Sci Eng Ethics (2018) 24:947–970
https://doi.org/10.1007/s11948-016-9762-5

ORIGINAL PAPER

Appropriating Video Surveillance for Art and Environmental Awareness: Experiences from ARTiVIS

Mónica Mendes[1] · Pedro Ângelo[2] · Nuno Correia[3] · Valentina Nisi[4]

Received: 1 February 2015 / Accepted: 3 February 2016 / Published online: 22 February 2016

Abstract Arts, Real-Time Video and Interactivity for Sustainability (ARTiVIS) is an ongoing collaborative research project investigating how real-time video, DIY surveillance technologies and sensor data can be used as a tool for environmental awareness, activism and artistic explorations. The project consists of a series of digital contexts for aesthetic contemplation of nature and civic engagement, aiming to foster awareness and empowerment of local populations through DIY surveillance. At the core of the ARTIVIS efforts are a series of interactive installations (namely B-Wind!, Hug@tree and Play with Fire), that make use of surveillance technologies and real-time video as raw material to promote environmental awareness through the emotion generated by real-time connections with nature. Throughout the project development, the surveillance concept has been shifting from the use of surveillance technology in a centralized platform, to the idea of

✉ Mónica Mendes
monica.mendes@fba.ul.pt

Pedro Ângelo
pangelo@void.io

Nuno Correia
nmc@fct.unl.pt

Valentina Nisi
valentina.nisi@m-iti.org

[1] Faculdade de Belas-Artes da Universidade de Lisboa, and M-ITI, Lisbon, Portugal

[2] Faculdade de Engenharia do Porto, Porto, Portugal

[3] NOVA-LINCS, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Caparica, Portugal

[4] M-ITI – Madeira Interactive Technologies Institute, Universidade da Madeira, Funchal, Portugal

veillance with distributed peer-to-peer networks that can be used for science and environmental monitoring. In this paper we present the history of the ARTiVIS project, related and inspiring work, describe ongoing research work and explore the present and future challenges of appropriating surveillance technology for artistic, educational and civic engagement purposes.

Keywords Media art · Interactive installations · Surveillance · Veillance · Sustainability · Environmental awareness

Introduction: From Nature Contemplation to Civic Engagement

A healthy relationship between the evolving human society and the changing natural world demands an iterative rethinking of communication and interaction paradigms through the exploration and adoption of new and emerging technologies. Motivated by a growing number of projects valuing art exploration and design as an effective way of spreading sustainability messages, ARTiVIS—Arts, Real-Time Video and Interactivity for Sustainability—is an ongoing research agenda that investigates the use of real-time video and other kinds of environmental monitoring data as source material for developing engaging interactive art experiences (Mendes 2012). Such experiences are meant to foster environmental awareness and empower communities to act sustainably. The project activities described in this paper consist of a series of interactive art installations, a hardware kit that allows people to easily setup a video stream of their chosen forest, and an online platform that aggregates the real-time video streams together with forest monitoring systems.

Over time, ARTiVIS has become an umbrella project bringing together a collective of people working with digital art and information for sustainability purposes.

Forest covers 31 % of the planet's total land area.[1] Every year, millions of hectares of land across the planet are ravaged by fierce forest fires which burn out of control, destroying the environment, crops, homes and, in the worst case scenarios, lives (Fig. 1). Living in places extremely exposed to forest fires, like Portugal (Viegas 2009), we are very sensitive to the destruction of forest patrimony by fire hazards, and "Globally, 95 % of all fires are caused by various human activities" (FAO 2004). Despite previous measures (Forest 2014; GMES 2010), an attitude towards prevention prevails pertinent and urgent (FAO 2004). As citizens doing research and art practices, we can also play a role for effective change in people's behavior regarding forests protection: *What are the possibilities of proposing constructive approaches to the destructive dynamics of fire that aggravate climate change?*

The ARTIVIS project is strongly based on the use of real-time video and the appropriation of surveillance technology for artistic and civic purposes. Real-time video is often used to help several kinds of sports practitioners, such as surfers, windsurfers and skiers, where by looking at the video stream of webcams placed in

[1] United Nations, International Year of Forests. http://www.un.org/en/events/iyof2011/wp-content/uploads/2011/10/Fact_Sheet_IYF.pdf.

Fig. 1 Maçal do Chão, the place where everything started: *Quinta de Santo André* after a forest fire in 1994. | The same *Quinta de Santo André* in 2012, showing the results of a reforestation project 18 years after the forest fire

some specific environment, they can discover significant visual information on the conditions to practice such sports. If we take surfing as an example, surveillance technology can deliver real-time informations on surf, the sea waves height, the wind and the crowd. We envisaged that such treatment of the visual information regarding landscapes could then be extended to other contexts—What if we use this information for forests protection? Moreover, what about combining this surveillance capability with the potential for contemplation?

Hence, in the ARTiVIS approach, the real-time video of natural landscapes and features is brought to fruition not only for its immediate function of reporting information, but also for aesthetic contemplation, as windows to nature, as an opportunity to take a moment from our hectic lives and rest our eyes on some beautiful visuals, remembering that nature is very important for us humans, aesthetically and functionally, hence worth motivating us to take care of it. On these bases rests the will to provide and maintain a monitoring platform for those who subscribe to the ARTIVIS agenda in the form of a network of surveillance systems aimed at nature and monitored by the ARTiVIS community.

ARTIVIS has taken steps towards fulfilling its goals through practice-based research with a critical attitude and experimental approaches. During the course of the project we created diverse working prototypes going through phases of investigation, conceptualization, development and presentation in an iterative development process. This research was accomplished with the collaboration of people from diverse contexts and backgrounds, whether hackerspaces, research institutions, or local populations and took place in a series of events, including artistic residencies and sprints, hackerspace meetings and workshops (Fig. 2).

Surveillance, Artistic Explorations and Environmental Protection: Is Big Brother Going Green?

Nowadays, there is an increasing number of webcams of many different kinds used for multiple purposes. After XCoffee, known as “the first application breaking down the barriers of distance” (Stafford-Fraser 2001), many applications of live streaming video using surveillance cameras as input have been proposed. A growing number of international institutions focus on forest research by using surveillance

Fig. 2 Collaborative team work during the Hug@ree sprint the rural village Maçal do Chão and artistic residencies for B-Wind! and Play with Fire at O Espaço do Tempo in Montemor-o-Novo and Artropocode in Santiago de Compostela

technology for fire prevention (Forest 2014; GMES 2010), and video surveillance projects for forest fire prevention and early detection include automatic fire detection based on image processing (Veira and Matos 2011; Stula et al. 2012) and air monitoring with wireless real-time capturing devices installed in flying robots.[2] Educational initiatives and environmental activists enable the continuous observation of fauna and flora through the use of surveillance cameras using real-time video.[3]

However, surveillance is a controversial theme for its potential invasion of privacy and the use of the data. Victoria Vesna's installation Another Day in Paradise, composed by three preserved trees—"surveillance", "video" and "touchscreen"—raises a counterpoint that make us reflect upon the effects of surveillance systems in planned communities (Vesna 1998).

In a different sense and scale, Observing Surveillance is a large project that documents and promotes public debate around the presence of video cameras placed in the capital of the United States after September 11 by exhibiting images as an attempt to communicate ideas to the people. "Watch the watchers" is the goal of this so-called "battle over the control of the technology of observation" (Epic 2002).

This controversial perspective is not shared by everyone. In *The Art of Surveillance*, Manovich states: "Like normal video surveillance cameras that are tracking us everywhere, webcams rarely show anything of interest. They simply show what is there: the waves on the beach, somebody staring at a computer terminal, an empty office or street. Webcams are the opposites of special effects

[2] Microdrones. http://www.microdrones.com/en/applications/areas-of-application/monitoring/.

