Digital album with augmented reality: Francisco de Paula Santander Ocaña University botanic garden "Jorge Enrique Quintero Arenas"

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Abstract. Francisco de Paula Santander Ocaña University has a botanic garden. The University Botanic Garden Jorge Enrique Quintero Arenas was created with the mission of preserving the dry forest ecosystem and the types of vegetation and flora present in the northeast of Colombia, providing adequate spaces for research and environmental education. From new technologies that can be integrated without affecting the environment and generate various changes in the way of learning, solutions are proposed for continuous improvement, which in the end is done in favor of sustainability, quality of life and a smart botanic garden. This paper presents the results of the software prototype, whose purpose is to make known all the biodiversity that is available. It was done through a digital album applying augmented reality, where those interested will find the different species with their relevant information.

1. Introduction
The University Botanic Garden Jorge Enrique Quintero Arenas was created according to resolution 0319 of September 22nd, 2016 at the Francisco de Paula Santander University, Ocaña, with the mission of using the botanical appreciation to inspire, educate and serve as a focus of scientific development and committed to the biological diversity of the northeastern part of the country; over the years, it has been consolidated as one of the most important projects where hundreds of students have enjoyed the garden services, guided visits to the living collections and the conservation area, talks, conferences, celebrations, orchid garden, camping, bird watching, astronomical observatory, among many others.

Therefore, the project aims to experiment with new technologies that can be integrated without affecting the environment by generating changes in the way of learning about existing species in the botanic garden, and the use of the infrastructure under the IPV6 protocol is planned [1], that allow IoT devices to be implemented, generating smart environments in the botanic garden in a safe way, integrating them into the university's current network, seeking the interoperability of both IPV4 and IPV6 protocols and supporting all security processes under the network scheme defined by software, likewise the use of QR codes, in order to apply the augmented reality (AR) that allows the interaction between the real world and virtual elements.
According to the above, the development of this digital album with augmented reality will serve to educate and encourage students and the community in general to approach reading in a more didactic way, since it will be complemented with texts and images, characteristics of the existing flora and fauna species, important information storage that can be evidenced from any device with an internet connection, allowing the entire region to know in depth about the existing biodiversity richness. The paper is divided into introduction, background, methodology, contextualization and results.

2. Background
Martins et al, [2] describe the garden of virtual delights, an interactive installation developed for the botanic garden of Coimbra, with the aim of attracting visitors and promoting the garden visibility. The installation builds and simulates an artificial ecosystem, where visitors become part of this ecosystem, interacting effortlessly and without problems with artificial organisms. The installation name is a reference to the Hieronymus Bosch's masterpiece "The Garden of Earthly Delights".

The ecosystem is composed of several species, which constitute a food chain. Each species is characterized by its physiology and behavioral characteristics: appearance, dimension, energy, lifespan, speed, resistance, reproduction and predatory behavior. The organisms are influenced by the presence and movement of visitors, which become part of the ecosystem and at the top of the food chain [2].

Within this context, it is necessary to know a little about the history of the Botanic Gardens as centers that work for the biodiversity conservation; then, these spaces arise from different needs, mainly the preservation of different flora and fauna species, which at world level has become a paradigm that has involved different entities in the process of researching and agreeing on strategies that will allow reaching common references facing this situation [3].

On the other hand [4], built a botanical data recovery system by applying its own search interface called 'Concentric ring view' for multifaceted metadata. This system allows users to search in a flexible and intuitive way by combining attributes with simple operation. The attributes used as search keys are visual and botanical features such as the flower color, the leaf shape, the flowering season, and so on, it is considered, that this system allows users to not only search for plant names, but also learn the plant morphological characteristics and taxonomy.

Botanic gardens vary widely in design and purpose, but most are typically associated with environmental conservation, education or historical interpretation. However, studies have shown that botanic garden visitors are often motivated by recreational and leisure interests [5]. One of the policies that distinguish a botanic garden from a purely exhibition garden is the practice of accessing plants when they enter the collection and then keep track of this material throughout life [6]. In this way, plants can also be used as bioindicators and their participation in communication networks can make a significant contribution to building a smart and green community [7].

Getting down to business in what has to do with AR, it has been evidenced that, until recently, this was one of the latest technologies that offered a new way of teaching. Due to the increasing popularity of mobile devices worldwide, the widespread use of RA in mobile devices such as smartphones and tablets has become a growing phenomenon [8].

The use of augmented reality mobile applications as learning tools is not very widespread among teachers as it is presented as a development tool and a method to design and deploy learning activities [9]. As it has been increasingly adopted by various industries as a marketing tool, tourism professionals have come to recognize its promising potential in the tourist's experiences [10].

On the other hand, museums are places where informal learning can be encouraged to involve students and provide opportunities for learning, applying a gamified approach based on the concept of sticker album collection and its integration into a mobile augmented reality app. The concept of sticker album collection is quite familiar to most people, mainly from their youth, and is the main dynamics of the gamification design, which commits the student to collect more stickers and progress exploring the museum [11].
A community can become smart and ecological through the strategic deployment of Information and Communications Technology infrastructure and services to achieve the sustainability policy objectives [12].

