BioCyberUrban ParQ: Brasilia's Smart National Park as an Extension of Our Senses

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Abstract. Brasilia Smart National Park as an extension of senses is the second stage of a project entitled parQ prepared in the Computer Art Research of the University of Brasilia (Midialab). The project was started in 2011 and aims to transform the National Park of Brasilia into a bio-cybernetic artwork. We introduced smart technologies that can scan signals/information issued by living beings, objects and the environment, to be used as parameters and variables of a Computational System of Senses Extension (CSSE), which will generate in real-time a multimedia concert based on gathered information from the park. The goal of BioCyberUrban parQ project is to connect the living things, objects and environment in order to enable their cybernetic communication/coexistence in Sarah Kubitschek Park (Brasilia's city park). Art and society context aim the processes of physical, intellectual and moral users consciousness development, along with all living beings in the City Park. Therefore we seek for a better ecosystem coexistence, integration and communication through the crowd-collected data as the foundation of this cyber community.

Keywords: Biocybernetic art · Multimodal interaction · Computer art · Pervasive computing

1 Introduction

The BioCyberUrban parQ project was developed at the Computer Art Research Laboratory (Midialab) in collaboration with laboratories from the Faculty of Technology and the Scientific Technology Development Center (CDTC), both from the University of Brasilia. It started in 2011 and was designed to be developed in stages, as raising funds for its development. Undergraduate, graduate and post-graduate students from the University of Brasilia and the Community College of Brasilia (IESB) are involved[1].

[1] The main students involved are Guilherme Shimabuko, Marcelo Rios, Juliana Hilário, Ana Lemos, Bruno Braga, Sidney Medeiros, Camille Venturelli Pic, Claudia Loch, Roni Ribeiro, Fábio Fonseca, Hudson Bomfim and Eber Felipe Oliveira.

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ParQ was be implemented in Sarah Kubitschek Park, which is the largest urban park in the world, with 1.62 square miles, overcoming the Central Park in New York. This park allows on foot or cycling activities for both amateurs and professional athletes. There is a 2.5 miles route for beginners and two longer routes for more experienced athletes, with 3.7 and 5 miles. Besides sport practices, there are several restaurants, a large woodland with picnic tables, an amphitheater, a kart track, playgrounds, an amusement park and an equestrian center. It is signed by three important people in the art, architecture and urbanism fields: the architectural design is by Oscar Niemeyer, the landscaping work was done by Roberto Burle Marx and urban area was developed by Lcio Costa (all of them have participated on the concept and construction of Brasilia).

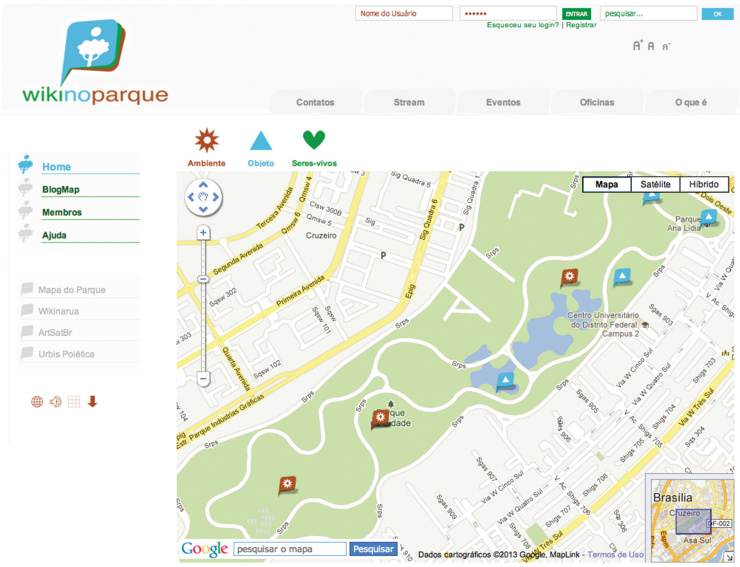


Fig. 1. ParQ social network interface (2014).

