Study on the Design and Development of Responsive Plants Information Services

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Abstract
With the increased recognition of the importance of plant resources comes greater interest in plants information. However, there is lack of services that provide information that would offer in-depth knowledge on plants and continuously engage user interests. It would be desirable to develop a service that provides high-quality information on plants in tandem with relevant auxiliary data. This study aims to design and develop a responsive, Web-based service model in which gigapixel images of plants with culturally relevant information are integrated. Service usability in PC and mobile environments, and satisfaction levels against other similar services will be measured on service usage and user interviews will also be conducted to gain further insights on users' need in this domain.
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1. Aim of Study

User-friendly, scientifically verified, high-quality information services on plants are rare commodities, even now when there has been heightened awareness for importance of such information that would impact research in various academic disciplines. Table 1 summaries the issues, perceived from user perspective, which exist in information services on domestic and international plants.

Issues	Content
Expert-focused	Plants information contains overly scholarly descriptions and terminologies.
Low-quality content	Most information is delivered in text; insufficient amount of high-quality images.
Not suitable for mobile environment	Demands are high on mobile contents; current services are not geared for mobile users.

Table 1. Issues perceived by users in plants information services

This study aims to address the problems listed in Table 1, by providing 1) customized information to users' need, 2) improved content quality, and 3) mobile-friendly interface and contents. Our proposed service is designed and developed in view of the above goals, and will be measured by user tests for usability. Table 2 lists action items for achieving the stated goals.

Goal	Action items
Customized information to users' need	Integrate cultural/art contents with plants information for increased user interest. Provide cultural/art background information for each plant.
Improved content quality	Provide high-quality content on plants using gigapixel photographing, 3-D object imaging, and multifocal imaging.
Mobile-friendly interface and contents	Develop Web services that employ responsive Web technologies for mobile environment. Develop a mobile viewer tailored for gigapixel

contents.

Table 2. Issues perceived by users in plants information services

Two research questions will be used to measure the usefulness of the service developed.

- Will the integration of cultural/art information with plants information affect user evaluation of the service?
- How will the improved content quality affect user evaluation in both Web and mobile environments?

2. Technical Background

The study employed gigapixel photographing, 3-D object imaging and multifocal imaging techniques to procure high-quality contents. Table 3 describes a brief technical summary for each technique.

Imaging Technique	Description
Gigapixel photographing	A gigapixel image refers to an image bitmap of one billion pixels, holding 1000 times more information than a megapixel image. It is usually created by specialized imaging software that combines images taken by a high-resolution camera.
3-D object imaging	An object is scanned 360 degrees in rotation. A special viewer is required to view the image.
Multifocal imaging	A special multifocal camera, Lytro camera, is used to take images of an object. A special viewer is required for viewing.

Table 3. Imaging Techniques

Drupal CMS (Content Management System) is used for content management. Drupal, based on PHP, is a stable and flexible platform, and has been used for the purposes of personal web sites to enterprise-level content management(Patel et al., 2011).

Responsive Web technology refers to techniques optimized for maximum user experience in PC, tablet, and cell phone environments and their corresponding display layout variations. This study uses the Foundation front-end framework as its responsive web design and technology(Horek, 2014).

3. Literature reviews

Examples of the most well-known information services on plants are Encyclopedia of Life (EOL), iNaturalist, and The Plant List. The EOL aims to provide information on all the organisms on earth, offering information on approximately 3.5 million species (or organisms) gathered from various content providers (Parr et al., 2014). iNaturalist receives pictures of species posted by users and taxonomists resolve species identification (Bacher, 2012). The Plant List is a comprehensive database of plant names, related images, and record statistics on 350,000 plant species (Kalwij, 2012). These services contain valuable plant records with images and geographic data; however, it lacks in engaging ordinary users, since they are mostly designed for experts. Wikipedia also contain sundry information on plants, especially well-known species, and mostly in English only.

4. Service Model Design

This study used plants data curated at the Korea National Arboretum. The Korea Biodiversity Information System (KBIS) at the institution provides on the Web rich sets of metadata, classification, and textual data both on animals and plants, as well as Web services and openAPIs (Moon Youngju, 2012). The plant metadata gleaned from the KBIS had originally 27 elements, which the authors further divided and refined to a list of 60 elements. The details of refined metadata are described in the Table 4. The main reason why we divided compound elements into simple elements is to ensure the accuracy of data entry and to utilize those in the faceted retrieval.