[3] Griffins nest at Portas de Ródão, Portugal http://www.publico.pt/ecosfera/grifos.
Bats cave at Alviela, Portugal http://www.publico.pt/ecosfera/morcegos.
Eagles Cross Borders project, Estonia and Latvia http://pontu.eenet.ee/player/kalakotkas.html.

films: feeding us the banality of the ordinary rather than the excitement of the extra-ordinary" (Manovich 2001, p. 11). The theme of video surveillance and CCTV footage in digital cinema and the use of real-time video as material for filmmaking have been explored in very exciting new ways. Video surveillance that Hollywood movies use is more real, less mediated, even "artfully crappy" (Kammerer 2004), as the CCTV footage directly from the source. Selected examples include Timecode by Mike Figgis[4] for its multiple screens aesthetics as in monitoring screens, Alice by Marco Martins[5] on the role of video monitoring as the method to find the lost child, and Look by Adam Rifkin[6] regarding the issue of lack of privacy and the point of view from the surveillance cameras.

Our increasing lack of privacy and the aesthetics of surveillance have been explored with unusual shots and video resolution in Person of Interest. This thriller looks like a mixed reality game where "the notion of preventing crimes rather than solving them is an appealing twist".[7] This is done through the analysis and cross-checking of the huge amounts of surveillance data where "pattern recognition software identifies the anticipated victims, while cutting-edge surveillance technology tracks them down".[8] The visual concept of surveillance video displaying the timecode was actually inspired by the Los Angeles Department of Transportation surveillance cameras. The immediacy of the digital medium is expressively represented through the webcams feed visual interface together with the interchangeability of multiple perspectives in a pulsing rhythm.

Furthermore, interactive experiences engaged with the use of technologies are increasingly embodied in video based environments. Pioneering work in this area is Netlag by the French collective Pleix, a project that showcases their subversive view, displaying the videos of webcams found all around the world captured with custom software through snapshots during 24 h. This video piece generates a living world view of videos synchronized and placed on a geographical map, as it creates an overview of the rhythm of life due to the presence of the sun and to the earth rotation (Pleix 2004). In a similar vein, Surveillance Saver[9] is a screensaver that displays surveillance cameras content of places from around the earth in real-time.

In Stanza's netart works, real-time video of networked surveillance cameras is the raw material for a series of artworks on surveillance and networked data that processes and displays surveillance cameras content of places from around the earth in real-time, such as The World Is Watching, The World Is Waiting, Panoptic World, CCityV, and Fabrica. Several of his installations created from live CCTV and webcams are based on networks and focus on surveillance of nature and the pastoral landscape: Performing sheep, The Singing Trees of Tremough, This

[4] "Timecode" in IMDB. http://www.imdb.com/title/tt0220100/.

[5] "Alice" in IMDB. http://www.imdb.com/title/tt0459072/.

[6] "Look" in IMDB. http://www.imdb.com/title/tt0810951/.

[7] In "'Person of Interest': TV review", Los Angeles Times, by Mary McNamara (2011). http://articles.latimes.com/2011/sep/22/entertainment/la-et-person-interest-20110922.

[8] "'Person Of Interest' Creator Jonathan Nolan Isn't Paranoid—Or Is He?", by Susan Karlin (2012). http://www.fastcocreate.com/1679107/person-of-interest-creator-jonathan-nolan-isnt-paranoid-or-is-he.

[9] SurveillanceSaver. http://i.document.m05.de/?page_id=438.

England: A Green and Pleasant Land. In his artworks and research, Stanza raises potential problems about observation, surveillance, and the ethics of the control space, questioning the world we will live in as "a much bigger brother than the Orwellian vision, it's the mother of big brother" (Stanza 2010).

In several artistic works to date, such as Third Person, an interactive display by Lozano-Hemmer (2006), and Les Voisins by Ricardo Jacinto,[10] the video is being captured in situ and is integrated in a predefined screen, where filters are applied to the streaming video.

Camille Utterback's interactive installation "Abundance" uses a surveillance camera that tracks pedestrians and translates their movements into abstract shapes that appear and interact on a projection onto the San Jose City Hall building. Residents moving through the plaza at night "become part of a collective visual record, and transform the building into a playful and dynamic canvas" and alter their "sense of ownership and belonging to a place that is already theirs as a public civic space" (Utterback 2007). Hand from Above is an experience inspired by the mythical story Land of the Giants and Goliath, displaying on a screen a giant hand that plays with pedestrians on the street, who are "tickled, stretched, flicked or removed entirely in real-time by a giant deity" (O'Shea 2009). Hand from Above playfully challenges our perception of spaces and objects, by enabling the virtual and the real to coexist in real-time. These interactive installations presented in public spaces both demonstrate participants' engagement and the importance of the spatial scale of the installation.

Ethical considerations were addressed in Rara Avis and teleportation experiments by bio artist Eduardo Kac and the controversial movie Faceless by film maker Manu Luksch. The inversion of the observer to that of the observed in Rara Avis is achieved through the viewer being watched by the video cameras that are the eyes of a robotic bird, then occupying the position of the caged bird. This approach undermines the traditional construct for viewing in which the observer maintains a powerful control over the observed (Paul 2003; Kac 1996). On the other side, by using only footage from CCTV, Luksch subverts the system by investigating and exploring the UK Data Protection Act and EU Directives that give people "the right to access the personal data held in computer databases", which included the CCTV recordings used as raw material in the Faceless movie (Luksch 2007).

At The Artist is Present, Marina Abramovic proposes new concepts for performance anchored on the use of video: as videoart, as documentation, and as live video for performances (Abramovic 2010). This multimedia setup is not limited to the Museum space, expanding to an online platform. With Sousveillance, Mann et al. (2003) brings awareness of this "inverse surveillance" as a counter to the organizational surveillance issue, and Wafaa Bilal (2011) has chosen to implant a camera in the back of the head—The 3rd I—that during a year automatically captured photos every minute, and transmitted them to a website.

Our research perspective on environmental activism in Media Arts and Design is close to what Fuad-Luke dubs as an apolitical approach, that is done through participatory discussions and design's organizing principles such as "usability, the

[10] Installation at ARCO Contemporary Art Fair 2007, Vera Cortez Agência de Arte, Madrid.

project, human needs, or 'doing good by design'" (Fuad-Luke 2009). Although the core of activism is still highly political, activism is arguably becoming more cultural, a statement that Ann Thorpe emphasizes in her review on Fuad-Luke's overview of activism within the design culture: "these concepts contrast fairly sharply with the more conventional activists' language that deals in rights, struggles, grievances and claim", and contribute to rethinking design practice.[11]

Art as a part of the global warming discourse has also been evident during the United Nations Climate Change Conference:[12] "Artists are waking up to climate change" (Bunting 2009), regarding both exhibitions Earth and RETHINK—at the intersection between Art, Culture and Ecology. During COP16,[13] the first art exhibit visible from space—350 eARTh[14]—is a new way to communicate how climate change is impacting our planet and what creative solutions will contribute to limit CO_2 emissions in our atmosphere.

Digital Artists such as Tiffany Holmes have engaged in eco-visualizations projects (Holmes 2007) in order to sensitize audiences towards sustainability issues and climate change.

Talking Tree[15] presents the data that the tree is witnessing and is a specific example of a project that takes advantage of the "Internet of Things" (Ashton 2009), creating a powerful narrative from an Internet connected object.