The development the parQ system [1] was separated in two distinct stages: The first one is composed by a social network [2], (Fig. 1), an android app to explore the park (parQ), pedParQ android app for counting footsteps, a cyber-object bench with a scale for measuring weight (Fig. 2), QRCode signposts (Fig. 3) and an ambient sound for plants and humans composed by sensors (further explained in Sect. 3). All these components aim to encourage coexistence among living things, objects and environment, to enable the coexistence and cybernetic communication in the City Park of Brasilia.

The social network parQ was implemented in 2011, adapting functions such as the graphical user interface and the database server itself from Wikinarua [3], integrating the park's security cameras with the social network, a web-radio, network communication implementation and data interaction visualization between living beings, objects and the environment. The second stage aims to develop

and install cyber objects in the park, with a function to communicate and feed the social network and mobile devices by sending different types of information. That is, while being used by the public, these objects are build up according to their interests.

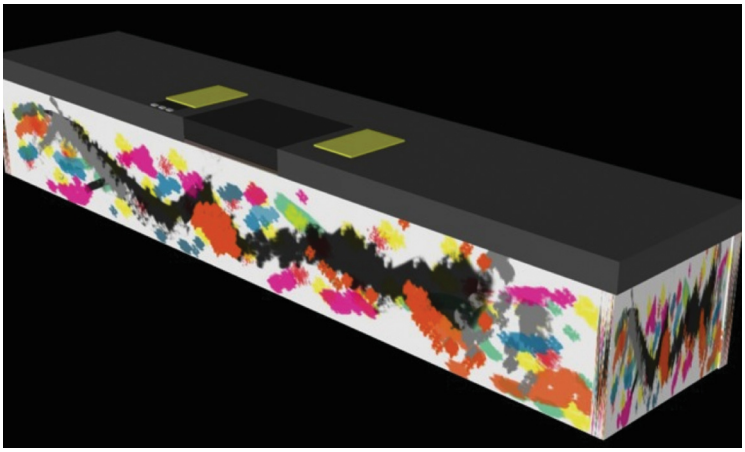


Fig. 2. Exact 3D model of the implemented bench-scale.

The system has three main principles: the first one is knowledge about the operating environment, the second is reproduction quality and the third is presence metaphor. By definition, it is a social network as a social entities set, such as individuals or social organizations connected by relationships built from their social interactions. With the advent of Web2.0, new possibilities and paradigms have emerged. Between these newborn paradigms the most relevant for this social network is the content and modeling construction of its final shape been made through user interactions. With this new user provided content there might be the rise and formation of new social groups.

The main features of parQ are:

- Computational open platform;
- Collaborative Mapping/Data crowdsourcing;
- Interaction between members;
- Data Sharing;
- Construction of Identities;
- Augmented Reality Application;
- Distribution and communication of applications, games, cyber objects and widgets;

The project assumes that currently one of the most important subjects in the urban context addresses the reshape of the infrastructure in the urban centers to become intelligent, self-sustainable and humane. This project is moving along

Fig. 3. 3D simulation of QRCode signpost and smart trash can final design.

this line of questioning, reflecting that this idea can extend the social relations and allow people to participate deeply in the life of the city to maintain the balance between the natural and the artificial elements. In this context, the methodology applied considers that it is vital to develop interfaces for natural interaction human- computer, which in this project, the search for a practical way to connect the living beings, the environment and the objects of the City National Park, in a aesthetic perspective.

The connection, occurs whereas the theories of sustainability, as well as the computational art, the calm computer technology, ubiquitous computing and pervasive, Augmented Reality, the design, among other studies, which can contribute to structuring the poetry of an artistic computational ecosystem.

2 Theoretical Framework

In parQ's theoretical context Art, Computer Science and Engineering fields are involved in order to develop objects whose characteristics are derived from ubiquitous and pervasive computing. Giving continuous communication and computer technical progresses, it seems that we're riding in complete computing activities integration into human everyday.

The creative process in this project involves clear notions of pervasive computing where computers are within the objects. Moreover, the project uses the ubiquitous computing in which computers are scattered and hidden in the environment of the Brasilia's City Park, an ubiquitous art inclusion into everyday life. According to Luigi Carro and Flvio Rech Wagner [4], there are currently great demand for mobile computing, ubiquitous and high computational power.

