Humans as Avatars in Smart and Playable Cities

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***Abstract*—We compare the behavior of avatars in videogames with the expected behavior of humans in smart environments, particularly smart urban environments. As a result of this comparison we conclude that many aspects of controlling an avatar in a game environment will also be seen in controlling human behavior in smart urban environments. We predict a convergence of videogame environments with smart urban environments where the Artificial Intelligence (AI) of the game environment can be compared with the AI of the smart urban environment that is responsible for the functioning of the smart city. Game characteristics such as immediate rewards for good behavior can also be foreseen.**

Keywords—smart environments, smart cities, playable cities, videogames, urban games, augmented reality, avatars, persuasive technology, human-computer interaction

I. Introduction

Our daily environments become smart. Our home, our office, our streets and our urban environments will become embedded with sensors and actuators that not only monitor our behavior, but also have impact on our behavior. Actuators provide feedback to our behavior. Feedback can consist of multimedia messages on our smartphones or other wearables, including our clothes, tattoos, make-up and, in the future, implants. But there can also be feedback displayed on public displays and on objects that are part of our digitally enhanced physical environments. Feedback can consist of changes in the environment, movements of objects, changes in appearances of objects, for example using smart materials. This feedback supports us in our activities, but it can also support the environment when it persuades to act in a specific manner and it is not necessarily the case that we are aware of this persuasion or maybe even misleadingness.

Environments can also 'change' their appearance by augmenting them with personalized digital information using augmented reality technology. Pokémon GO! is an example where 2D information is projected on an image of the real world. 3D information, such as animated 3D objects or embodied agents, can also be added. In this way the physical world can be linked to a designed digital world.[1] Nowadays, augmented reality usually refers to an overlay with visual information requiring a device (head-mounted display, special glasses) that allows us to look at a 'reality' where additional visual information is projected on such a device. Adding audio information to a physical environment is something that already is 'natural' and accepted. However, augmented reality can also address modalities such as touch, smell and taste, that is, adding artificial or artificially augmented touch, smell and taste experiences to an environment that we inhabit.

Humans inhabit smart environments that have sensors and actuators and provide augmented multi-sensory experiences. Their natural perception capabilities augmented by their wearables make humans living sensors and actuators, that is, living nodes in a Network of Things (NoT) that can be manipulated similar to what can be done with other nodes in the NoT.

In this short paper we compare smart environments such as smart cities with videogames. In videogames we have avatars that represent human players. The avatars are controlled by gamers, but there is also control by the AI of the game and there are constraints on the behavior because of the narrative of the game, the interaction possibilities and the (virtual) physics. In a smart urban environment we also have constraints on the behavior of city dwellers using sensors and actuators and there is also a narrative, that is, an expected, preferred or enforced sequence of acts. We will elaborate this comparison in the sections that follow and will argue that there will be a convergence of videogame environments and controlled avatar behavior and smart cities and more or less controlled city dwellers' behavior.

II. Avatars in Videogames

In video game environments we have 'avatars' that represent the human players in the game. Originally the word 'avatar' refers to the incarnation of a Hindu deity in human form. Nowadays an avatar is a virtual representation of a gamer in a videogame. It is controlled by the gamer and in a game it performs tasks and it interacts with other virtual characters that represent other gamers or that are controlled by the AI (Artificial Intelligence) embedded in the game environment. Avatars can have a human-like appearance, but they can as well be represented by a position and viewpoint orientation, similar to the way we are viewing the real world without being aware of our body. But an avatar can also be represented visually as a back of the head or shoulders, or as part of a gun that is used by a gamer to locate and track a target as in the usual first-person shooter games. These avatars are called role-playing characters (RPCs). They can be distinguished from other game characters, the non-playing characters (NPCs), that is characters whose behaviors are not under control of the human player. The game's AI decides how NPCs behave, move around, enter joint activity and, most

[1] Pokémon GO! was announced in 2015. It should be mentioned that already in 1968 Ivan E. Sutherland introduced an augmented reality view on a physical environment [1]. Game environments, for example Quake, have also been linked to physical environments [2] more than decades ago.

978-1-5386-2089-2/17 $31.00 © 2017 IEEE
DOI 10.1109/CW.2017.23

of all, match their behavior to that of the role-playing character(s).

Apart from a gamer's control by keyboard or joystick of an avatars game activities, there are constraints that follow from the designer's game narrative and constraints that follow from the virtually modelled physical characteristics of the world presented to a gamer. As an example of the former, the game's narrative, we don't expect our game shooter protagonist to suddenly turn into a peace preferring avatar. And, an example from the latter, even in a virtual world we expect that there are real world physical constraints, for example constraints that prevent an avatar from colliding with walls or to enter a physical zone of intimacy with other role-playing or non-playing characters that are present and have a game-playing role.

