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Cloud powered Plant Image Warehouse

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Abstract

Cloud powered plant image warehouse serves as an instrumental solution for various scientific and academic personnel involved in research, education and extension at NARES (National Agricultural Research and Education System), through providing a common image dataset that complements for efficient and more productive activities by saving them time, space, hassle and financial resources. This web based image repository enables the entire scientific community to access the freely available resources contributed by the fellow researchers who worked on common areas of interest, besides facilitating to acknowledge the one who originally contributed. This also enables them to have better control and use of meta data with tagging and custom theme usage.

The Plant image warehouse has been developed by using XAMPP an open source platform, which works on the Cent OS, using Apache Web server and MySQL a relational web based data management system and PHP, the object oriented scripting language. The third party software used in developing this image warehousing database is ZenPHOTO, a configurable software system wherein the users are able to upload, search and share the images. The graphical user interface is restricted to static webpages where, upon request from the user, server sends the response unchanged, unless modified by the uploader. This potential plant image warehousing technique will outstand as an authentic and reliable source of plant image database to the entire working community at NARES (National Agricultural Research and Education System).

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Keywords

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Database;
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Introduction

Over many decades, the researchers and academicians in the NARES (National Agricultural Research and Education System) in various disciplines have been putting huge efforts in finding solutions to various challenges encountered in the field of agriculture. Common to all approaches, there is certain need to fairly include images of

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crop species, varieties or insects subjected to their academic or research demands, because the better and efficient interpretation requires adequate visual representation. This technique provides greater scope for accessing huge amount of genetic data available by explicitly linking it with corresponding phenotyping responses.[5] These inherently scalable digital solutions provide more reliable visual cues relative to human assisted plant recognition techniques.[3]

In order to supplement the research, academic activities & extension activities and in order to ensure that the existing gap between the researchers is abridged, computer scientists have been working to develop several software solutions to handle the huge image databases that can be accessed by all the researchers working on similar lines. Apart from these, the image based tools also help for assessment of plant health based on symptoms and signs usually appearing due to diseases, nutritional deficiencies, phytotoxicity, etc.[2] This cloud powered plant image database developed has been benefitting the researchers through hassle free, tailored image search and access from a single web based platform wherein, all the scientific details of the species presented in the database, can be furnished along with the details of the person contributing the source following a series of pre-processing steps viz., image acquisition, segmentation and annotation;[7] facilitating proper citation and query solving if any. Furthermore, this technique is of great acclaim to increasing number of personnel working on to develop machine learning algorithms that require huge amount of image datasets.

Materials and Methods

The Plant Image Warehouse was developed with following hardware and software tools:

Hardware

Server : Any Physical/Cloud Server with 16 vCPUs, 32GB RAM

Client : Any Desktop/Laptop/Tablet with Browser

Software

Following is a reference list of software used to develop and implement the software:

Operating System :	Cent OS
Software :	ZenPHOTO (version 1.4.14)
Client-Side Interface :	Laptop with Browser
Database Server : (*Back-end*)	MySql Community Edition
Web Server : (*Middle Tier*)	Apache HTTP Server with Tomcat Engine
Public domain URL :	http://pgdma.in/imagewarehouse
Admin URL :	http://pgdma.in/house/zp-core/ imagewareadmin.php

A Centralized software server runs in the background and creates a specific web path with custom JSON format that records the mapping of all the resources to be managed and is directed towards the database.

Server path :	/home/public_html/pgdma.in/imagewarehouse
WEB path :	/imagewarehouse
PHP version :	5.6.40
MySQLi version :	5.6.41
Database name :	pgdma_zen331

A relational database management system (RDBMS) is designed and developed based on client-server approach.[6] The Plant image warehouse was developed as a relational database for initially hosting the image gallery related to Groundnut crop which could hold a large number of images related to wide varieties of the crop, that can be seamlessly worked out with other crops as well. The image warehouse has been implemented in Cloud based elastic Linux machine using Apache/Tomcat™ as Application Server and MySql™ as Database Server. The plant image database developed is powered by ZenPHOTO, an open source software. The Server side logic has been implemented by using Java Server Pages (JSP™) Technologies.

Additionally, image info which is specific to individual images is available under each image in the database, comprising details like original time and date of the image taken, focal length, aperture and other details that would as well help in phenological research studies.