This proposal has also been inspired particularly by the autopoietic mechanisms of life and the reflection of how living things are organized, developed, evolved and adapted to the environment. The concept of autopoiesis, as the organization of the living, originated in the Chilean biologists Humberto Maturana and Francisco Varela work in 1970s [5]. This idea was developed in the theoretical biology context and was early associated with artificial life simulation long before the term artificial life was introduced in the late 1980 s in [6]. Pier Luisi presents a good concept review in [7]. Besides we are influenced by the work of Garnet Hertz [8] and Stocker and Schopf [9].

When items are organized in a system, the interactions between components cause a qualities set, which is not owned by any isolated component. For example a given capacity of a living being, like running, cannot be expressed by any of its isolated organs. In the same way a machine like a computer has higher qualities levels than the sum of its parts. Some the objects we're developing aim to use living being knowledge to solve problems. They represent knowledge, data gather or rules like any other computer. These rules and data might be triggered when necessary by digital devices. These objects possess a software layer that allows them to execute some tasks which might involve a decision making process. This knowledge is some times incorporated by some snippet code in order to reflect a knowledge change in the code itself.

The ParQ project presents a systemic approach, since it's being developed in the context of pervasive and ubiquitous computing, which thus is required. We recur to Weiser and Brown's concept of calm technology in order to project information systems able to perform in the outskirt of our attention, based on cognitive psychology studies about attention mechanisms [10].

All computers and intelligent machines as we know today are cybernetic applications. Cybernetics has also provided powerful methods to control two main systems: society and economy. A cybernetic system may be identified as an element set, which interact with each other. These interactions set might be based on substance information or energy exchanges. The elements of this compound system react and change according to these exchanges, changing itself or the possible interactions set with other compounds. Communication, signal, information and feedback are main concepts of the cybernetic field, fitting all criteria to also be an autopoietic system.

Ubiquitous computing will let the user visit the park without paying too much attention to the fact that there is a computer system allowing a more natural and transparent human-computer interaction. On the other hand, pervasive computing enables this natural interaction since the gathering and interaction data been made through everyday objects, embedded with computing devices. This mix of ubiquity and pervasiveness enable a cybernetic communication fluid among living beings, environment and cyber objects [10]. Mark Weiser in 1988 proposed this new idea with the phrase ubiquitous computing, when he was Xerox Palo Alto Research Center (PARC) Chief Technologist.

At the same time one aim to dilute the devices medley that surrounds computer technologies, parQ seeks to make unnecessary too much cognitive effort

from the users to perceive the motivation behind the artistic proposal, using ubiquitous computing. By adopting unexceptional objects and expanding some of their original functions with computing devices that can process information and communication with other systems, like our social network.

It also involves an environment information system, containing the data visualization gathered from animals and environment. In order to achieve it we do recur to biosensors, which are sensorial devices used to determine the concentration of substances and other parameters that might be interesting from the biological point of view. These biosensors might communicate wirelessly, like smart sensors to enable the digitalization of such environmental data. The correspondence between the system and the real world considers that the information is truly relevant also from an aesthetic point of view.

Finally this research considers the Soundscape concept, as invented by Murray Shafer and the World Soundscape Project (WSP) [11], in order to understand the intersections between art and science in a transdisciplinary ambient acoustic project. We aim to find out which are the main aesthetical principles that regulate the sonic environment of the City Park, including the connected devices, people and the park itself.

3 Our Senses in Landscape

In some countries the parks are important areas of transformation. For example, architects, artists, private sector and public authorities of Rotterdam, the second largest city of the Netherlands, came together to create a green space that is both recreational and garbage recycler at the same time, called Recycled Island [12].

This garbage island is about floating space that helps to troubleshoot a major challenge faced worldwide: ocean pollution by plastic artifacts. They intend to create an artificial island that will recover waste plastic from the Nieuwe Maas river before reaches the Northern Sea. Nevertheless this island is meant to be also a park where people can have recreational activities.

According to creators, this is possible because the garbage collected is relatively "fresh" and therefore has a higher potential for recycling. Furthermore, the building blocks are designed in a way that plants can grow. The bottom platform has a rough rustic finishing where plants may have sufficient surface to grip and fish will have a place to lay eggs.