A gamer controls its avatar, but there are constraints provided by narrative and virtual sensors and actuators that allow the AI of the game to know about the gamer's intentions, preferences, emotions, and commands. Explicit commands can be recognized by algorithms that understand natural language speech or keyboard input, that understand facial expressions and eye gaze movements and expressions, and that understand other nonverbal information, for example sensory information from smell, touch, or taste, that becomes available for algorithms that interpret such information and provide feedback. This feedback can be an utterance in a conversation or a change in the environment, for example a light that is turned off or on, an artificial smell that is emitted, or a kiss or touch that is wirelessly mediated by a future internet.

Videogames have virtual sensors and actuators. There are virtual detectors that prevent you from becoming too close to other characters, that prevent you from colliding with a wall, or to make it impossible to shoot someone who is out of reach. Actuators make such activities impossible, but also make changes to the environment required by a gamer's activities. Having won in a sword fight or having built a new home requires a change in the environment, and this change can be about appearance, as usual, but it can also address other sensory experiences that involve audio, touch, scent, and taste, dependent on the application.

III. Smart and Playful Urban Environments

City management and public administrations increasingly require resources collected, maintained and processed by ICT (Information and Communication Technology). Integration of separate resources allows better decision making and optimization of services. In addition to traditional resources that contain information about energy consumption or some traditional public services such as parking, use of public transport, traffic or garbage collection, sensors embedded in urban environments can monitor the condition of buildings and roads, they can monitor noise and air quality, traffic flow, city energy consumption, presence in public spaces and many other aspects of city life. The concept of 'smart city' has been introduced to emphasize this use of ICT in a city environment [3]. The concept of smart cities has been embraced in many countries and in many cities. Civic authorities have been keen to incorporate this smart city concept into their views on making cities more efficient, that is, being able to manage a city towards efficient energy consumption, taking care of a city's traffic problems and using ICT to improve public safety [4].

Clearly, collecting and interpreting data is one aspect of smart cities, the other is to act upon the interpreted data. This can be done in traditional ways, that is, decision making by civic authorities and city management about traffic management, lighting, safety, crowd control, et cetera. But, of course, information obtained from sensors can be interpreted and in real-time processed by actuators that act on their environment, whether they are embedded in streets, public spaces, bicycle roads, buildings, parking places, or street furniture. As an example, in San Diego, California, streetlights are becoming part of an urban IoT that monitors air quality, traffic flow, pedestrian behavior at crossings, availability of vacant parking places, detect gun violence, and control lighting [5]. Another example is the testing of sensors in the streets of Wellington, New Zealand, to detect screaming, shouts, sleeping on the street or smell paint fumes from graffiti [6].

Actuators fed with sensed information can act on their own, regulate energy distribution, control traffic lights and suggest or enforce different traffic behavior, display messages to the public and suggest or enforce different behavior, or issue warnings. Actuators can make changes to a physical environment. Moreover, see also the next section, actuators can deal with 'augmented' humans, that is, humans that can use digital technology to augment their sensory and intellectual abilities and making them smart and living nodes in the IoT [7]. Obviously, being a node in the IoT also means that the IoT can decide about information made available to that particular node and how to process information coming from that particular node.

These views on smart cities are rather limited. They don't take into account how citizens would like to experience a smart city environment, want to establish relationships with others in their community or want to cooperate with others, using available sensors and actuator or introducing them their selves, to improve living conditions in their community. Moreover, these views don't take into account how children can be made to enjoy a particular smart environment that allows them to discover and challenge intellectual, physical, and social challenges. Or, having smart environments that allow unsupervised outdoor play and independent mobility for children.

In addition to smart cities there is the notion of 'playable cities'. Why not use sensors and actuators that become embedded in our city environments for designing playful events and activities in which city dwellers can participate or can help to create? Can we make cities more playful, adding entertaining and humorous events to our daily experiences? The concept of playable cities has been made popular in the city of Bristol in the UK. The term 'playable city' was considered to be a people-centered counterpoint to the idea of the data-driven "smart city". Various playful activities using smart sensors and actuators were introduced, but only for a short period of time. We can mention the 'Hello Lamppost'

project where citizens could use their mobile phones to conversationally interact with street furniture. Or the 'Shadowing' project, in which street lights were equipped with infra-red cameras that captured shadows of passersby. The streetlight projected one of the shadows in its database when someone passed the streetlight, surprising that person with a shadow different from his or her own shadow (see Fig. 1). Every year a new project is chosen to be implemented in the Bristol's streets [8]. Several other projects are mentioned in [9].

Fig. 1. 'Shadowing' (Chomko & Rosier, London, UK) [8].