KBIS metadata elements	Refined metadata elements
Plant name	Plant name
Scientific name	Scientific name

Classification	Classification
Taxon	Taxon
Japanese name	Japanese name
English name	English name
Flowering time	Flowering time
Flower color	Flower color
Dispersion*	Country, chief producing district, altitude(min), altitude(max)
Shape	Shape
Height*	Min value, max value, diameter
Leaf*	Upper classification, lower classification, type, min number of leaves, max number of leaves, leaf edge, min length, max length, min width, max width
Flower*	Pistillate flower color, pistillate flower peculiarity, male flower color, male flower peculiarity
Fruit*	T/F, type, shape, min length, max length, diameter min, diameter max, peculiarity
Stem*	Stem color, stem description
Root	Root
Bark	Bark
Branch	Branch
Growing environment	Growing environment
propagation	Propagation
Cultivation*	Afforestation, weed scraping, roguing, pruning, thinning, harvest
Utilization*	Medical, dietary life, common
Protection method	Protection method
Similar species	Similar species
Peculiarity	Peculiarity
Damage by disease and pest*	Name of diseases, name of pests
Pest control	Pest control

Table 4. Refined metadata elements

Unique IDs were assigned to each plant gathered from the KBIS. Figure 1 shows the final service model designed.

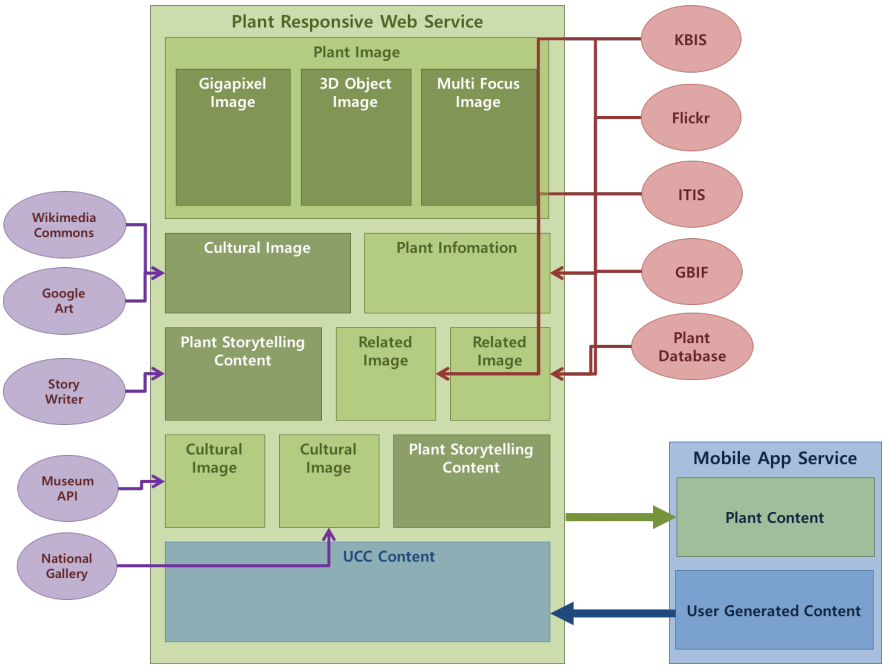

Figure 1. Plant Responsive Web Service Model

Cultural/artistic contents relevant to plants mean the artistic or storytelling resources whose topics are mainly plants. For instance, a sunflower is presented with the landscape paintings, still lifes, and/or photographs, as well as historical or artistic storytelling resources, that feature the flower, so that the user can access to as comprehensive resources as possible to the given plant.

Various sources of cultural/art data were obtained and analyzed for potential integration with the plants information. Artistic images with relevance to plants were obtained and integrated from gigapixel images from Google Art Project and images from Wikimedia Commons. Also, plant images from such sources as Plant Database and Flickr are made accessible through openAPIs(Proctor, 2011; USDA, 2013). Users can also contribute to the collection by posting their images stored on their mobile phones. Also available are the resources of the most comprehensive public data portal at www.data.go.kr, from which cultural, artistic, and storytelling resources related to plants were selected and made accessible by open APIs. A committee of experts (plant taxonomists, culture and arts professionals, and professional storytellers) was formed to validate the legitimacy of the content linked in our service.

