LEAF++

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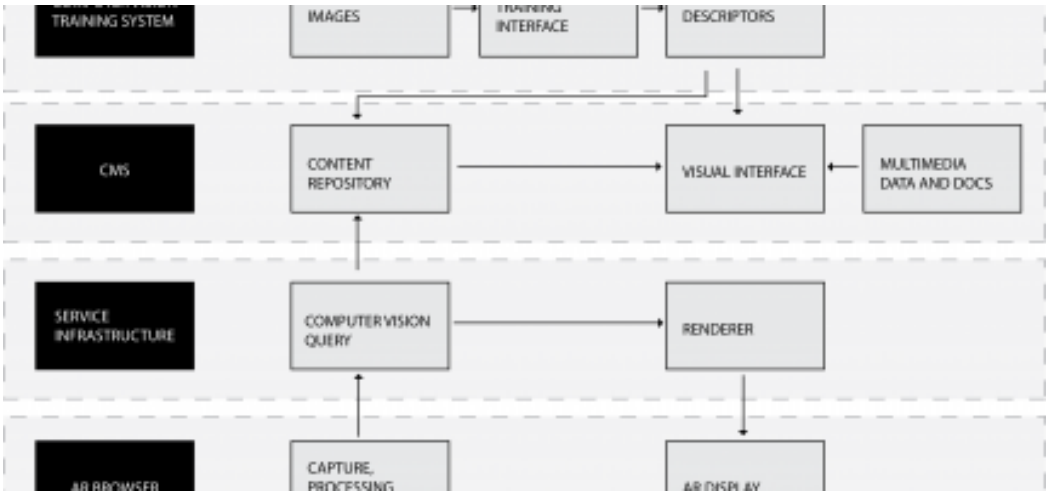
Leaf++ is the product of a research project that aims at designing a prototypal interactive system involving computer vision, gestural interfaces, augmented reality technologies and cross medial platforms to create a novel tool to experience botanical information about plants and their leaves.

A computer vision system in a mobile application is able to recognize the leaf and to show available information.



Leaf++ logical architecture (courtesy of the authors)

Introduction

"The Third Landscape – an undecided fragment of the Planetary Garden – indicates the sum of the spaces in which man gave up to nature in the evolution of the landscape. It regards urban and rural forgotten places, spaces for transit, industrial wastelands, swamps, moors, bogs, but also the sides of roads, rivers and train tracks. The whole of these forgotten places are reserves. De facto reserves are: unaccessible places, mountain tops, uncultivated places, deserts; Institutional reserves are: national parks, regional parks, «natural reserves»." [1]

Gilles Clément's Planetary Garden is one of the most suggestive answers to the mutation of the definition of urban space. Planetary Garden is to economic and urban globalization what urban gardens were to the cities of the 19th Century.

The Third Landscape is a connective fabric composed of residual spaces that tend to take a liquid state, never preserving shape, resisting governance. Classical preservation or environmental conservation

tools such as surveillance, protection and the creation of limits and borders cannot apply to the Third Landscape without destroying its characteristics, as Clément writes [2] “not property, but space for the future”. An idea of space that goes beyond the ideas of landscape as a place for identity, being used as an asset for local societies, and as a strategic tool for memory.

As John Barrell spoke about “the dark side of the landscape” [3] while pointing out the imposition of a point of view of a single social class, with Clément we could speak about a “light side”, for the Third Landscape is not an exclusive model but an inclusive one: “a shared fragment of a collective consciousness”. It is based on a planetary remix (brassage) which is at the origin of the current richness of ecosystems. [4] Clément talks about the necessity of training our gaze into recognizing and understanding the Third Landscape. This requires a new possibility for vision and knowledge dissemination in urban natural environments, a renewed sense of aesthetics, and a morphed sensibility for the possibilities for interaction and communication offered by our surroundings.

Our current interaction and interrelation with the natural environment in urban spaces is mainly delegated to an institutional definition of borders and is rather far from the traditional knowledge of the ecosystem and its elements. Globalization and daily routines often force human beings to recognize plants and vegetables only in terms of their use in products that are found in supermarkets, or of the trees and bushes that decorate the sides of our roads. People progressively lose contact with the knowledge about the seasonality and origins of vegetables as they have come to expect any given product at any given time in a supermarket. One study, [5] among many other studies of a similar scope, gave advice to farmers in remote parts of the world encouraging the production of off-season products for export and highlighted this practice as a truly effective marketing strategy based on the documented assumption that consumers want specific products all-year-round.