The current Bristol definition of a 'playability city' does not assume initiatives of local city dwellers to use sensors and actuators in order to make changes to their environments. The concept has been commercialized and the 'playability' has been degraded to the city equivalent of an amusement park attraction that is made available for a certain period of time in a public space and city environment. This is different from an earlier 'definition', where it was mentioned: "The Playable City is imagined as a city in which hospitality and openness are key, enabling residents and visitors to reconfigure and rewrite city services, places and stories. The Playable City fosters serendipity and gives permission to be playful in public."[10] There are not many examples of cities where citizens or communities initiate sensor networks to serve their community. Available examples deal with crime prevention or the measurement of traffic and airplane noise levels or air quality [11]. This may change in the future with a growing maker and DIY culture and cheaper sensing and actuator technology that is now becoming available.

IV. Smart, Augmented and Controlled Humans

As should be clear from the previous section, smart environments make it possible to detect and distinguish human behavior. Sensors monitor activities, they include interpreting gestures and postures, analysis of facial expressions and non-verbal speech, affect recognition and speech recognition and understanding. Although algorithmic performance of each one of these human-computer interaction possibilities may be poor, fusion of multimodality information can provide a smart environment with detailed knowledge about a particular user, his activities, preferences and intentions. It allows the environment to anticipate behavior and activity and it allows the environment to influence behavior and activity. The user is not necessarily aware of this role of the smart environment.

Smart technology embedded in the environment makes it possible to obtain detailed information of the user. This is amplified by smart technology that is used by the user. Smartphones, smart textile, smart bracelets, smart watches, smart glasses and fitness trackers do not only augment a user's intellect and senses, but also provide information about the user to the smart environment. The user as a 'living node' in the IoT can be 'controlled' by the smart environment that he or she inhabits. The user's real world is linked with a designed digital world that augments a user's reality and that is not designed or controlled by the user. Presently augmented reality or virtual reality requires special glasses or cumbersome headsets. In the future we may have microprojectors in glasses that project on contact lenses for a full screen display. This makes it possible to have AR and virtual reality experiences in everyday outdoor situations.

Brain-Computer Interfaces are among the devices that can provide information about a user's mental state, emotion, and intention. Presently the emphasis is on non-invasive techniques using electrodes that are attached to the skull. Invasive techniques, for example ECoG (Electrocorticogram), that has electrodes positioned on the cortex, are more precise and can become more acceptable in the future. Brain or neuro-stimulation provides a smart environment also with the possibility to influence the behavior of a particular individual in its environment.

From the observations in this and the previous sections we can conclude that we can compare digitally enhanced physical environments, that is, smart environments and particularly smart cities with videogame environments. Rather than having virtual sensors and actuators in a videogame environment, we have physical sensors and actuators in a real world environment. And, rather than having avatars controlled by a human player, and controlled by the game environment, we now have humans not only acting in a smart environment, but that also are controlled by the smart environment around them.

V. From Videogames to Smart Urban Environments

In the previous sections we alluded to similarities between videogame environments and digitally enhanced physical environments. In videogame environments we are represented by avatars. They perform in controlled settings, where the control comes from the AI of the game, the narrative and the virtual equivalents of physical constraints. In our physical environments we have sensors and actuators, not only in the environment but also on our body and in the future probably also in our body. Therefore we can consider ourselves as nodes in the IoT and we should be aware that our actions will be steered by intelligence that is not necessarily ours but has been implemented in the environment and our wearables and rather represents the intelligence of civic authorities and those that design and maintain the NoT.

In videogames we encounter behavior of gamers that does not follow the rules of the game [12]. Rather than follow the narrative gamers can explore the environment and make decisions that counter the aims of the game to see what will be

happening. Bugs in a game can lead to humorous situations and they can be shared with others [13]. Hence, looking for bugs is considered to be an interesting sport. Videogames have led to mischievous humor. Many examples of mischievous humor exist. We can find examples of game play where a gamer is bullied, where trolls make playing impossible, and where gamers cooperate and conspire to make entertaining and successful gaming for others impossible. Appropriation of games by modding, that is making changes to the game mechanics and the game contents, is also practiced by experienced gamers. In fact, game companies sometimes make code available for 'modders' and are interested in new versions or applications of their code. And, of course, finally we should mention game hackers that show the vulnerability of game designs, for example massively multiplayer online role playing games [13].

In smart urban environments that have sensors and actuators we can expect such mischievous behavior as well. It can be humorous, it can be fun for pranksters, trolls and hackers that inhabit a smart city environment, it can also lead to negative experiences of others living in the same smart environment. In Fig. 2 we have summarized our vision of the convergence of videogame environments and smart and playable cities.