5. Service Development

Taxonomy, View, Block, Cache, and Solr Config, and other Drupal modules were used to develop core back-end services. A gigapixel viewer and a 3D Object viewer were separately developed as Drupal modules, and in case of a multifocal viewer, we use the one provided by Lytro(Georgiev et al., 2013).

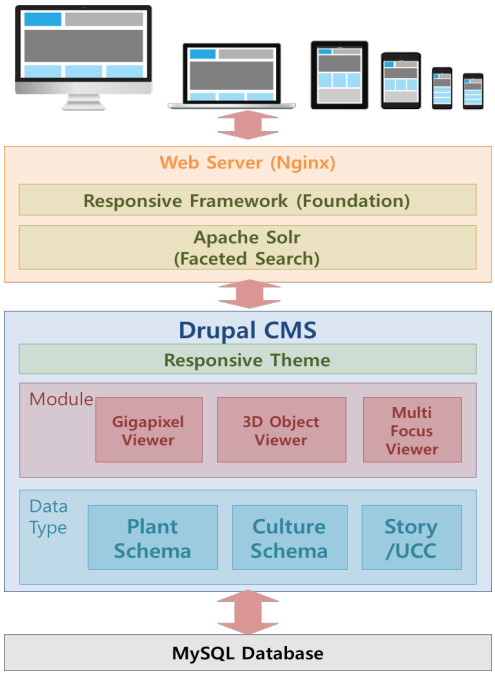

Figure 2. System Architecture

Figure 2 shows the system architecture. In order to enable faceted search over plant metadata, Apache Solr search engine is used. Themes and front-end screens were developed based on the Foundation framework. Figure 3 shows samples of user screens.

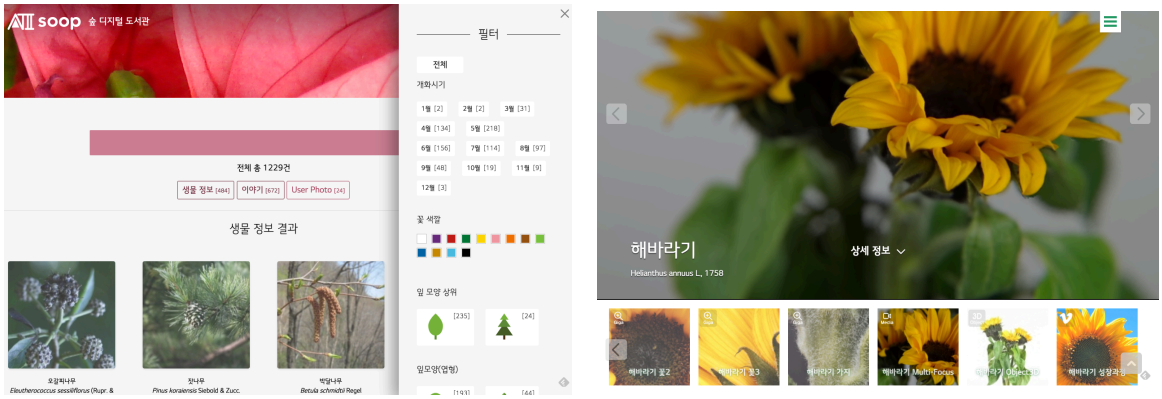

Figure 3. Samples of Plant Information Service screens

As shown in Figure 3, various filters can be applied to plant metadata for more focused search, and each plant species is linked to related information when available. When a plant preview image is clicked, either the gigapixel, 3D object, or multifocal viewer is activated based on the character of the image.