Stepping outside of the supermarkets, we see that plants still remain within the great unknown as regards the majority of inhabitants of urban spaces. In cities, plants populate the periphery of our world view, living a life that is mostly aesthetic and excluding practically all forms of knowledge about their origins, characteristics, benefits and roles in the ecosystem, which remain largely hidden from the majority of citizens.

Leaf++

Leaf++ is an ubiquitous, interstitial information tool.

It is designed as a new “eye” that can be used to look at the natural landscape of our cities.

It is designed to help us see and understand the Third Landscape.

Leaf++ is an augmented reality system which employs computer vision techniques to recognize plants from their leaves, and allows us to associate them with digital information, interactive experiences, and generative aesthetics whose purpose is to create a disseminated, ubiquitous, accessible form of interaction with the natural environment, realizing a suggestive, exciting, desirable and accessible contact with the knowledge, wisdom and awareness about the inhabitants of the natural ecosystem in our surroundings.

Leaf++ shifts our focus in the vision of urban landscapes.

It is a tool for a new vision which, through augmented reality, enables the creation of an additional layer on our visual landscape: an infoscape and information landscape which is directly and coherently added to our vision; a new field of vision that is accessible by looking at the world through a mobile device which acts as a new lens on reality; a new vision in which leaves and plants come to a new visual life as the computer vision system actively searches for them and highlights them, populating our view with information about their origins, living conditions, characteristics and interactions with our urban/natural ecosystems.

Leaf++ acts as a distributed, dynamic, real-time, emergent geographer of the Third Landscape: each vision of a member of the plant kingdom in an urban space triggers a mutation of the map which is shared in realtime by all persons using Leaf++, providing a fluid cartography of the Third Landscape. These new visions are turned into an ubiquitous sensorial experience, transformed into morphing, moving images and sounds which create a state of wonder that further connects us to this new visual landscape.

Methodology

The Leaf++ project has been designed and implemented through the following methodological steps:

- initial briefing, which produced the definition of the concept;
- the choice and experimentation of several technologies which could be used to realize the concept;
- the design and implementation of several prototypes, which were used in an iterative, participatory process;
- the generalization of the best prototypal solutions into an open platform;
- the usage of the resulting platform to create two use cases, for education and artistic performance.

Leaf++ was intended as an augmentation for vision, to increase the level of awareness about the natural environment, to promote the establishment of a collaborative set of practices for dissemination, sharing and communication of knowledge and information about the ecosystem, and to create an ubiquitous digital interactive layer onto the natural environment that could be used for education, expression and for artistic and performative purposes. Anthropology, Cognitive sciences, Biosemiotics, Environmental Psychology and Aesthetics, together with a wide range of disciplinary experiences in geography, geoecology, geobotany, ecology, landscape architecture and planning, converge in the direction of landscape ecology, and find landscape as a common meeting place. Several definitions of landscape emerge from all these approaches, as reported in Farina: [6]

- “the total character of a region” (von Humboldt);
- “landscapes will deal with their totality as physical, ecological and geographical entities, integrating all natural and human ('caused') patterns and processes ... ” (Naveh);
- “landscape as a heterogeneous land is composed of a cluster of interacting ecosystems that is repeated in similar form throughout” (Forman and Godron);
- “a particular configuration of topography, vegetation cover, land use and settlement pattern which delimits some coherence of natural and cultural processes and activities” (Green)
- “a piece of land which we perceive comprehensively around us, without looking closely at single components, and which looks familiar to us” (Haber).

All of these definitions move across several dimensions in which landscape can be described, with the more cognitive-oriented ones (such as Haber's) resulting in broader visions that are able to bypass the

concepts that might classically be viable for public administrations to enact their policies and strategies, and to produce a more fertile humus for creation of a significative description of the planet which is able to include expressive and performative possibilities for humanity.