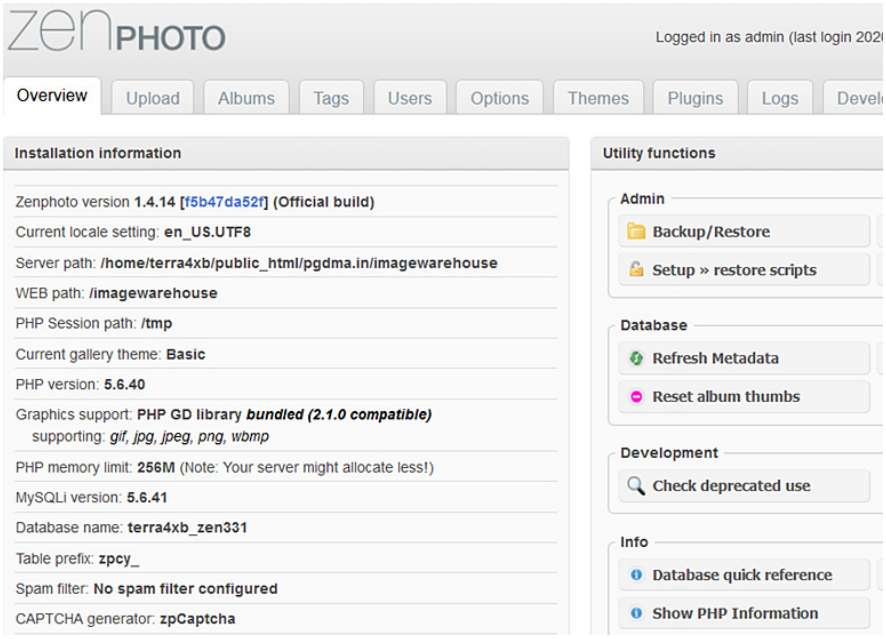

Fig 1: Dashboard of the software with various configuration options

Results and Discussion

The Salient features of the image warehouse developed are discussed below:

Database Server

In this Client server environment, the database server is employed at the lowest layer which entirely runs the database software. The database Server upon receiving the SQL requests executed by the client, processes the request and executes the answers over the computer network back to the client. The server holds the DBMS and is responsible for concurrency control, recovery, database storage and retrieval.

The Web Server

The web server acts as a mediating link between the database server and web browser and is responsible for delivering the content to a website. After receiving the request for data from the website by the client, the web server communicates with the web browser using HTTP. In order to deliver the content to the web browser, the web server supports server side scripting languages which in this case is PHP, to encode the business logic into communication. The Web Server waits for the result of the request it has sent to the Database Server and transfers it to the browser in suitable form when it is received.

Browser

The browser is the client side interface, an application program used for interacting with all the information on the world wide web. The browser uses HTTP to make requests of the web servers throughout the internet on behalf of the browser user.

The plant image database is developed using MySQL as RDBMS. The database is developed in a such a simple way so as to make it accessible to every user even without much computer competence.

The database is developed by using an open source configurable software ZenPHOTO (version 1.4.14) that is well proved to enhance the user's workflow by handling huge amount of image database. It enables us to freely structure and design the theme as per our requirement. Each theme page requires three standard filter calls termed as theme functions. They are as listed and explained under:

zp_apply_filter('theme_head') Best way is that it is to be placed right before the theme's </head>. This way theme CSS does not accidentally override plugins that come with their own CSS like video players etc. This filter also uploads jQuery base file, wherein lot of standard functionality and plug ins are jQuery based.

zp_apply_filter('theme_body_open'); – Place right after the <body> tag
zp_apply_filter('theme_body_close'); – Place right before the </body> tag

The Other Standard Theme Pages

theme_description.php (Required)
This description file gives ZenPHOTO, information about your theme which is displayed in the themes page of the ZenPHOTO admin backend.

theme.png/theme.gif/theme.jpg (Required)
It should be 150x150px at least and represent a screenshot of theme used. It is displayed on the themes tab on the ZenPHOTO backend.

index.php (Required)
This is the gallery index (home page) of a theme. It's read and displayed when someone visits the main gallery page. It usually prints the top level albums.

album.php (Required)
This page is displayed when someone clicks on an album link from your gallery page (index.php). This page displays sub level albums of an album selected and/or the thumbnail overview of images within that album.

image.php (Required)
This page is displayed when someone clicks on a specific thumbnail picture on your album page (album.php). It then displays the single (sized) image.

search.php (Recommended)
It's actually nearly the same as the album.php since it does display albums and images as a result of a search.
Source: www.zenphoto.org.[1]

jQuery Framework
It is a feature rich JavaScript library and is cross-browser complaint which automatically handles JavaScript code suitable for each browser (internet explorer, Chrome, Firefox and Safari). It is licensed under Apache 2.0 and being an open source it is free to use and is being used by many number of developers. To our use, it serves as a file upload widget with multiple file selection, drag & drop support, progress bars, validation and preview images, audio and video for jQuery.

