rights and the right to privacy. If these unaccountable practices continue [43], the fusion between the digital world of information with the actual experience of the city offers a bleak future.

The merging of bits with the urban environment has produced re–contextualizing models such as digital

graffiti, urban interactive screens and games that were based on offering alternative experiences of the urban environment. In commercial ventures this merger is manifested in the commodification of every aspect of the spatial experience of the city and everyday life and, as shown in the paper, the merging of bits with urban space becomes a vehicle for capitalist spatialisation. Following on from Lefebvre's method of observing social space, these environments and interfaces are visual mediations of the intersection of everyday life and activities with the space of information. How these interfaces and technologies of informing location and proximity to objects, places and things are appropriated in everyday life — what kinds of rhythms emerge from this union and the effect those have in the spatiotemporal perception of the urban environment — must be studied — casting a critical eye on the ideologies these interfaces at once conceal and abide by.

About the author

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Notes

1. Foth, *et al.*, 2009, p. 182; Flanagan, 2008, p. 13; Tuters, 2004; Sotamaa, 2002, p. 41.

2. Elden, 2004, p. 185.

3. Lefebvre, 1991, p. 39.

4. Lefebvre, 1991, p. 40.

5. Lefebvre, 1991, p. 377.

6. Space as a concrete abstraction is a key concept expressed by Lefebvre (see Stanek, 2011, p. 113; Elden, 2004, p. 39, p. 217; Shields, 1999, p. 63; Soja, 1989, p. 120). It explains that the idea of homogeneous space is made up of compartmentalized spaces. Space fragmentation has been observed from the time of the Parthenon monument. The conception of the monument's totality is acquired by fragmenting its spaces into compartments; the whole is conceived by its parts. In the modern world, social space, "no longer totalizes its elements" (Lefebvre, 1991, p. 232), other forms of architecture occupy the monumental role of temples, palaces, shrines and social places that the agora and the Roman baths did in antiquity. For example, social housing becomes "the substitute for the monumentality of the ancient world" (1991, p. 232). Breaking up the urban environment, by allocating areas for dwelling, areas for work and leisure, and assigning industrialist centres of production (on a global scale) allows for the formation of an abstract space. Space appears homogeneous: it is through its fragmentation that the notion of concrete abstraction is achieved. Abstract space as discussed by Lefebvre (1991), is the notion of a controlled way of perceiving reality and being in space.

7. Staken, 2011, p. 193.

8. Stanek, 2011, pp. 192–193.

9. Lefebvre, 1991, p. 40.

10. See Stanek, 2011, p. 129; Merrifield, 2006, pp. 108–112; Elden, 2004, p. 190; Shields, 1999, pp. 160–167.

11. Lefebvre, 1991, pp. 413–414.

12. Lefebvre, 1991, p. 33.

13. Lefebvre, 1991, p. 285.

14. Lefebvre, 1991, p. 233.

15. Lefebvre, 1991, pp. 41–42.

16. Lefebvre, 1991, p. 233.

17. Lefebvre, 1991, p. 40.

18. The world of data, or the world of information, can be thought of in all of its forms and complexities. It includes: data defined both as raw data — as in bytes and bits — and as media rich data, such as text, video, pictures; intelligent architecture and smart rooms; geocoded media; interactive screens in the urban environment; data packages sent and received between devices and stationary processors; GPS coordinates; metadata generated by users in Internet browsing and preferences in social media

sites. Mobile media in the form of text, video and pictures; infrastructural networks, such as fibre wire, antennas and Wi–Fi networks.

19. Mitchell, 2003, p. 129.

20. Laurel, 1993, p. 161.

21. Plant, 2002; Fortunati, 2002, p. 49; Green, 2002, p. 289; Ling, 2004, p. 123.

22. Castells, 2004, p. 85.

23. Graham and Marvin, 2001, pp. 33, 139.

24. de Souza e Silva, 2006, p. 265.