In a similar way, The "Noah's Ark" [13] project is another interesting example. Based on the biblical legend, this dashing space that floats amid the ocean will provide food through the agriculture in fertile lands, filter rainwater and use solar, wind and waves clean energy. The project was created by a couple of architects from Serbia, Aleksandar Koksimovic and Jelena Nikolic, has the shape of a buoyant and sustainable space that aims to harbor the survivors of natural disasters.

Designed to be itinerant, this structure has rings and underwater towers, responsible for the Ark stability. Noah's Ark is a self-sustainable floating city

that is able to support a wide series of living species, from aquatics to terrestrial beings that might have been evicted from homeland by natural disasters or even war.

These floating buildings are also able to connect to other floating structures or ships and boats through a submarine cable network, as well as to dock on land - particularly in order to rescue of the survivors.

Another important work we are studying relates to the urban water sources and is called Nascentes Urbanas, which aims to restore and preserve existing water sources, springs and streams in urban and rural environments. It aims to maintain the natural underground water supply network in order to extend its reach, contributing to effective preservation of groundwater. They aim to maintain and preserve the riparian areas through reforestation and mitigate the causes and effects of pollution, which causes flooding, droughts, soil erosion and siltation of waterways.

The riparian reforestation associated with a fauna and flora protection plan aims to enable the creation of ecological corridors, preserving biodiversity, harmonizing the management of water resources with regional development and environmental protection. It might also encourage the protection of waters against actions may compromise the current and future use.

Socio-educational activities on rational use of water, prevention of soil erosion, promotion and integration of actions in defense against critical hydrological events that offer health risks, public safety, economic and social losses are of extreme interest. Such actions will be possible through a network of partners and project staff through social technologies. Community participation in such actions is possible through distributed work centers.

4 Human-Computer-Nature Interaction

The users of the city park are an active part of the artwork, because they can collaborate with its extension or not. To achieve and facilitate this collaboration we are currently working with wireless sensor networks. Those networks, at our current development stage, presents the most appropriate technology for the creation of a pervasive and ubiquitous computing system that allows the user to listen a multimedia concert composed in real-time by the sensor gathered information (Fig. 4).

In our approach, the constituent elements of the park can communicate and therefore provide feedback information to the CSSE. For example, a user can track its path while running in the park and, at the same time, warn about any infraction against the environment or it's living beings by sending messages through the CSSE, Through their mobile devices, these data are supplying the aesthetic component of multimedia concert composer.

We are also considering the creation of a multimodal Human-Computer-Nature Interaction related to a connection between the virtual and physical environments through natural modes of communication [14]. In this sense, we