The concept of cognitive landscape, and of its possible contaminations through technologies and the results of the more advanced contemporary research in urban anthropology, has been a fertile domain for discussion during the initial phases in which we gave shape to the concept. A cognitive landscape can be thought of as the result of the mental elaboration by every organism of the perceived surroundings. [7]

We decided to contaminate the observations found in Farina's analysis of the theory of cognitive landscapes and of the mosaic theory within Clément's idea of nomadic observation of a constantly mutating environment, by focusing on the value of being able to recognize and understand the fluid and ever-changing natural ecosystem in a process that is inclusive, collaborative and disseminated.

In this mindset, we described a series of objectives, which later formed the concept for Leaf++:

- to create a tool for vision or, even more desirably, a new or mediated vision;
- to create an accessible and natural interaction metaphor, as close as possible to the practices to those which we are accustomed to; one which is easily executable by a wide range of persons across cultures, age groups, skills;
- to create an open platform so that it will, in and of itself, create an active ecosystem of practitioners wishing to use and modify it to enable more practices and possibilities for vision, awareness, understanding, expression and ubiquitous knowledge sharing;
- to create a usable information and interaction layer that is easily hooked onto the elements of the natural environment and that is accessible through mobile devices;
- to create a process which harmoniously conforms with the processes of our vision; just as we interpret what we see geometrically, symbolically, culturally or through our memories, experiences and relationships, Leaf++ should progressively populate our mediated field of vision with aesthetics, information, knowledge, possibilities for relation, understanding and interaction, just as details progressively emerge while we look at things;
- to create an aesthetic, sensorially stimulating, cognitively suggestive experience; one which is able to trigger wonder and emotion, to inspire action and participation, to activate cultures and open dialogues.

Along the lines defined by these objectives the research group set forth in designing the experience which was to be then implemented. The most pressing point turned out to be one regarding the ability to characterize Leaf++ as a “vision.” Current Augmented Reality (AR) systems did not completely satisfy us with their interaction metaphors and in the composition of their interfaces as most of them heavily relied on movie-generated ideas of what an augmented reality interface should look like: radars, sonars, floating icons and other visual assets seemed to create videogame-like experiences that, while being usable and (in some cases) wonderful to look at, did not match the feel and aesthetics of the “new vision” which we wanted to produce. Our desire was to create a lens, a see-through transparency onto which the additional information layer would visualize in the most natural possible way.

Another pressing characteristic to be researched was the bypassing of the limits imposed by GPS driven augmented reality systems and to create an experience that was strongly based on (computer) vision.

One of the objectives which we regarded as being not only strategic but also fundamental in promoting the vision which is defined by the Leaf++ project was the requirement for openness of the technologies used and produced in the process. Due to this consideration the research team opted not to use any of the existing commercial (even if free) platforms that are currently available to perform computer vision based AR. We chose to develop our own technology and to release it for open usage to the international scientific and artistic community (the source code of all software used in Leaf++ is currently available on the project's website under a GPL3 license). The production of an open, working platform is, in fact, one of the most outstanding results of the project, and it fully supports the idea of open, accessible knowledge which we tried to enact in the natural ecosystem by engaging the making of Leaf++.

During the second phase of the project, the technological architecture was defined.

We chose to develop a mobile AR browser with the characteristics defined during the previous stage. The chosen mobile platform was developed for Apple's iPhone, mostly due to the availability of a stable development environment and for its ease of use – to satisfy the requirements in terms of accessibility and usability – and due to the availability of multiple international development groups dealing with computer vision issues such as the ones involved in the project, thus allowing us to establish an effective mutual collaboration which proved to be both effective and rewarding.

The platform which was created for Leaf++ is composed by the following elements:

- a trainable computer vision module
- a multimedia CMS (Content Management System)
- a service infrastructure

A computer vision (CV) module is used to provide image recognition features to the system. The CV module uses SURF (Speeded Up Robust Features) algorithms and techniques to identify the various types of leaves. The SURF image detection techniques and descriptors described in Herbert Bay, et al. [8] are used in the system together with a customized version of the optimizations described in Maha El Choubassi and Yi Wu. [9]

Specifically, the CV component is integrated in a system enacting the following process:

- image acquisition
- generation of feature descriptors
- classification and initial configuration of the CMS

A guided procedure allows the user to capture all the images that are required to correctly identify the relevant visual features of the leaves that are to be added to the system. In the next phase of the process an interface is used to navigate the groups of images of each feature and to use them in generating the SURF descriptors that will be used in the end system. Each descriptor uses information captured by the images as suggested in [8] and [9] to create the data that is needed for the realtime image recognition process. An initial version of the descriptor is generated automatically and the user is guided through a series of iterations whose objective is to refine this initial information, thus producing a better, more efficient, descriptor: by iteratively modifying selected parameters, and using the leaves in front of the camera, the expected results are compared to the effective ones, thus identifying the needed modifications to the descriptors.