Additionally, it supports chunked and resumable file uploads and client-side image resizing. Works with any server-side platform (PHP, Python, Ruby on Rails, Java, Node.js, Go etc.) that supports standard HTML form file uploads.

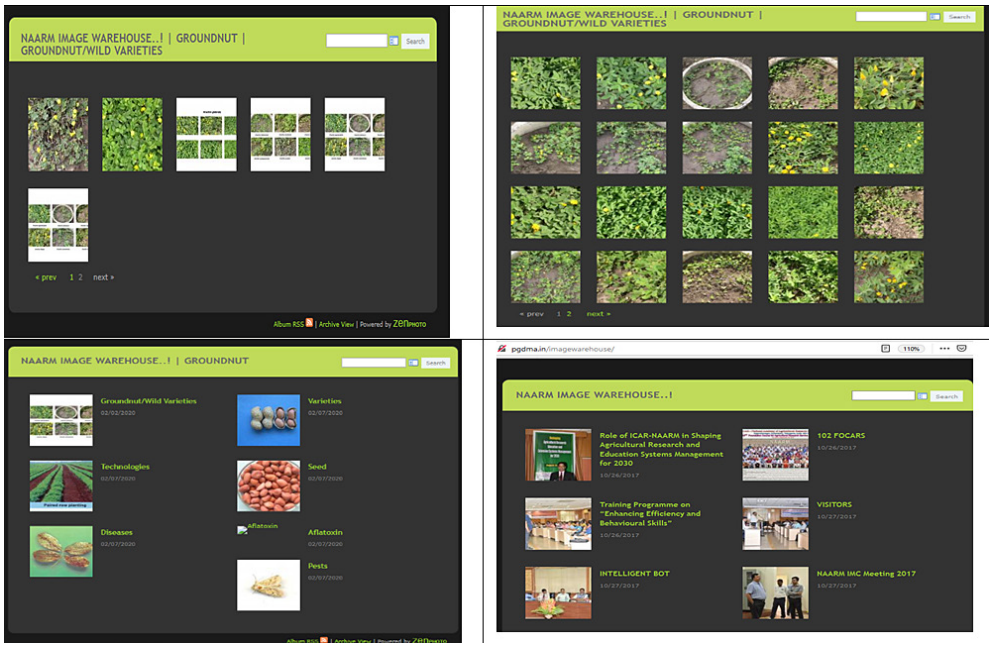

Fig. 2: Screen showing different categories of Images at http://pgdma.in/imagewarehouse/

The plant image database has been implemented in the public domain (http://pgdma.in/imagewarehouse) to make it accessible to many users, using MySql RDBMS (http://www.mysql.com/). MySQL Cluster endows us to meet the database challenges of next generation web, cloud and communication services with well principled capacity, uptime and swiftness.[4,8] Firstly, after logging in through the user ID and password, we will be directed to an admin dashboard wherein several tabs appear.