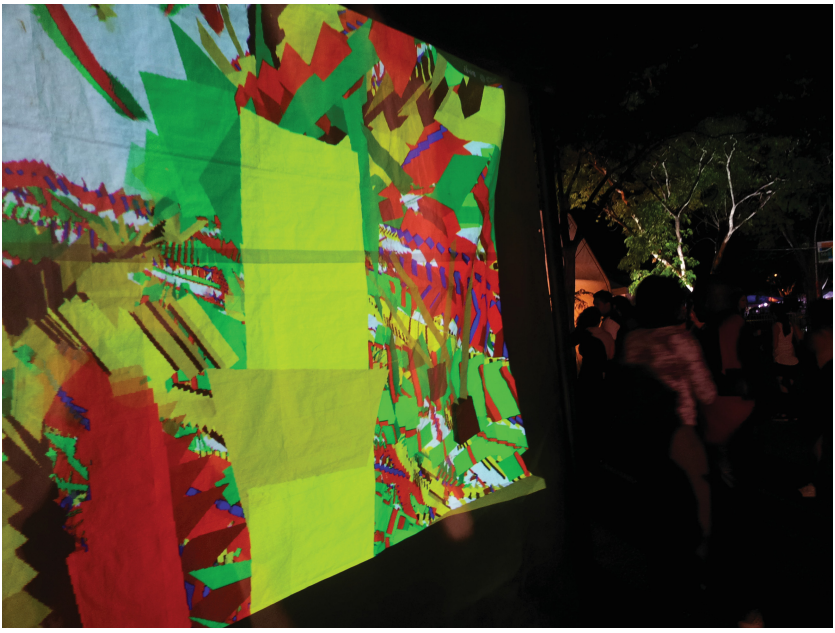


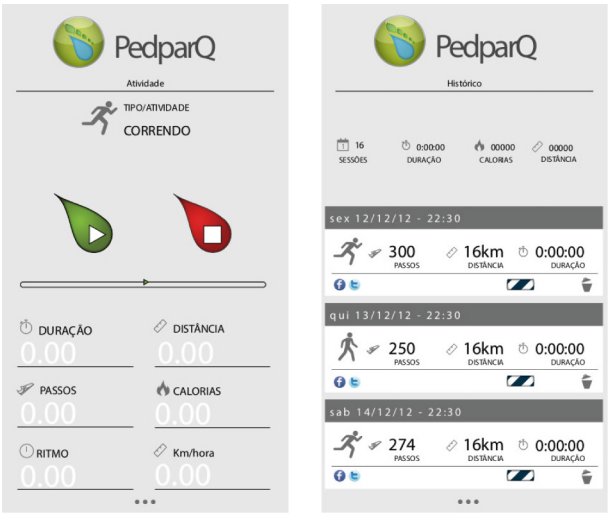
Fig. 4. 3D simulation of QRCode signpost and smart trash can final design (2013).

understand that the natural and the digital environments might be represented as cooperation between emotional and intelligent machines, thus creating and emotional and intelligent environment with living species.

In order to explore this multimodal interaction some artists are currently transforming signals emitted by nature, as signs of plants, animals or the environment, to show the possibility of coexistence between different species, causing changes in our own perception about the meaning of life.

One example of this interaction is a game-art (Fig. 5), developed during the first stage of this project and currently under extension that aims to connect the park users with our parQ network through the use of mobile devices. The game entitled PedparQ [1] (ped stands for feet in Portuguese) aims to avoid user sedentarism. Therefore, when activated, PedparQ counts the footsteps and if it doesn't reach a minimum, will consider the user as sedentary and in this case an alert sound is played on the mobile device. This game art will be connected to parQ social network and will send automatically this data.

For the second CSSE development stage, there are trash bins that send an alarm signal when they are almost full. Bikes can transmit real-time images of the environment; a park bench may have a function of weight balance; a fitness bar extends its function and monitors users physiological signals; a totem displays and sends information about the air quality.



(a) Application menu (b) User's activity history

Fig. 5. PedParq application running in an android phone (2013).

Through this multimodal signals, the CSSE will allow the visualization of data variation that later will be analyzed though data mining algorithms in order to detect whether the park is in harmony or not. Then it can respond by turning the lights on, generating sounds, flash messages in led panels installed in the park or around the lake, compose a multimedia concert with images and sounds. Then, the whole park becomes a live element, starring the scene, in constant aesthetic transformation.

In addition to user-dependent interfaces we are designing a sensor wireless network involving specific data-gathering devices distributed along the park. Those connected nodes are able to pre-process, store and send sensing data to adjacent nodes. Through the analysis of each node we can measure various parameters for a more effective management of the park network.

Those independent sensors are a subsystem that feeds a collaborative online data management platform, which stores the information to an open database. Open data can be interpreted and visualized by third-part applications, like the Wikisensing [15] platform.

Other services allows developers to incorporate real-time graphics and widgets on third-part web sites, as well as analyze and process historical data taken from data feeds and send real-time alerts from any data flow to control scripts, devices and environments. We highlight in this proposal the sensors relevance as a fundamental part of the new interfaces that promote more natural interactions to the user.

Sharing this approach, the artist Victoria Vesna, created an acoustic networks of birds [16], this three-year research project is led by evolutionary biologist Charles Taylor. This project has helped to expand our acoustic senses in

our daily environment and called our attention the Santa Monica Mountains where they went on songbird recording and tracking. It is quite a challenge, since this research aims to go beyond the territorial and mating aspects of bird communication. They aim to discover semantic and lexical data in bird singing.

Another interesting art project that dialogues with our main concepts is entitled Telebiosfera [17], developed by Carlos Nobrega (2014). He aims to build a hybrid environment (composed of natural and artificial elements), in which an immersive experience is possible through telematics bio-communication between distinct geo-located ecosystems (Fig. 6). This telematics communication occurs between two small domes that allow the visitor to view and interact with a remote peer environments. Each Telebiosfera is meant to receive and transmit ecosystem images and data in real-time.