Two different approaches for pollution visualization as forms of environmental activism were presented at Ars Electronica. *Nuage Vert* is an urban and community art project where, through the surveillance of people's factories and plants, the French art team Hehe makes pollution perceptible by using a thermo-sensitive camera and the smoke from a factory chimney as a projection surface (Evans 2008). Citizens are being indirectly watched through the air pollution they produce, becoming aware of a site that is visible and ignored (a waste incinerator), thus realizing the impact that their waste production has on the environment. Recognized by its "unfolding sociopolitical relevance", Nuage Vert was the recipient of the Ars Electronica 2008 Golden Nica because it demonstrates "how art is capable of encompassing an entire city—its public sphere, its industry and its inhabitants".[16] Here a paradox is explored through a green cloud-shaped laser projection on the smoke screen, that is both fascinating and disturbing.

[11] In "Book review: Design Activism—Beautiful Strangeness for a Sustainable World", comments by Ann Thorpe, design activism 2010. http://designactivism.net/archives/227.

[12] COP15—15th Conference of the Parties to the United Nations Framework Convention on Climate Change, Copenhagen, December 7–18, 2009.

[13] COP16—16th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), Cancún, Nov. 19–Dec. 10, 2010.

[14] 350 eARTh—Using art to spark a climate change movement. http://art.350.org/earth_earth/.

[15] Talking Tree (2010) EOS Magazine, Happiness Brussels. http://www.engadget.com/2010/09/20/talking-tree-communicates-with-the-world-via-facebook-and-twitte/.

[16] In "'Golden Nica, Prize of the Ars Electronica, for Pollstream", by Luminapolis (2008). http://luminapolis.com/en/2008/06/ars-electronica-preis-fur-pollstream/.

"Bringing poisons afloat" is the tagline of In Fondo al Mar, which brought a different kind of pollution visualization to surface at Ars Electronica 2010, "Repair the Environment—Doing the right thing" panel.[17] This independent project by designer David Boardman and journalist Paolo Gerbaudo, is a data visualization platform on sinking incidents in the Mediterranean Sea, involving ships "which are suspected of having carried toxic and radioactive waste" (Boardman and Gerbaudo 2010). In order to get a better factual understanding, the visualization collects all the relevant information through community participation, aiming to bring evidence to support the investigations about these incidents. This work is also a relevant reference for the ARTiVIS online platform, regarding community participation and the geographic visualization.

Climate change and surveillance are very relevant and currently discussed topics in the areas of the digital arts and design. The role and potential of design research in the transition towards sustainability (Pine and Gilmore 1998) has been discussed in mainstream design and digital media art events. The Design Museum's Sustainable Futures exhibition highlighted "the changing role of the designer and reveals how design can make a difference".[18] In the scope of the transdisciplinary platform for experimental art, design, research and activism Pixelache Helsinki, Camp Pixelache in 2012 was designed around the overarching theme of "Do It With Others", where artists, makers, cultural producers, researchers and activists work collaboratively "to create new co-production models for artifacts events with sustainability as the core goal";[19] sub-themes included "The Art of Gathering Environmental Data", a series of events concerned with collecting, publishing and using environmental data in Art and Science practice, covering issues of special focus for ARTiVIS, such as environmental monitoring in the context of open data.

Community Building and Local Culture has also been a driving force for the project since the start. Michael Gurstein's work in Community Informatics is an important research especially in what relates to how to make information technology accessible to rural and impoverished populations (Gurstein 2007).

Collaborative systems research projects involving volunteer environmental monitoring through information and communication technologies in Portugal came to the conclusion that "Public participation within environmental monitoring may contribute to increasing the knowledge on the state of the environment at the same time it promotes citizens' involvement in environmental protection" (Gouveia et al. 2004, p. 135). Public Lab extends this potential of community participation in environmental monitoring to the development of low-cost open-source hardware scientific instruments and of open source software tools to support them (Griffith et al. 2011).

[17] Panel at Ars Electronica 2010. http://www.aec.at/repair/en/program/repair-the-environment/.

[18] Sustainable Futures: finding solutions at the Design Museum—Can design really make a difference? http://de.phaidon.com/agenda/design/events/2010/march/31/sustainable-futures-finding-solutions-at-the-design-museum/.

[19] Camp Pixelache Helsinki. http://www.pixelache.ac//camp12/programme/call-for-proposals-demos/.

The ARTIVIS Project Outcomes

The ARTiVIS system as a whole is comprised of an online platform, a DIY forest surveillance kit and a series of interactive experiences that use real-time video of forests as a medium for contemplation, artistic expression and environmental awareness (Fig. 3).

The online platform is meant to function as a hub for the ARTIVIS community, creating a platform for the aggregation of real-time videos of forests and their corresponding artistic explorations. This platform aims to stimulate consciousness and the prevention of forest fires and related damages, as well as creating a community of activists and nature caring people that, while using the ARTIVIS resources, can improve them, and exchange data and ideas. One of the ways video streams can be made available to the platform is through the use of an open hardware DIY forest surveillance kit. This kit is a publicly available prototype aiming to repurpose surveillance technology and empower people and their communities to protect their forests.

In order to progress and evaluate the ARTiVIS research assumptions, we conceived and produced a series of interactive installations that used real-time video as raw material. B-Wind!, Hug@ree and Play with Fire were the three ARTiVIS experiences developed, publicly presented and evaluated in the scope of this research. B-Wind! focuses on the poetry of the movement highlighting how local action can have consequences in remote places; Hug@ree enhances the silent relationship between humans and nature through the physical contact with nature and on how individual action can collectively become relevant; Play with Fire

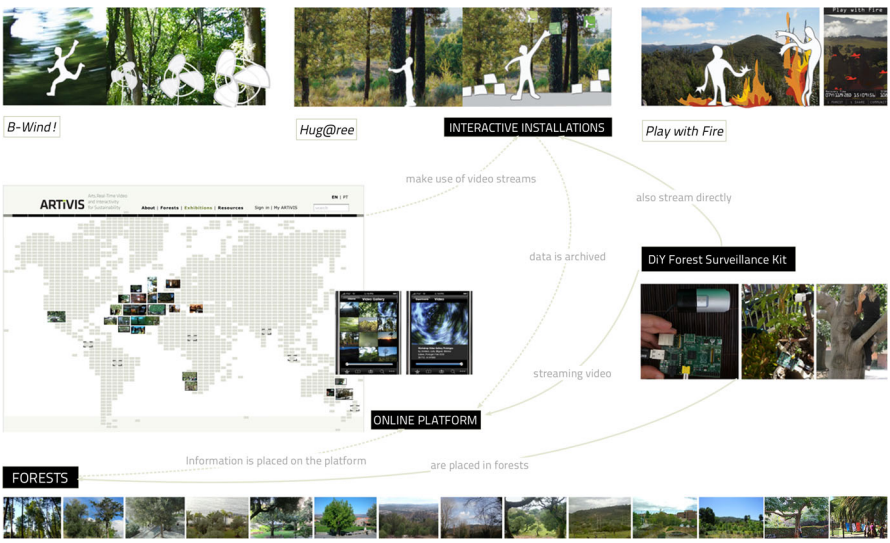

Fig. 3 Diagram of the ARTiVIS system components, their correlations, and user experience

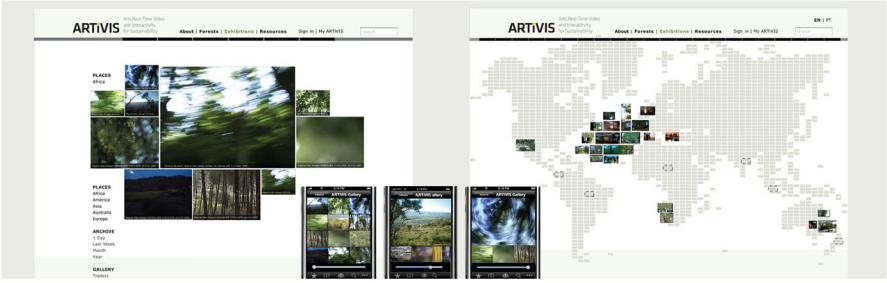

Fig. 4 ARTiVIS online platform category cloud (*left*) and space-based interface (*right*), including past events and future places, and interface for mobile devices displaying a video gallery and video playback

explores the paradox between aesthetic contemplations of dangerous but mesmerizing spectacles, such as forest fires and its consequences.

