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The Implementation of IoT-Based Android App Vegetable Health Check Using Image Processing

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Abstract**—** *The main problem of the vegetable farmer is to identify the health status of the crop when the leaves start to decolorize. The study aimed to help the farmer identify an early detection to mitigate the possible disease of the plants. An application software based on Android operating was developed and installed on the farmer's smartphone to scan the leaves of the vegetable and send it to the database web server to analyze the images using image detection technique with a dataset of different types of identified diseases of the leaves. As a result, the researcher provides a better alternative, fast and accurate detection by using image pre-processing, segmentation, extraction, and classification using MATLAB that can be more reliable than other older methods.*

Keywords**—** *Image Processing IoT, Local Server, Mobile Application*.

I. INTRODUCTION

Early detection of the vegetable plant's health is one of the vital problems of the farmer due to a lack of knowledge to identify the status of the plant leaves. The researcher developed a system to scan the leaves using their smartphone. Designed a mobile application based on the Android operating system and installed it on the farmer's smartphone.

A mobile application is a product grown explicitly for use on little, remote registering gadgets, such as cell phones and tablets, rather than work areas or PCs [1]. It is a software application program that you can download and access directly using your smartphone or another mobile device, like a tablet or music player [2].

Image processing reconstructs phases of data through an inverse Fourier transform and converts the phase data to displacements and strain [3]. Image processing is utilized for distinguishing a sick piece of a plant by checking an assortment of pictures of that plant, which prior were seen as rotted [4]. Mobile applications have been only extraordinary in the manner organizations work. In 2020, around 3.5 billion individuals overall owned a cell phone. Mobile applications present the most effective, direct, and adjustable method for conveying data about an item and urge clients to stay faithful to a specific brand [5]. Image processing is a strategy to play out a specific procedure on a picture, get an upgraded picture, or concentrate some valuable data from it. Advanced picture handling strategies help control digital images using PCs [6].

The Internet of Things (IoT) with environmental sensing and image processing device has opened a new era to monitor the health of plants. Classification of plant diseases in early stages using image processing and analyzing environmental sensing data not only help farmers to get healthy plants but also maximize production. To monitor and classify plant diseases, IoT is essential to send images and feedback [7].

Pechay (Brassica rapa L. cv gathering Pak Choi) is an erect, biennial spice, produced yearly around 15-30 cm tall in the vegetative stage. Applaud leaves are organized spirally and spread. The petioles are extended and develop upstanding, shaping a subcylindrical pack. The inflorescence is a raceme with light yellow blossoms. Seeds are 1 mm in breadth and are flush to blackish brown in shading [8].

The harm to plants brought about by rivalry from weeds and by different nuisances, including infections, microbes, organisms, and bugs, altogether debilitates their usefulness and, in certain occurrences, can obliterate a yield. Today, reliable harvest yields are gotten by utilizing illness-safe assortments, natural control practices, and pesticides to control plant sicknesses, bugs, weeds, and different vermin. In 1983, $1.3 billion was spent on pesticides, barring herbicides, to secure and restrict the harm to crops from plant illnesses, nematodes, and bugs. In any case, the potential yield misfortunes without any pesticide use extraordinarily surpass that esteem [9].

The correct recognition and classification of the plant disease are essential for the successful cultivation of the Plant, and this can be done by using image processing. Digital image processing is a technique used and implemented to detect diseases in plants. First, the image pre-processing is used to get clear, noiseless enhanced leaves images. Then, these enhanced images are used to leave diseases detection and its analysis [10].

To ensure the health of a vegetable, particularly the Brassica Rapa, the system implemented real-time checking. Therefore, the system consists of a mobile application, which will enable the farmers to take images of Brassica Rapa using their mobile phones and send them to a server. The central system in the server will analyze the pictures based on visual symptoms using image processing algorithms to measure the health condition.

The study aims to develop and implement a Mobile Application Using Image processing to check the health of vegetable leaves. The upgraded technology is mainly applied on the Brassica Rapa to create an application that can help the users for their vegetable plants if healthy or unhealthy. In general, it can also use in any vegetable plant that requires early monitoring. It will require a dataset for other vegetable plants stored in the database web server.

Conceptual Framework

This study is anchored on the idea of Digital Image Processing, where digital processing images employ machine vision in digital image computer processing. It can also say that

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it uses computer algorithms to get enhanced images or extract helpful information. Image processing mainly includes importing the image via image acquisition tools. Then, analyzing and manipulating the picture, the result can be an altered photo or a report based on that image. Figure 1 shows the concept of the study.