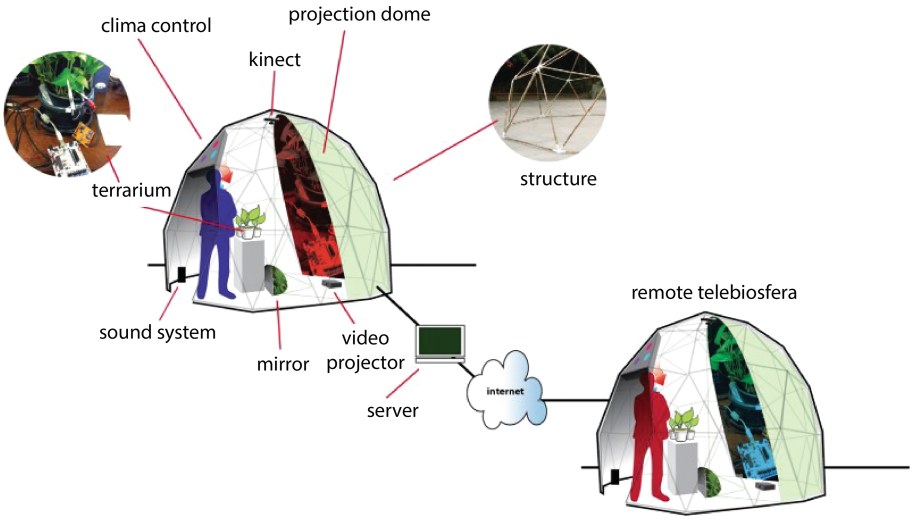


Fig. 6. Telebiosfera architectural diagram (2014).

Artists Sabrina Maia and Lasaro Camargos developed an artwork entitled eSYLPH [18] that allows the user to experience a electronic presentation of elsewhere blowing wind. Each time a user presents itself in front of the camera sensor a geographical position is randomized and then is presented as digital sylphs based on weather forecast application programming interface (API).

Those mutant sound clouds are audio-visually rendered in real-time and materialize according to the weather API data such as wind speed and direction that controls its virtual clouds chromatic variation, dispersion and movement.

Common features appear in the three mentioned artistic projects. First the multimodal interaction occurs between humans, machines and nature. Second, the technologies are not really suitable for this interaction, because the proposals

go beyond what machines are able to process. Finally, the interaction generates visual and sound based on the perceived signals, causing new emergent aesthetic perceptions, dissolving the boundary lines between culture and nature.

5 Conclusion

The real - and most important - challenge in our project is to transform the traditional Brasilia City Park in a smart environment artwork, considering art as a major factor of social and ecological transformation. The concept of intelligent park is related to the proposal for shaping smart cities, which until recently was subject treated only in science fiction. The idea is to create sustainable and efficient environments with a high degree of connectivity and hence with better levels of life quality.

In a short time, the concept of smart cities has overstepped the academy and the utopic plane. What nowadays is included in the field of smart cities are ways of thinking about urban life and the use of technologies that, somehow, has always been among the concerns of urban experts.

As well as the projects mentioned above, our project was designed to be part of the urban nature. In our case, was designed for the National Park of Brasilia, combining art and technology. Our project uses multimodal technology that allows the ecosystem - its vegetation and the park environment - to express through sounds that are, in a sense its feelings.

The transdisciplinary design incorporates the study of plant science, microelectronics, computer interaction human nature, and software design, integration and data communication.

The management system has a complex, heterogeneous scenario, since it includes: closed and open space, growth and development of vegetation; treatment systems such as irrigation, fogging and lighting; communication tools such as computers, personal digital assistants, mobile devices, park users and external sources of information (like forecast and natural disaster stations).

The whole system consists of sub-systems set and these elements provide connection/communication and delivery real-time information between/to phones and databases. The social network, parQ.unb.br, can be considered itself a complex autopoietic living system since it is able to self regulate through human interaction, reflecting the changes in it's inside configuration and database, according to these interactions and data gathering.

parQ software can be set to a parallel universe, in which each biological entity culture is considered/represented as digital one. Thus, for example, a tree becomes an e-Tree, assuming a technological system layer, other layers other living beings are visiting the park itself and the environment, its climate, its architectural objects. This way, we hope that it might provoke human self-expression among with human integration with the environment.

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