In the following sections we will describe in more detail each element of the ARTIVIS project.

Online Platform

The online platform was initially conceived as the core output of the ARTiVIS project, under the general concept of participative video surveillance. The platform is designed to link forest video streaming nodes provided by members of the community with consumer nodes like art installations or community surveillance users (Fig. 4).

ARTiVIS has diverse target audiences—designers, visual and media artists, performers, curators, technologists, environmentalists, urban and rural areas citizens of every age. We aim for users to visit and return to the interactive environments. These environments should be accessible from multiple remote locations through devices with Internet access, and in interactive installations.

The visual interface should integrate the display of real-time videos showcasing the forests, processed visual interpretations, and exhibitions. Part of these contents has been created and published in each of the ARTiVIS projects sites and in the research iterations blog.[20] User registration and photo or video input submission, community forum, statistics and "adopters" database are also part of the content to be provided in the online platform.

A space-based map interface is being designed to locate live online events and the context of local cultures. The time based and the space based interface is where the whole diversity of past, present and upcoming events are mapped, including webcams implementation, interactive installations exhibitions, and participation in events such as conferences, demonstrations, and workshops.

Another planned feature is to have a growing database constantly archiving the video footage. These archives are meant to be used as an information registry, and also as a source for artistic creation. They will be used both as a broad source of raw

[20] http://artivis.net.

video regarding nature for artistic experimentation and for rapid prototyping, providing access to diverse resources, such as footage to be compressed, and also for diverse educational and research purposes related to the theme.

Creating an original platform from scratch that is able to support streaming data from forests in different places of the world proved to be a considerable challenge in what concerns information architecture, programming and design. Although initially planned for implementation in the scope of this research, the development of the online platform remains at the proof of concept stage. In order to respond to this challenge, the research focus was shifted from a bottom-up approach to a top-down approach—to first develop the parts needed for the interactive installations, which allowed us to verify our research questions and then extract the requirements for future infrastructure.

DIY Forest Surveillance Kit

The ARTIVIS DIY Forest Surveillance Kit is an open hardware and software kit that aims to repurpose surveillance technology to bring people and their communities together to protect their forests (Ângelo and Mendes 2013). Resulting video streams and collected data are expected to be uploaded and then become part of the online platform network for crowdsourced surveillance and artistic manipulation purposes (Fig. 5).

Recognizing that "to prevent and control destructive forest fires, the involvement of communities is crucial" (FAO 2004), the kit has also been a seed for workshops that provide communities with the skills and resources to help deploy new nodes in the ARTIVIS network. These workshops consist of assembling the open hardware kit for forest surveillance and hands-on creative experimentation with real-time video.

An ARTiVIS kit is composed of a series of hardware modules that can be chosen from common off-the-shelf parts depending on cost, power, network bandwidth or infrastructure restrictions. These hardware modules are controlled by a set of software modules connected to the ARTiVIS online platform. In technical terms, the kit is provided as an open specification for building hardware compatible with the platform, an open hardware reference implementation that can be used for community workshops and for the interactive experiences, and open source software that runs on the kit and interfaces with the platform (Fig. 6).

Early development work on the kit's design was performed throughout the development of the ARTiVIS interactive installations. A solar power supply is currently being designed to allow kits to be more autonomous when deployed in the field. Limitations to overcome include telecommunications issues related with network signal, strength and speed. Further iterations will allow the registration process for the ARTiVIS online platform and the implementation of this open source hardware and software surveillance kit, together with its broad dissemination. Moreover, we foresee growing a developer community around the project that helps maintain, improve and adapt the kit to specific environments and for other purposes, such as replacing expensive hardware setups for remotely watching animal behavior.

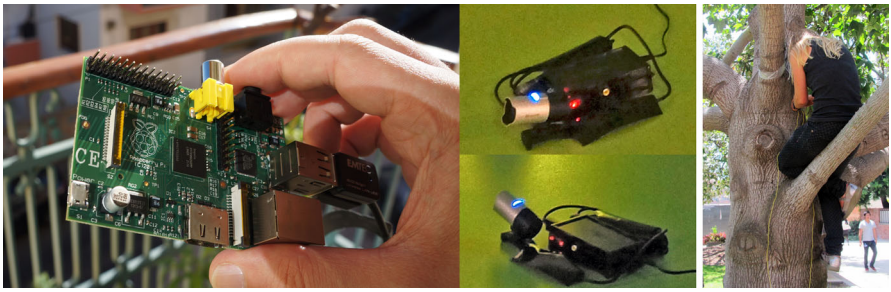

Fig. 5 Prototype of the ARTiVIS surveillance kit showing the CPU module based on the Raspberry PI platform, using a USB HD camera as camera module, and a USB mini WiFi adapter as network module (*left* and *center*), and deployment of the kit (*right*)

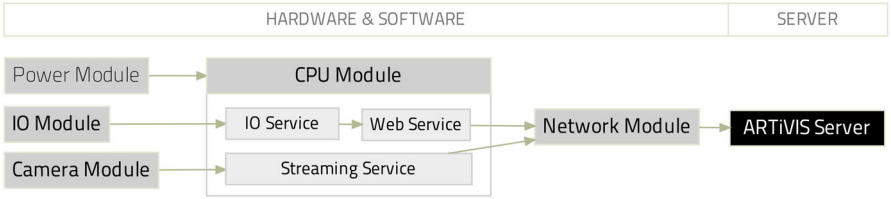

Fig. 6 ARTiVIS DIY forest surveillance kit system architecture

This ongoing collaborative research effort is documented with more resources and technical details in the project website.[21]

B-Wind!

What is the feeling of becoming the invisible wind? Will you cherish the trees, or will you trigger a hurricane?

Inspired by these questions, the B-Wind! interactive installation was designed for users to perform the invisible character of the wind, triggering visual effects on the onsite projected footage of the forest and at the remote forest itself. B-Wind! bridges the physical and the digital world, connecting users to the forests and raising awareness on environmental sustainability by letting the audience play the role of a natural element in first person and in this way affect the environment. In B-Wind!, we focused on the poetry of movement to bring attention on how local action can have consequences in remote places (Fig. 7).

B-Wind! embodies a choreographic approach to raise awareness on nature and the poetry of movement, engaging its public by demonstrating a real immediate interaction effect between their actions and the chosen natural setting. The installation is implemented as two connected spaces. On the first space there is a large scale projection of the video stream of a remote forest, and in front of this projection the users' movements are captured and used to control the rendering of

[21] http://diy.artivis.net.

Fig. 7 B-Wind! Interaction effects both indoors on the real-time video projection and outdoors on the fans activation on the trees

visual effects. On the other space, at the remote location, the users' motion is used to control wind fans that influence the real trees. This concept recalls Edward Lorenz's metaphor on the "butterfly effect" (Dizikes 2008), in which the wind waves are provoked by the subtle flickering have the "hurricane effect" in a remote place. What B-Wind! proposes is, in fact, close to the concept of telematic experience, which was technologically very demanding. However, the ultimate challenge of the B-Wind! interactive environment, was to be responsive and able to provide an immersive experience that make us abstract from reality, close to the magic circle evasion from reality (Huizinga 1955).