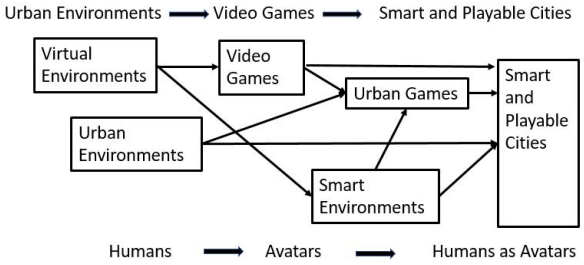

Fig. 2. From videogames to smart and playable cities.

VI. Conclusions

In this short paper we argued that future smart environments, particularly smart and playable cities, will not be that different from nowadays videogame environments. Both have sensors and actuators and in both environments human activity is controlled by a narrative, physical constraints and 'mechanics'. In a game it is the game AI and the game mechanics, in the city it is the 'smart city AI' and the 'smart city mechanics'.

Obviously, there are many videogame genres: adventure game, role-playing games, shooter games, puzzle games, et cetera. Many games are not about competing or winning, but about role playing, cooperation, exploring environments, solving puzzles, surviving, or being successful in simulated real-world tasks. In this paper we didn't zoom in on specific genres. In shooter games weapons have to be used, other games require stealing and deceiving. This is easier and has less severe consequences than in real life. But nowadays sensing technologies are as well concerned with handling deceptive, aggressive and violent behavior, as we mentioned earlier [5,6], including the detection of gun violence from video images [14]. Maybe this should be seen as an additional argument about the convergence of videogame technology and urban IoT technology.

Many observations in this short paper concern the smart control of behavior of human beings in smart urban environments. No doubt, taking into account many 'invisible' decisions that are made in the development of smart cities [15], ethical considerations need to be discussed.

Acknowledgment

I gratefully acknowledge the many useful comments of four reviewers. In this short paper it was not possible to include all their suggestions. This will be done in an extended version.

References

[1] I. E. Sutherland, "A head-mounted three dimensional display," Proceedings of the December 9-11, 1968, fall joint computer conference, part I (AFIPS '68 (Fall, part I), New York, NY, USA: ACM, pp. 757-764, 1968.

[2] B. Thomas, B. Close, J. Donoghue, J. Squires, P. De Bondi, M. Morris, and W. Piekarski, "ARQuake: an outdoor/indoor augmented reality first person application," 4th Int'l Symposium on Wearable Computers, pp 139-146, Atlanta, Ga, USA, 2000.

[3] A. M. Townsend, Smart Cities, New York, London: W.W. Norton & Company, 2014.

[4] M. Deakin, "Smart cities: the state-of-the-art and governance challenge," Triple Helix, 1:7, 2014, pp. 1-16.

[5] A. Scott, GE, Intel, AT&T team up to put cameras, mics in San Diego, Reuters, Feb 2, 2017. http://www.reuters.com/article/us-ge-sandiego-idUSKBN1611YU

[6] E. Hurley, "Surveillance expert critical of Wellington's CCTV and sensor system," Newshub, May 23, 2017. http://www.newshub.co.nz/home/new-zealand/2017/05/surveillance-expert-critical-of-wellington-s-cctv-and-sensor-system.html

[7] D. De Luca, M. Del Giudice, M. Dellosta, A. Fonsati, A. Osello, F.M. Ugliotti. "Augmented and virtual reality for smart cities users' awareness," INTED2017 Proceedings, 2017, pp. 4333-4342.

[8] A. Nijholt, "Towards playful and playable cities," Chapter 1 in Playable Cities: The City as a Digital Playground. A. Nijholt (Ed.), Singapore: Springer, 2016, pp. 1-20.

[9] A. Nijholt. "How to make cities more fun," The Wall Street Journal. https://www.wsj.com/articles/how-to-make-cities-more-fun-1496163790, Online May 30th, 2017.

[10] Call for Proposals – Making the City Playable Conference – Watershed, Bristol, UK, September 10th & 11th 2014. See also https://www.playablecity.com/

[11] C. DiSalvo, M. Louw, J. Coupland, M. Steiner, "Local issues, local uses: tools for robotics and sensing in community contexts," Proceedings 7th ACM conference on Creativity and Cognition (C&C '09), New York, USA: ACM, 2009, pp. 245-254.

[12] J. Švelch. "Comedy of contingency: making physical humor in video game spaces," Int. J. Commun. 670 8, 2014, pp. 2530-2552.

[13] A. Nijholt, "Mischief humor in smart and playable Cities," Chapter 11 in Playable Cities: The City as a Digital Playground, A. Nijholt, Ed., Singapore: Springer, 2016, pp. 235-253.

[14] R. Olmos, S. Tabik, F. Herrera, "Automatic Handgun Detection Alarm in Videos Using Deep Learning," https://arxiv.org/pdf/1702.05147.pdf, 2017.

[15] D. Bianchini, I. Avila, "Smart cities and their smart decisions: ethical considerations," IEEE Technology and Society magazine, pp. 34-40 Spring 2014.