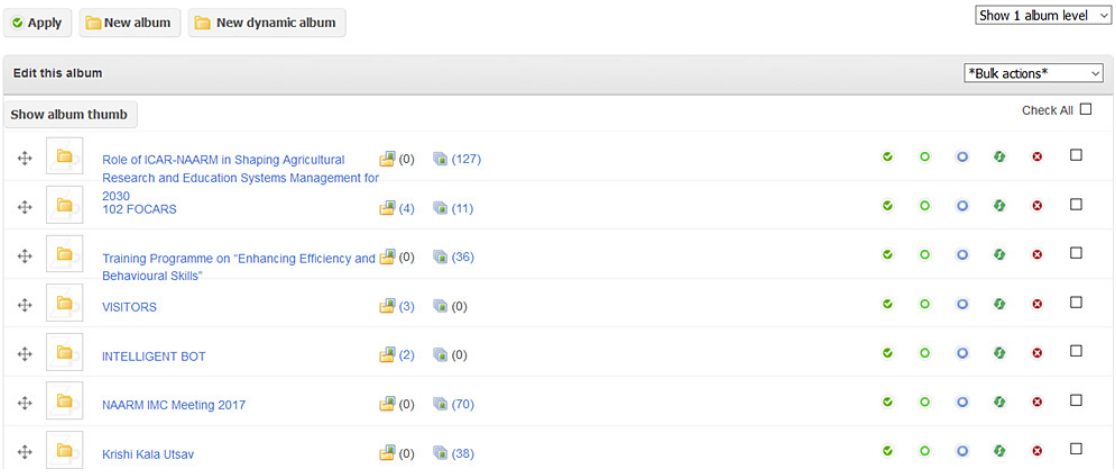

Fig. 3: Screenshot showing the various Albums at the platform

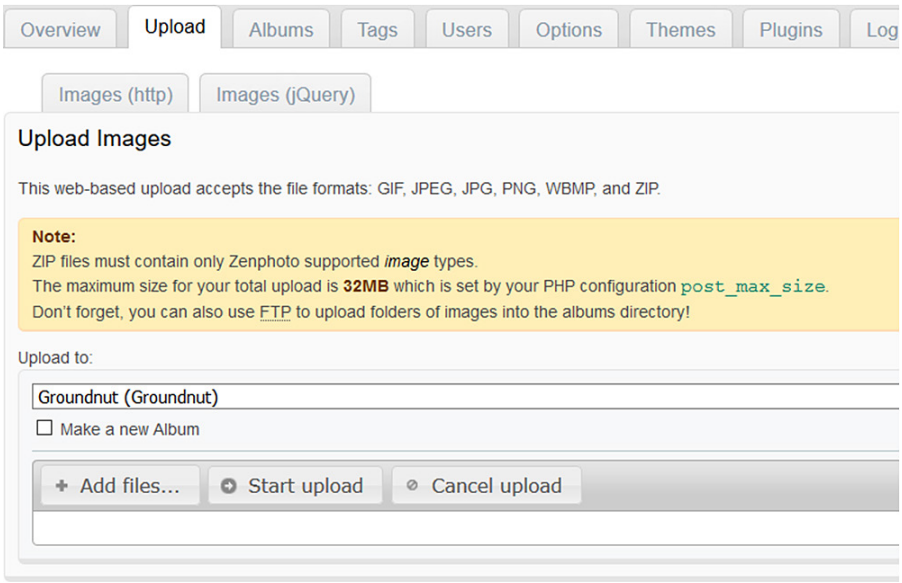

Fig. 4: Screenshot showing the mass upload options of images to the warehouse

Overview, that provides a brief outlook of our user account (in short the other tabs that follow – Upload, Albums, tags, comments, users, options, themes, plugins and logs) furnishing the details of the software version being used, theme details, number of albums uploaded, number of active plugins and filters and utility functions in a separate column along with the comments made. Later, under "albums" tab over admin dashboard, there appears an Edit gallery option under which we can edit the images previously uploaded or add in required commands

to new album, that is going to be created. Therein, we get to add Album title, Description, encrypt the file with password if required, date, location, custom data, sort sub albums and images, and can also add the theme, watermark, thumbnail and code blocks of our choice. We also get to decide whether to publish the album and also if to allow the comments from other users and save the commands chosen. Then, any number of files can be uploaded into specific albums on a single go under "Upload" tab giving details to each image like title, description, custom data, watermark, etc., similarly as we do in case of albums and then saved. It is to be remembered that the image size should not exceed 990Kb. Further, we can add tags to each image by which the users get to quickly access all the images with similar tag.

Following the same procedure as stated above, several image files related to groundnut crop are currently being maintained as a database along with NAARM image warehouse developed on similar terms. Simultaneously, efficiency and validness of loading, updating and querying of data is continuously tested. Further a flexible, user-friendly interface to maximize the accessibility and receptiveness of the stored image files was integrated to the database developed. Further, it is anticipated that the use and development of image warehousing technique is absorbed by all the academicians and researchers which would supplant the conventional tedious research studies.

Conclusion

In light of critical importance of research, much required to find the potential solutions to continuously emerging challenges, any efforts put to supplement the tedious process would be of great advantage to improve the research productivity and efficiency. One such effort led to the development of Plant image warehousing technique, with an intention to integrate the entire image resource outcomes generated out of the research, education and extension activities under a single platform. Web and SQL based systems minimize learning time and facilitates easy exchange of resources that would make realize the importance of large image database networks. This technique if absorbed and used more in a systematic way has the potential to turn out to serve as a national repository and common referencing platform accessible to the entire scientific community.

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Conflict of interest

There is no conflict of interest with other parties, as the work is internally done in ICAR-NAARM.

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