The installation used a commercial IP camera at the forest location wired to the installation space, where a standard webcam and custom computer vision software captured the users' movements and translated them into visual effects over the video projection and into speed control commands which were sent over DMX to the wind fans running in the forest location.

B-Wind! was mostly developed during a residency at O Espaço do Tempo, in Montemor-o-Novo, Portugal, where it was assembled for the residency showcase and publicly exhibited for 3 weeks. During this exhibition period, another camera was used to remotely monitor the exhibition space and record participants' interactions for further study.

Hug@ree

Everyone should hug a real tree every now and then… Hug@ree and engage into a symbiotic relationship with nature.

This was the motto adopted for Hug@ree. Motivated by fostering close exchanges between humans and trees, Hug@ree provides a bond between urban beings and the forest, pointing at a fun and nature friendly use of technology, creating awareness and promoting nature friendly practices. Hug@ree promotes affection through physical contact with nature, highlighting how simple individual actions can collectively become relevant (Fig. 8).

The Hug@ree interactive experience encompasses two distinct moments. An instrumented tree outdoors detects participant's hugs and transmits the information

Fig. 8 Hug@ree installation: a real tree being hugged, and interaction indoors shows the tree in real-time with the videoloops generated from the tree hugs outdoors. Participants drag the small videos in the touchscreen interface, becoming part of the human hugs foliage

to an indoor space. While a camera continually records the tree outside, custom software captures and keeps the last few seconds of video. When a hug "trigger" reaches the wireless radio receiver, the software saves the video and sends it to an interactive tangible projection. Then, participants place the video loop of their own hug on the screen tree, becoming leaves of a collective experience in a videoloop hugs gallery. The hugs are both displayed locally as a video collage and are shared with other Hug@tree installations around the world, creating a global shared embrace of nature. Hug@ree addresses networking practices and actions that contribute to influence the current behavior regarding environmental protection. While conceiving and designing Hug@ree we enjoyed thinking that participants will be stimulated to remember to hug trees even later on in their lives, and start to thinking of them as living generous and silent friends. A healthy relationship between humans and nature is an essential element that today's society needs to cultivate and prioritize. We hope through our installation to raise some awareness in that direction.

The development of Hug@ree started at an AZ Labs sprint project, a 2 days focused work marathon where a team of programmers, hardware hackers and activists got together to build a working prototype of the installation. After the initial prototype, development continued iteratively along a series of public exhibitions of the project, where necessary site-specific adaptations were performed and where data from user observation and testing was incorporated into the next development steps.

Hug@tree is an ongoing evolving interactive art installation. It has been shown and adapted to several international venues (Fig. 9).

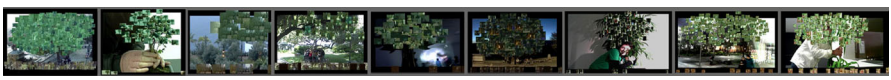

Fig. 9 Hug@tree previous presentations: Pop Up in Lisbon, AZ hackmeet in Porto, Artropocode in Santiago de Compostela, UCLA in Los Angeles, Summer in Maçal do Chão, Balance-Unbalance in Noosa, ISEA in Sydney, and European Researchers Night in Lisbon

The interactive installation premiered at the Pop Up collective exhibition in Lisbon in 2010. Its implementation in this cultural and urban context aimed to express cities' new values regarding sustainability in the present and the future. The project presentation included contributed photos and videos of people hugging real trees as part of the 350.org and Greenpeace "10/10/10 Global Work Party".[22]

Later, a bonsai "portable" version premiered at AZ Labs creativity hackmeet exhibition in Porto. Hug@ree was then presented at TEI'11 Art Explorations to foster locals' awareness of the rich natural beauty of Madeira island's Laurissilva forest endangered by recent forest fires.

A new Hug@ree node was installed at UCLA in the scope of the Summer Institute program of the SciArt NanoLab under the theme "Imagine the Impossible", and it was presented in the environment day subject sessions. A modified version of Hug@ree was essayed during the first Artropocode meeting, in Santiago de Compostela, where Hug@ree was presented as a demo. In the most playful part of the meeting, Hug@ree became an extra entertainment during the night, allowing us to grab surprising screenshots with the VJ performance and the participants dancing scenario. Another Hug@ree node has been set up in the Summer season at the small village Maçal do Chão. We started the use of the DiY Forest Surveillance kit and a portable touchscreen in our participation in both Balance-Unbalance in Noosa and ISEA in Sidney, premiering ARTiVIS in the Australian continent, followed by the European Researchers Night in Lisbon.

The installation was later redesigned by a broader team for Hug a Tree in Africa, presented at the 2014 Participatory Design Conference Art Track, where the connection among different tree nodes and humans was highlighted by connecting Trees from Portugal and Namibia (Mendes et al. 2014b). The installation was presented simultaneously in three remote places and video loops were placed in the tree foliage of the trees in the diverse places. Hug a Tree in Africa makes use of human participation and technology to provide connection on three different levels: by connecting trees from distant places among themselves, by connecting trees with people that love them, and by connecting nature lovers with other nature lovers from distant places.

Play with Fire

Challenging constraints, 'don't play with fire' is the motto for this experience, assuming both wild and innocent sides, rebellion and protectionism.

Play with Fire explores the paradox between the aesthetic wonder and danger of forest fires. In a game-like environment with negotiable consequences, participants become aware of the consequences of forest fires. The score is a measure of the destruction—here the game is subverted and participants get a real notion of the consequences (Fig. 10).

Play with Fire is a performative, immersive experience that invites people to interact with real-time video from selected forests by playing with virtual fires through gestural interaction. This interactive digital art installation was conceived

[22] Hug@ree "10/10/10 Global Work Party" in 350.org. http://archive.350.org/hugree.

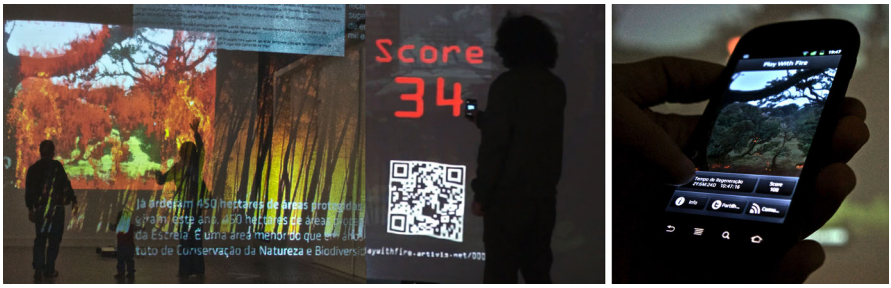

Fig. 10 Play with Fire installation at Creative Algorithms exhibition. Scenes show the news mashup and participants interaction, score result and the mobile application displaying the result consequences

and designed in order to stimulate activism and raise awareness in the area of sustainability and climate change, particularly related to forest fire hazards. With Play with Fire we proposed acting in the setting of a performative art installation as a means to understand the implications of forest fire hazards and their connection with sustainability and climate change.

The Play with Fire experience initially presents its audience a mashup of forest fire news, followed by the participants playful interaction with fire on the forest projection through a gestural interface. Finally, Play with Fire connects to its audience mobile phones granting access to a user specific web application depicting the forest they burnt, regenerating in real-time. Depending on the user's performance, the forest will take from some months to years to return to its original state.