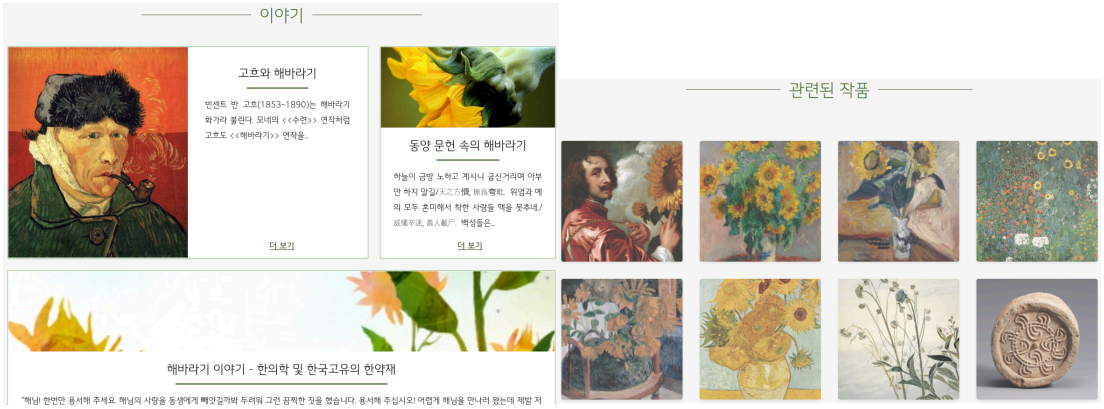

Figure 4. Example of storytelling and cultural/artistic content

As shown at Figure 4, pertinent storytelling/cultural/artistic content is displayed for a given plant.

6. System Evaluation

Both qualitative and quantitative evaluation will be performed on the service. Google Analytics will be used to collect, and perform quantitative analysis on, menu item usage, user demographics such as region, devices being used, access patterns, and user environments. Qualitative evaluation will be carried against various user groups for service comparison between the system developed in the study and other similar external services.

Users are divided into three groups: regular, semi-professional, professional. The regular group holds users with sufficient experience and knowledge on personal computers and mobile devices; the semi-professional refers to those who are not academically engaged in plant studies, but, for example, belong to plant interest forums or are guides at an arboretum or botanical garden. The professional group is those who are academically engaged in plant studies or who work as researchers at plant-specific research centers or institutions.

7. Conclusions and Future Plan

This study presents a plants information system that integrates high-resolution plant images with other cultural/art contents relevant to plants. An openAPI-based service model was developed, which in turn was implemented in Drupal with three in-house viewers and faceted search capabilities. The system will be launched and accessible through the Web(http://soop.info), in January, 2016.

In three months after the launch, the system usage data collected by Google Analytics will be analyzed, and cross-evaluation against other similar services will be carried out according to various user groups. In the long run, the authors envision that the system will be evolved to serve big-sized screens such as smart TVs, covering a full spectrum of displays: the Web, mobile, and smart TV.

8. References

Bacher, S. (2012). Still not enough taxonomists: reply to Joppa et al. Anim. Conserv, 5, 245-249.

Georgiev, T., Yu, Z., Lumsdaine, A., & Goma, S. (2013, March). Lytro camera technology: theory, algorithms, performance analysis. In IS&T/SPIE Electronic Imaging (pp. 86671J-86671J). International Society for Optics and Photonics.

Horek, K. (2014). Learning Zurb Foundation. Packt Publishing Ltd.

Kalwij, J. M. (2012). Review of 'The Plant List, a working list of all plant species'. Journal of Vegetation Science, 23(5), 998-1002.

Moon Youngju, & Lee Jongho. (2012). A Study on the Factor Affecting Continuance Intentions of Bio Resource Information System. e-business Studies, 13(4), 275-291.

Patel, S. K., Rathod, V. R., & Parikh, S. (2011, December). Joomla, Drupal and WordPress-a statistical comparison of open source CMS. In Trendz in Information Sciences and Computing (TISC), 2011 3rd International Conference on (pp. 182-187). IEEE.

Parr, C. S., Wilson, M. N., Leary, M. P., Schulz, K. S., Lans, M. K., Walley, M. L., ... & Corrigan Jr, M. R. J. (2014). The encyclopedia of life v2: providing global access to knowledge about life on earth. Biodiversity data journal, (2).

Proctor, N. (2011). The Google Art Project: A New Generation of Museums on the Web?. Curator: The Museum Journal, 54(2), 215-221.

USDA, N. (2013). The PLANTS Database (http://plants. usda. gov). National Plant Data Team, Greensboro. North Carolina, 27401-4901.

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