25. Gordon and de Souza e Silva, 2011, p. 101.

26. Frith, 2012, p. 132.

27. Frith, 2012, p. 140.

28. Frith, 2012, p. 132.

29. Hemment, 2006, p. 354.

30. For a comprehensive discussion of urban screens see this journal's special issue number 4 (2006), *Urban screens: Discovering the potential of outdoor screens for urban society*, at http://firstmonday.org/issue/view/217.

31. Indicative list of digital graffiti projects:
Graffiti Research Lab, Vienna, New York and Mexico (http://graffitiresearchlab.com).
Egoscope, 2006, Sao Paolo, Brazil by Giselle Beiguelman.
Poetrica, 2003–2004, Sao Paolo, Brazil by Giselle Beiguelman.
Cityspeak, 2005 by Jason Lewis.
Hello World, 2003, Mumbai, Geneva, Rio de Janeiro, New York by Johannes Gees.

32. Tuters asserts that the relationship of locative media to the Situationists is a paradoxical one, because of the military origin of location-based technologies (Tuters, 2012, p. 269). Equally, the figure of the flâneur and its metaphorical use in locative media discourse is largely critiqued (Zeffiro, 2012, p. 255). All locative media projects, however, contextualized location to reinterpret the experience of the urban environment.

33. Location–based games, both commercial and artistic, blurred the boundaries of public and private space and created alternative experiences inside the urban environment (for an up–to–date discussion see de Souza e Silva and Frith, 2010). Widely recognized and influential location–based games of that period are:

Samurai Romanesque, 2001. Tokyo, Japan.
Botfighters, 2001. Finland, Sweden and Russia.
Blast Theory, a U.K.–based artists' group:
Can You See Me Now, 2002. Sheffield, Rotterdam and other cities.
Uncle Roy is All Around You, 2003. London, ICA.
I Like Frank in Adelaide, March 2004. Australia.
Mogi, 2004. Tokyo and Japan.
PacManhattan, 2004. New York. U.S.

Regarding early location–based games and the blending of the physical world with the game's imaginary world I have talked about this elsewhere (see Drakopoulou, 2010).

34. Lefebvre, 1991, p. 41.

35. Tuters, 2012, p. 269; Wilken, 2012, p. 244; Goggin, 2011, p. 181; de Souza e Silva and Frith, 2010, p. 486.

"By the 2010s however, locative media's Situationist rhetoric had been turned on its head, with location–based services becoming a key tool in a corporate strategy to re–imagine the city and 'the social' in terms of 'gamification'" (Tuters, 2012, p. 269). Gamification explains how interface design in smart devices, and especially navigational maps, is influenced by videogame design of the 1990s (see Chester 2012, p. 324; Tuters, 2012, p. 269; Deterding, *et al.*, 2011). The negative effect of gamification on interfaces today is due to the personalized experience that they offer that conceals the culture of consumption that is seemingly tangent to smart devices.

36. Lefebvre, 1991, p. 233.

37. Stanek, 2011, p. 142.

38. Merrifield, 2006, p. 109.

39. Lefebvre, 1991, p. 51.

40. Fraser, 2007, pp. 679–680.

41. Best definition of 'spatial branding' is provided by an interior design agency: spatial branding is "the use of space as a media to express the Corporate Brand" (Duke Richards, 2012). This definition is very close to Lefebvre's definition of representational spaces.

42. TOYOTA diji 2012. GIS navigation: http://www.toyota-europe.com/Images/toyota-daqa-2012-tme-006-full_tcm280-1113214.jpg — Messages displayed on car: http://www.toyotablog.nl/wp-content/uploads/2012/03/Diji-toyota-geneve-2012.jpg.

43. There is growing resistance to the Google glass project. A bar in Seattle, in a pre–emptive attempt, has banned Google glasses, before they are released to the market (Bishop, 2013; Champion, 2013). Also, there is a blog campaigning to raise awareness on the issues of privacy they pose (Anonymous, 2013).

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