Play with Fire triggers controversial feelings by combining "the wonder and danger" of a forest on fire, effecting attitude change towards environmental protection. The experience paradoxically encourages playing with forest fires, in order to raise awareness towards its prevention. This duality becomes part of the experience, and raises concerns in the audience mind, such as the pleasure and excitement of playing with fire versus its effects on a natural resource such as a forest. The experience concludes with visuals of a forest virtual regeneration process underlining the message: the forest will eventually grow again, but what is the price?

Play with Fire as an artistic experience has been designed, from the beginning, to be ambiguous, even "wicked". Questions raised by the audience in public presentations have focused mainly on its paradoxical nature: "Won't Play with Fire inspire people to be arsonists instead of forest caretakers?"

Play with Fire uses two mechanisms to convey its message. The first is procedural rhetoric, where the participant plays with a system in a game-like environment and through this is able to understand the perverse dynamics of forest fire. The second mechanism is cognitive dissonance, where after his destructive play, the player is confronted with a "score" that reflects the time it will take for that forest to recover from his actions. The mobile application where the player can accompany the forests recovery in real time is key for reinforcing this message, that is needed to inspire change in personal attitude towards forest fire. A constant

reminder of the experience to be treasured and shared by the participant for a long time.

The implementation of this experience brings some important technical challenges, namely the capture of user gestures, the real-time rendering of fire effects, the illusion of destroying a forest over a real-time video stream, and the mobile component of the experience. After the conception, design and initial prototyping of Play with Fire, the main implementation took place with the collaboration of the members of the multidisciplinary team developing the interactive installation. Development started with building on the outputs of the previous interactive installations, especially B-Wind!. Play with Fire was accepted for development at the AZ Labs Colab projects residency in October 2011 at O Espaço do Tempo, followed by a week of public exhibition. Regarding research work in progress and dissemination, the conceptual framework and developments were presented at ISEA 2011, integrating the Sustainability panel. A scaled down version was demonstrated at ACE 2011 Creative Showcase and Interactive Art. The full implementation of the interactive installation premiered at the Creative Algorithms exhibition at the Knowledge Pavilion in Lisbon, where the main set of tests and user observation were done. Play with Fire was also presented and tested at the Pop Up event in the scope of Guimarães 2012 European Capital of Culture.

These presentations in urban cultural contexts were followed by a demonstration at the small village in the North of Portugal, Maçal do Chão, in order to present an artistic approach to a rural population affected by forest fires and to test the feedback of the different local cultures.

At the DIS 2012 Demonstrations we set up a presentation of the fully working scaled down demonstration that allowed participants to play with fire and to visualize the videos of previous exhibitions (Fig. 11). Finally, evaluation results were presented at NordiCHI 2012 (Mendes et al. 2012).

Emerging Themes

Through the development and public presentations of the various components of the ARTIVIS project, we gained significant experience with the important technical issues surrounding the creative use and appropriation of surveillance technologies, especially real-time video. We also had the opportunity to witness first hand the possibilities afforded by the use of these technologies for artistic and civic purposes (Fig. 12).

The development of some of the project components, like the DIY kit, was sparked by the high cost and lack of flexibility we faced when attempting to use off-the-shelf surveillance equipment. The development of other components, like the online platform, was also impeded because the technology we needed wasn't openly available and the cost of commercial alternatives was prohibitive for our budget. These difficulties however led us to an important observation, that open, low cost, easily available hardware platforms like the Raspberry Pi could be used to replace and improve upon existing commercial solutions for video streaming while at the same time allowing for more flexibility in what they could be used for. The kit's

Fig. 11 Play with Fire installation at Civic Veillance workshop demonstration at JRC-IPSC. Scenes show the surveillance camera outdoors, participants interaction, and the resulting score with the corresponding consequences

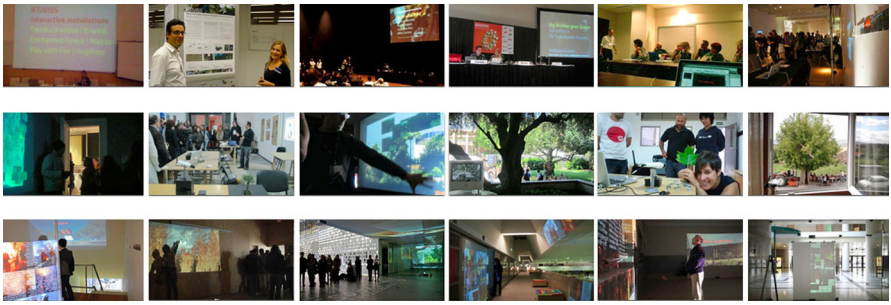

Fig. 12 A sample of the many public presentations of the ARTIVIS research including residencies, hackdays, workshops, exhibitions, conferences and seminars

development process included a series of community workshops where the participants learned how to assemble their own kits and explored the creative possibilities of real-time video streaming for use on their own projects (Ângelo and Mendes 2013).

The use of low-cost DIY streaming nodes led us to another important observation, that the centralized online video streaming platform we were trying to build could mostly be replaced by a distributed, peer-to-peer network of video streaming nodes operated by users of the platform and that the hardware's flexibility would allow us to stream other kinds of environmental sensor data. This concept has powerful implications for environmental protection, that communities could get together to assemble these community-based sensor networks to monitor and protect their own natural resources.

Another relevant question was raised by the development of the ARTIVIS interactive experiences, especially Play with Fire, which was that although they seemed compelling to participants as aesthetic experiences, we had no way of knowing whether the intended meaning of environmental awareness was being transmitted effectively. In order to do so we invested part of our research work in the analysis of current methods of ascertaining user experience in Human–Computer Interaction (HCI) and on developing hybrid methods that could answer these questions. Beyond illustrating the potential of using HCI as a tool for artistic expression, our results have shown that interactive experiences involving real-time

video can be used effectively as drivers for establishing emotional connections with nature and environmental awareness. These results also open the door for another important avenue of research, that of extending these design and evaluation methods to interactive experiences that use data from distributed environmental sensor networks for civic awareness and engagement.

These two themes, community-based sensor networks and artistic explorations of environmental data for civic awareness and engagement, have emerged from our research and became our current research focus.

Community-Based Sensor Networks

The idea of community-based sensor networks builds on the increased connectivity of devices, systems and services promoted by pervasive computing technologies widely known as "The Internet of Things" (Ashton 2009). Through pervasive computing technologies the networking logic becomes applicable in every realm of daily activity, in every location and every context. This widespread availability of pervasive technology is empowering individuals to collect and understand sensor data regarding their context of life and the world around them.

The bottom-up decentralized approach we envision is focused on openly accessible technology to encourage voluntary cooperation and support individual and community empowerment, balancing off the asymmetry between citizens and powerful institutions that rely on centralized points of control like big corporations and governments, jeopardizing the potentially beneficial social impact of cooperative data sensing to drive community engagement, citizen science, public policy, natural resource allocation and environmental protection.

Many successful examples of community-based sensor networks already exist like the Air Pi Air Quality and Weather Project,[23] the Safecast Radiation Monitoring Network,[24] and the Blitzortung Lightning Detection Project.[25]

Although still mostly based on custom hardware and software, the development of these networks is becoming more accessible due to the proliferation of low cost open hardware connected device platforms like the Arduino Yun,[26] the VoCore[27] and the ESP8266,[28] and of web platforms to aggregate and publish the data like Thingspeak,[29] MediaSense,[30] Nimbits.[31]

However, the development of these networks still faces significant technical and social challenges. On the technical level the existing sensor network architectures

[23] http://airpi.es.

[24] http://safecast.org.

[25] http://blitzortung.org.

[26] http://arduino.cc/en/Main/ArduinoBoardYun.

[27] http://vocore.io.

[28] https://nurdspace.nl/ESP8266.

[29] https://www.thingspeak.com.