At the end of the process each one of them is associated to a series of keywords establishing a taxonomy whose nodes are associated to the visual elements of the various types of leaves.

This taxonomy is used in the CMS. The CMS is implemented using a customized version of the Wordpress content management platform. The taxonomy produced in the previous phase is reproduced inside Wordpress under the form of a “customized taxonomy”. Using the standard features of the CMS it is, thus, possible to associate multimedia content (videos, sounds, texts, documents and interactive experiences) to each part of the taxonomy and, therefore, to the visual elements of the types of leaves that have been added to the system.

The service infrastructure is used to bring all parts of the system together for the usage experience. A series of software components that can be readily integrated into iPhone applications connect to the device's webcam and enact the realtime feature recognition process. When a leaf is recognized, its identification is translated into a series of terms in the custom taxonomy and relevant content is fetched over the network by interrogating the modified Wordpress CMS. The multimedia assets are then progressively shown onto the smartphone's viewfinder, coherently with the realtime onscreen position of the leaf.

Results

Leaf++ has proven to be effective in realizing an experience in augmented vision, applied to the possibilities offered by creating augmented reality layers of information and interaction onto the natural environment. The open platform produced during the project is currently being used for two specific purposes:

- an education platform
- an art performance.

The education platform enables teachers and students to add information about the plants in their environment directly onto plants' leaves. This allows all subjects involved to create ubiquitous education, knowledge sharing and information dissemination processes. At FakePress Publishing we are currently using the platform to create ubiquitous publications on the themes of ecology, sustainability and food and dietary education, producing information facilities that are ubiquitously accessible about the natural seasonal availability of vegetables, their origins and characteristics, creating enjoyable, suggestive and interesting ways to re-connect with the knowledge and traditional wisdom about food and environment which is progressively being lost in our urban ecosystems.

Leaf++ is also being used for the execution of an art performance in which the system is not connected to a set of databases containing information but, rather, to a generative audio and video engine. In this “concert for augmented leaves” the performers use the leaves in front of cameras to generate suggestive audio and visuals. The performance is currently being developed into a fully participatory experience in which the audience takes the role of the performers and is free to move around urban space and generating the audio and video collectively, by augmented-looking at the leaves that come across: a concert in the Third Landscape.

References and Notes:

[1] Gilles Clément, Manifesto del terzo paesaggio (Macerata: Quodlibet, 2005).

[2] Gilles Clément, Le jardin planétaire. Reconcilier l'homme et la nature (Paris: Albin Michel, 1999).

[3] John Barrell, The dark side of the landscape: the rural poor in English painting, 1730-1840 (New York: Cambridge University Press, 1980).

[4] Antonio di Campli, Review of the "Manifesto del terzo paesaggio," May 2005, http://architettura.it (accessed September 2010).

[5] D. Singh, Production and marketing of off-season vegetables, 1st ed. (New Delhi India: Mittal Publications, 1990).

[6] Almo Farina, Principles and methods in landscape ecology (Dordrecht: Springer, 2006).

[7] Almo Farina, Ecology, cognition and landscape linking natural and social systems(New York: Springer, 2010).

[8] Herbert Bay, Andreas Ess, Tinne Tuytelaars, and Luc Van Gool, "SURF: Speeded Up Robust Features," in Computer Vision and Image Understanding (CVIU) Vol. 110, No. 3 (2008): 346-359.

[9] Maha El Choubassi and Yi Wu, "Vision and Image Processing Research Group / FTR Intel labs, Augmented Reality on Mobile Internet Devices," June 2009, http://drdobbs.com/article/print?articleId=227500133&siteSectionName= (accessed March 2010).