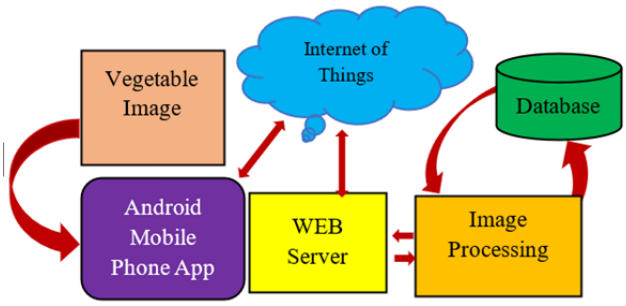

Fig. 1. Concept of the Study

Objectives of the study

The general objective of this research study is to design and implement the IoT-based mobile app health check using image processing that could help users check the health condition of their vegetable plant by using upgraded technology. The specific objectives are:

1. Create an easy method to distinguish the diseases of the vegetable leaves.
2. Design the mobile application that captures the image of the vegetable leaves using a smartphone.
3. Develop a dataset for a photograph with various diseases.
4. Evaluate the functionality of the developed system suitable for the users.

II. METHODOLOGY

The researcher used the ADDIE model to develop the entire system. This model is essential because this is the basis of the researcher to create a realistic solution. Figure 2 below shows the schema of the ADDIE model.

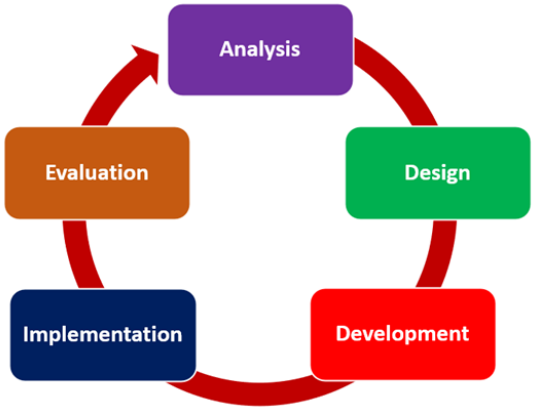

Fig. 2. ADDIE Model

Analysis Phase

The system is designed based on three main subsystems:
Data management system. Includes the application which accesses the data storage and displays the same to the end-user.
Data transmission system. It consists of a Wi-Fi connection that transmits the data from the application to the server.
Mobile application. It will send the data to the database to classify the data received and send it back to the mobile application, resulting from the process.

The researcher creates an east method in distinguishing the plant's health status by capturing plants from the smartphone camera for image detection and other techniques of image processing. Then, a MATLAB programing language is used to convert the captured image to the equivalent result.

Furthermore, the researcher identified the following for the fulfillment of the study:
Android Mobile Phone. It is used to capture the image of Brassica Rapa leaf and where the created mobile application is installed.
Local Server. It is designed to generate the application function ability.
MATLAB. It can be used to perform image segmentation, enhancement, noise reduction, geometric transformations, and registration and 3D image processing operations.
Basic4Android(B4A). It is software used in designing and making mobile applications.
SQL (with sqlxampp, DB manager). It is used to communicate with a database.
PHP (with javascript, CSS, and HTML). It is used in interacting with database servers like MySQL.
Image Processing. It uses a digital computer to process digital images through an algorithm. It allows a much broader range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and distortion during the process.

Design Phase

The researcher developed a mobile application for Android smartphone devices that uses its camera to capture the image. After taking pictures, automatically send the captured image to the server and compare the image to the WEB server and display the result. A Basic4 Android (currently known as B4A) is a rapid application development tool for native Android applications, developed and marketed by Anywhere Software Ltd. B4A is an alternative to programming with Java. B4A is an object-based and event-driven language. Figure 3 below shows the Android Basic.

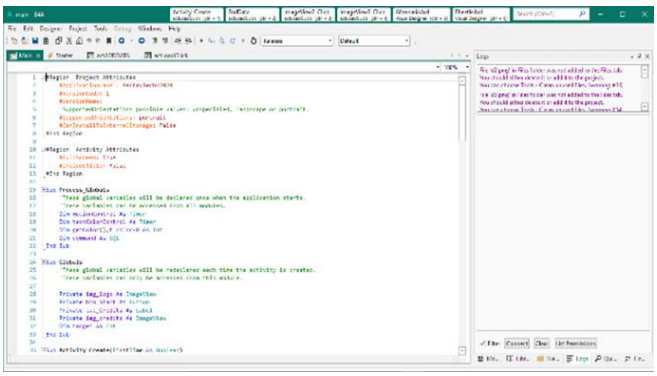

Fig. 3. The Basic4Android

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MATLAB is a prohibitive multi-perspective programming language and numeric enlisting environment made by MathWorks. We are registering climate created by MathWorks. MATLAB permits framework controls, plotting capacities and information, execution of calculations, making UIs, and communicating with programs written in different dialects. Figure 4 below shows the MATLAB environment.