3. Methodology

The approach is defined as mixed since it includes qualitative and quantitative analysis, where watching visits to the botanic garden will be made, interviews to personnel in charge and knowledgeable of the garden biodiversity, surveys to students, administrators and visitors.

It will be done in the following steps:

1) Construction of a literature review of the models, technologies, analysis of terms and concepts from the western and eastern world points of view on smart botanic gardens, new botanic garden tendencies at a national and international level.

2) Definition of the functional and non-functional requirements that allow the virtualization of the botanic garden “Jorge Enrique Quintero Arenas” (Compilation of all the biodiversity information the botanic garden has photographs, documents, relevant information).

3) Design of the botanic garden interactive scheme (digital album) based on technological tools such as augmented reality and virtual reality.

4) Development of the augmented reality designs of the different plants and animals in the botanic garden.

4. Contextualization

The botanic garden "Jorge Enrique Quintero Arenas" will have 3 trails, each with exceptional characteristics as shown in Figure 1.

Trail 1 is located in the area of moderately-intervened dense forest, it has about 1060m, which are distributed between slopes not exceeding 15 degrees; trail 2, includes from the goat project to the top of the university (Las calvas) and has a distance of 660m, it crosses El rampacho micro basin, it has slopes of 40 degrees, which makes it necessary to implement security measures; and trail 3, from El rampacho creek through the little-intervened forest area, for the back part of the poultry project, it has a distance of 968m, it also has slopes not exceeding 15 degrees. No anthropic intervention should be carried out on this trail since it is destined solely and exclusively for research. In this, a type of forest in the secondary succession process can be appreciated after having undergone an anthropic intervention process with the cattle grazing around 20 years ago.

Currently in the pre-mountain dry forest of the botanical garden we find a great variety of plants such as: Anthurium a red variety, epidendrum and variegatum (fire star and dwelling), campanulaceae and verbenaceae, as well as three additional types of orchids, all these plants are distributed over 31.28 hectares of the garden. Figure 2.
The botanic garden at Francisco de Paula Santander University, Ocaña, opens doors to the participation of national conservation agencies, with the aim of integrating them in the first dry forest botanic garden in Norte de Santander, becoming the first project of this type in the Catatumbo region, as well as an environmental protection zone for the territorial ordering basic plan (PBOT as in Spanish) of the municipality of Ocaña. Finally, the botanic garden establishes a place that benefits both the University and the community in general at the regional, departmental and national levels in three main areas: research, conservation and environmental education.

5. Results
Taking into account that the botanic garden is in a process of socialization and dissemination of the biodiversity it has, to students, faculty, administrators and visitors, the Plant AR project seeks that this information not only remain in those who can physically do the garden route, but from any place in a remote way, they can access and know all those fauna and flora wonders that characterize it, in a didactic and digital way with augmented reality as a more striking visual strategy. The programs used for the realization of the digital album with augmented reality are the following: Blender, Vuforia, Unity and Android Studio.

Below is a brief explanation of how species are created through the aforementioned software and that give life to the digital album; a 4k image of a fern leaf to become a 3D graphic, adjusting its height, width and the length Figure 3, then the image is duplicated to give shape to the fern, and likewise continue adjusting the plant Figure 4.

It is important to include Vuforia to the Unity document, installing the Vuforia file from the document, adjusting the properties and organizing the order in which the images will be recognized. Later, on the image, the graphic is positioned, in the middle of the image, and the width, height and length it will have is adjusted Figure 5.
Android Studio must be installed, and correctly install SDK and JDK for proper functioning; then, we proceed to organize the properties and the App name; finally, we press on run and the App creation starts, Figure 6. When the APK file is ready, it is installed on any device that has Android 5.0, so that the QR code can be read as shown in the Figure 7.

![Figure 7](image1.png)

**Figure 7.** Pilot test of the fern with augmented reality in a mobile device.

This is how each of the different fauna and flora species of the digital album are designed. The QR code is the marker that will help in the process of supporting augmented reality and will allow to show a friendly interface where the registered plant is observed; in this way, the garden visitors, with only approaching with their mobile device to the code, will obtain in a very interactive way the information and characteristics of each plant Figure 8; the interested people who cannot be physically in the garden, will be able to access the digital album from any place they are with internet access through the university website and get all the relevant information.

![Figure 8](image2.png)

**Figure 8.** Plant characteristics.

6. Conclusions
With the development of the digital album with augmented reality, spaces for environmental education are propitiated [13]; likewise, it will be possible to identify and know the richness through current fauna and flora collections, in order to generate knowledge and valuation of biodiversity in all its components at the ecosystem level.

Through the digital album, students from different careers, visitors and the community in general will be able to appreciate in order to educate themselves, in turn, to learn about important topics of the botanic garden, acquiring a sense of belonging and obtaining an environmental awareness necessary to face the emerging challenges on the current global stage.

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