[30] http://www.mediasense.se.

[31] http://www.nimbits.com.

encourage the use of a central server to aggregate sensor data, creating a single point of failure and increasing storage and bandwidth costs. These centralized servers also tend to create data silos posing difficulties for applications which need to combine data from different networks. Creating distributed networks of hardware nodes that collect, process and store data is the solution to this problem—although the standards and tools to help communities easily design and deploy these decentralized networks are mostly non-existent, we are actively working to develop them. A distributed network in which participants can voluntarily add nodes to the network also raises questions regarding data quality. In this regard our work is focusing on the study of strategies that leverage consensus between nodes that participate on the network.

A major social challenge for community-based sensor networks is their accessibility to communities. While focusing on low-cost and reuse of existing network infrastructures is a first step, the major problem is how to make these complex technical platforms accessible to as many people as possible. This requires the production of open educational materials, to be used to support community workshops and field activities that engage populations to build their own sensing networks and to use them effectively to protect their natural resources.

Another challenge to investigate is how open data initiatives, particularly those associated with environmental monitoring, are addressed by relevant policy at the local, regional, and national levels. Community-based sensor networks are uncommon, and they present numerous issues: how should broadband (or other) networks, many of them privately owned, handle such data? how might policymakers categorize such services in order to facilitate transmission and data sharing? how do current e-government efforts handle open data, and what models do they offer for the arrangements that might facilitate community-based sensor systems for social purposes? what practical problems might widespread sensor systems pose that would require policy action?

Our path towards answering these challenges posed by community-based sensor networks focuses on an integrated approach that combines the development of open hardware and hardware and software tools, the study of supportive policy frameworks and field activities to help real communities to leverage this technology.

Artistic Explorations of Environmental Data as Drivers for Civic Engagement and Awareness

Whereas artistic validation is partly a consequence of public presentation in exhibitions and other artistic and research contexts, the interactive experiences developed in the scope of the ARTiVIS project were meant not only to create compelling aesthetic experiences but also to promote environmental awareness. During the development of these interactive installations, some questions were prevalent: is it being effective? Are these experiences making people more aware of the underlying environmental concerns? Are we achieving our goals with it?

In order to answer these questions we looked into the tools and techniques of Human–Computer Interaction (HCI) to attempt to measure how effective these

Fig. 13 B-Wind! exhibition surveillance—82 h of recorded video

experiences were. The evaluation process evolved gradually from more standard usability aspects at the beginning to more subjective issues like subjective experience and environmental awareness.

In B-Wind!, we introduced observation in order to capture user behavior, which allowed us to better understand user behaviour and uncover several usability issues (Fig. 13).

In Hug@ree, we have introduced construct elicitation adapted from the repertory grid technique in order to capture emotional response to the installation (Mendes et al. 2014a).

In Play with Fire we introduced a hybrid method that assessed the users response over several experience dimensions—environmental awareness, emotional engagement, learning, usability, playful experience, aesthetic enjoyment—and correlated them to discover which factors were most important to promote environmental awareness.

The results of these evaluations suggest a strong emotional response from participants in these interactive experiences, that a message of environmental awareness is being transmitted, and that learning about how natural phenomena function (for example learning about the causes of forest fires) is a key factor in environmental awareness. These results also validate the potential of using HCI techniques as a tool to design compelling interactive experiences, and our ongoing work aims to explore further links between Art and HCI, like including the input of art critics and curators in the design process and using non-verbal data gathering through instrumentation (e.g.: bio-signal, posture).

This approach has been furthered with art-inspired eco-feedback systems in the scope of the SINAIS project related with energy consumption (Nisi et al. 2013), and in the design of the energy production visualization (Quintal et al. 2014).

Our current work is focused on extending the methods we previously developed and apply them to the design and evaluation of new interactive installations and eco-feedback visualizations that use data acquired from distributed sensor networks as source material. Through aesthetic explorations of the topic, we aim at creating awareness and stimulating environment care and respect of natural resources.

Conclusions and Future Perspectives

In this paper we have presented the ARTIVIS project, an ongoing research on the creative appropriation of real-time video for fostering environmental awareness. Through the development of an open hardware kit for video streaming, a prototype

online community platform for collaborative video surveillance of forests and a set of interactive art experiences with real-time video of forests, the ARTiVIS project has explored a green facet of Big Brother that proposes to protect the forests through surveillance.

From the results of the ARTiVIS research, we found that combining Art, Technology and Science methods in design practice can be effective to promote environmental awareness:

- The ARTiVIS interactive installations show that real-time video can be used to design meaningful poetic experiences to articulate concepts and design learning tools to raise empathy and understanding;
- Results show that people were engaged and open to new research and artistic approaches in both urban and rural environment, arousing curiosity, interest, and support for future events;
- From this process, we infer that these experiences contribute to a feeling of belonging, providing contact with nature and leading to social change through awareness of environmental issues.

Throughout our work, controversies around the theme of surveillance, the power of art in activism and social responsibility were expected—and are desired as input for healthy discussions evolving into better, flexible and creative proposals, rather than rigid solutions. In ARTiVIS, Art as a territory of experimentation, contestation, and transgression is also undertaken as an effective approach for environmental sustainability. Under the crossfire of surveillance purposes and social consequences where privacy is also questioned, and the creative use of real-time video in artistic contexts, ARTiVIS has its own place. Our work is offered here as a case study for the appropriation and use of surveillance technology to empower people to have a positive effect in society.

Over time our perspective on these themes has gradually shifted from the initial centralized top-down view of institutionalized surveillance technology, to a distributed bottom-up notion of citizen veillance (Tallacchini et al. 2014) where communities collaborate voluntarily to deploy data collection technology for socially meaningful goals. Our current research is focused on exploring this theme of citizen veillance through two themes that have emerged from our work: the development of community-based sensor networks and the use of interactive art experiences as drivers for civic engagement and awareness.

We are in the course of developing an open source software architecture to build, deploy and manage fully distributed, peer-to-peer environment sensing networks and applications, and will investigate how the low-cost open hardware and software sensing platforms can be deployed in order to collect and process data leading to behavior change and environmental awareness through eco-feedback and interactive digital media installations, ultimately leading to the design of a more sustainable world.

Acknowledgments We thank the Portuguese Foundation for Science and Technology (SFRH/BD/42555/2007 and SFRH/BD/518481/2012) and the UT Austin|Portugal Program for funding this research

and creating a stimulating and supportive research environment. We would also like to thank the AZ Labs network, constituted by LCD, altLab, and xDA. These media labs have been crucial to the development and implementation of the interactive installations accomplished in the scope of this research. We would like to thank Madeira Interactive Technologies Institute for providing material and research support for the HCI research performed during this project. We thank Ângela Pereira, Susana Nascimento and Alexandre Pólvora, European Commission Joint Research Centre—Institute for the Protection and Security of the Citizen—for providing us with the opportunity to share our work in what was a novel context for us and to connect with other researchers interested in the civic application of surveillance technology.

References

Abramovic, M. (2010). The artist is present. MoMA: New concepts for performance, New York. http://www.moma.org/interactives/exhibitions/2010/marinaabramovic/marina_exhibition.html. Accessed 14 Jan 2015.

Ângelo, P., & Mendes, M. (2013). ARTiVIS DiY forest surveillance kit. In *Proceedings of the 19th international symposium on electronic art—ISEA2013*. Sydney. doi:http://hdl.handle.net/2123/9718.

Ashton, K. (2009). That 'internet of things' thing. *RFID Journal*, July 22, 2009. http://www.rfidjournal.com/article/view/4986. Accessed 14 Jan 2015.

Bilal, W. (2011). The 3rd I. http://www.3rdi.me. Accessed 14 Jan 2015.

Boardman, D., & Gerbaudo, P. (2010). In Fondo al Mar—Bringing poisons afloat. http://www.infondoalmar.info. Accessed 14 Jan 2015.

Bunting, M. (2009). The rise of climate-change art. In: Rethink—Contemporary art and climate change exhibition. The Guardian. http://www.guardian.co.uk/artanddesign/2009/dec/02/climate-change-art-earth-rethink. Accessed 14 Jan 2015.

Dizikes, P. (2008). The meaning of the butterfly—Why pop culture loves the "butterfly effect" and gets the it totally wrong. The Boston Globe, June 8, 2008 http://www.boston.com/bostonglobe/ideas/articles/2008/06/08/the_meaning_of_the_butterfly/. Accessed 14 Jan 2015.

EPIC—Electronic Privacy Information Center. (2002). Observing surveillance project. Washington, DC. http://observingsurveillance.org. Accessed 21 Jan 2015.

Evans, H. (2008). Nuage Vert. Cluster Magasine, 7. Torino, May 2008 http://hehe.org.free.fr/hehe/texte/nv/. Accessed 26 Jan 2015.

FAO—Food and Agriculture Organization of the United Nations. (2004). Involving local communities to prevent and control forest fires. *FAO Newsroom*. http://www.fao.org/newsroom/en/news/2004/48709/. Accessed 12 Dec 2014.

Forest. (2014). Forest Information System for Europe (FISE). European Commission Joint Research Centre Institute for Environment and Sustainability. http://forest.jrc.ec.europa.eu. Accessed 14 Jan 2015.

Fuad-Luke, A. (2009). *Design activism—Beautiful strangeness for a sustainable world*. London: Earthscan Ltd.

GMES. (2010). Forest monitoring, global monitoring for environment and security. European Space Agency and European Commission. http://www.gmes-forest.info. Accessed 23 Nov 2014.

Gouveia, C., Fonseca, A., Câmara, A., & Ferreira, F. (2004). Promoting the use of environmental data collected by concerned citizens through information and communication technologies. *Journal of Environmental Management, 71*(2), 135–154.

Griffith, A., Warren, J., & Wylie, S. (2011). From grassroots mapping to a public laboratory. *Citizen Science Quarterly, 1*.

Gurstein, M. (2007). *What is community informatics (and why does it matter)?*. Milan: Polimetrica.

Holmes, T. (2007). Eco-visualization: Combining art and technology to reduce energy consumption. In *Proceedings of creativity and cognition—C&C'07*. Washington, DC.

Huizinga, J. (1955). *Homo Ludens: A study of the play-element in culture*. Boston: The Beacon Press. (1st ed. 1944).

Kac, E. (1996). Ornitorrinco and Rara Avis: Telepresence art on the internet. *Leonardo, 29*(5), 389–400.

Kammerer, D. (2004). Video surveillance in hollywood movies. In: Norris, McCahill, Wood (Eds.), Surveillance and society, CCTV Special (Vol. 2, No. 2/3, pp. 464–473).

Lozano-Hemmer, R. (2006). Third person. Bitforms Gallery, New York. http://www.lozano-hemmer.com/third_person.php. Accessed 14 Jan 2015.

Luksch, M. (2007). Faceless. In *Goodbye privacy, Ars Electronica 2007, Linz*. http://www.ambienttv.net/content/?q=faceless. Accessed 14 Jan 2015. 1 Sep 2010.

Mann, S., Nolan, J., & Wellman, B. (2003). Sousveillance: Inventing and using wearable computing devices for data collection in surveillance environments. *Surveillance & Society, Foucault and Panopticism Revisited, 1*(3), 331–355.

Manovich, L. (2001). From DV realism to a universal recording machine. http://manovich.net/content/04-projects/029-reality-media/28_article_2001.pdf. Accessed 21 Jan 2015.

Mendes, M. (2012). ARTiVIS—Arts, Real-Time Video and Interactivity for Sustainability. Ph.D. thesis. Universidade Nova de Lisboa, UT Austin|Portugal Program. http://run.unl.pt/handle/10362/9752. Accessed 12 Dec 2014.

Mendes, M., Ângelo, P., & Correia, N. (2014a). Hug@ree: An ARTiVIS experience for sustainability. *Transactions Special Section: Balance-Unbalance. Leonardo, 47*(5), 500–501.

Mendes, M., Ângelo, P., Correia, N., Nisi, V., Nunes, N., & Costa, D. (2014b). Hug a tree in Africa. In *Proceedings of the 13th participatory design conference—PDC 2014*. Windhoek. doi:10.1145/2662155.2662220.

Mendes, M., Ângelo, P., Nisi, V., & Correia, N. (2012). Digital art, HCI and environmental awareness: Evaluating play with fire. In *Proceedings of the 7th Nordic Conference on Human–Computer Interaction, NordiCHI 2012*. Copenhagen, doi:10.1145/2399016.2399079.

Nisi, V., Nunes, N., Quintal, F., & Barreto, M. (2013). SINAIS from Fanal: Design and evaluation of an art-inspired eco-feedback system. In *Proceedings of CHItaly 2013* (pp. 3:1–3:10). ACM digital library.

O'Shea, C. (2009). Hand from above, interactive installation. http://www.chrisoshea.org/hand-from-above. Accessed 21 Jan 2015.

Paul, C. (2003). *Digital Art*. Thames & Hudson—World of Art: Thames.

Pine, J., & Gilmore, J. (1998). *Welcome to the experience economy*. Boston: Harvard Business Press.

Pleix. (2004). Netlag, world webcam map. http://www.pleix.net/Netlag. Accessed 14 Jan 2015.

Quintal, F., Jorge, C., Nisi, V., Nunes, N., & Mendes, M. (2014) Watt-a-feeling—Raising energy production literacy through a tangible installation. In *AVI 2014 international working conference on advanced visual interfaces—FSEA workshop*, Italy.

Stafford-Fraser, Q. (2001). The life and times of the first web cam. *Communications of the ACM, 44*(7), 25–26. http://www.cl.cam.ac.uk/coffee/qsf/cacm200107.html. Accessed 14 Jan 2015.

Stanza. (2010). Sensity. Futureplaces 2010. http://futureplaces.org/essays/stanza-at-futureplaces-2010/ Accessed 26 Jan 2015.

Stula, M., Krstinic, D., & Seric, L. (2012). Intelligent forest fire monitoring system. *Information Systems Front, 14*(3), 725–739. doi:10.1007/s10796-011-9299-8.

Tallacchini, M., Boucher, P., & Nascimento, S. (2014). Emerging ICT for citizens' veillance: Theoretical and practical insights. European Commission Joint Research Centre Institute for the Protection and Security of the Citizen. Publications Office of the European Union. http://publications.jrc.ec.europa.eu/repository/handle/JRC90334. Accessed 21 Jan 2015.

Utterback, C. (2007). Abundance. Camille Utterback, interactive video art. http://www.CamilleUtterback.com/abundance.html. Accessed 27 Jan 2015.

Veira, P., & Matos, J. (2011). Forest fire finder. NGNS—Ingenious Solutions. http://www.ngnsis.com/products/ngns-all-over/forest-fire-finder. Accessed 14 Jan 2015.

Vesna, V. (1998). Another day in paradise' and 'virtual concrete:' installation and telepresence works. *Leonardo Journal of the International Society for the Arts, 31*(1), 13–19.

Viegas, D. (Ed.) (2009). Recent forest fire related accidents in Europe. Centre for Studies on Forest Fires, European Commission Joint Research Centre Institute for Environment and Sustainability. doi:10.2788/50781.