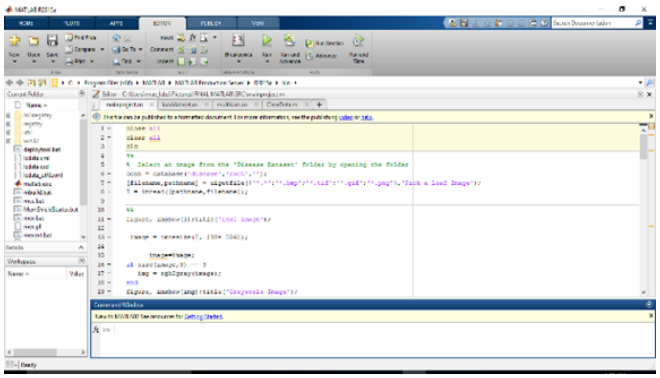

Fig. 4. The MATLAB Environment

As you might have guessed, a Host server is hosted locally on your computer while a remote server is hosted elsewhere. It might be a paid hosting plan, another computer on a local area network, or even a free hosting plan; regardless, a remote server is a server that is not on your computer. phpMyAdmin is a free and open-source tool written in PHP intended to handle the administration of MySQL using a web browser. It can perform various tasks such as creating, modifying, or deleting databases, tables, fields, or rows, executing SQL statements, or managing users and permissions. Figure 5 shows the phpMyAdmin Environment.

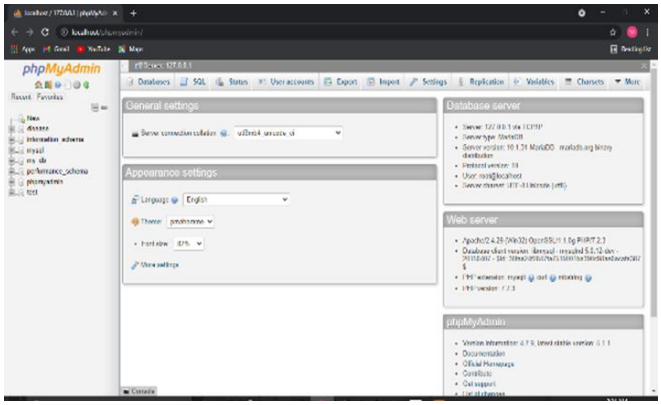

Fig. 5. The local server

A flowchart develops as a guide by the researcher in implementing the system. Figure 6 shows the flowchart of the procedure, which allows the user to capture or select an image. The input image will then classify to the image processing algorithm. The classification result will then send to display to the mobile phone application.

The flowchart shows the process of how the researchers developed the study. First, the researcher starts getting information about image processing and collecting information about diseases and control via the internet. They have also gathered sample vegetable images, specifically the Brassica Rapa, by capturing the leaf. Then, researchers design the system, specifically the mobile application interfaces. After that, the mobile application's development is then followed by the image processing programs using the appropriate software installed. Next, the collected data information and the images of Brassica Rapa indicated the different diseases and controls would be stored. And then, the system is being installed on the android phone and local server, and try the execution of the plan by capturing the Brassica Rapa leaf and checking what to analyze and identify the cause, and then displaying the health condition Brassica Rapa. Lastly, the system is evaluated with the result obtained throughout the process and the system's accuracy. It may include improving and maintaining its function ability and future updates.

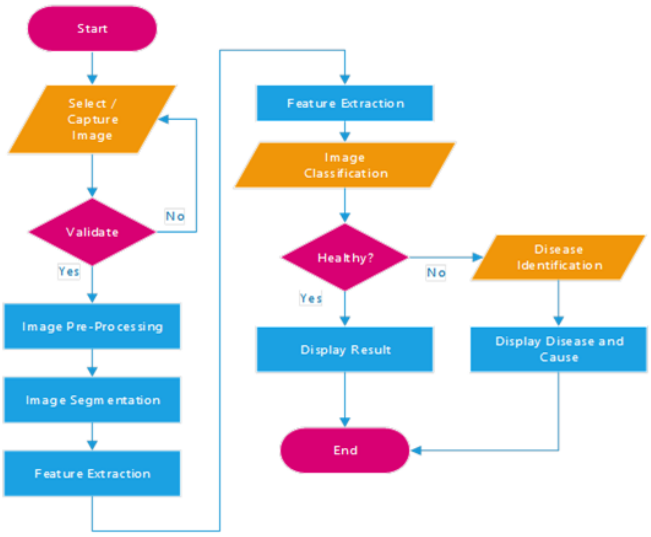

Fig. 6. System Flowchart

The study used the *Realme 6i* is, a smartphone with a specification stated that; a 6.5-inch HD+ notched display, quad rear cameras, and a single 16MP selfie camera. Its quad-camera setup comprises a 48MP primary camera, 8MP ultra-wide camera, 2MP macro camera, and 2MP depth camera. It runs on a MediaTek Helio G80 chipset with either 3GB or 4GB of RAM, Android 10 OS, and Realme UI software. A massive 5,000mAh battery powers the device with support for 18W fast charging technology via a USB Type-C port. This smartphone specification fits the hardware requirements of the system implementation.

Development Phase

After formulating all the designs of all modules, the researcher develops an Android mobile app, as shown in Figure 7. The front-end and back-end database scripts also include MATLAB's image processing techniques for image pre-processing, segmentation, and classification.

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Fig. 7. Android Apps installed in Realme 6i

Implementation Phase

The system consists of a mobile application, which will enable the user to take images of vegetable leaves, specifically Brassica Rapa, using their android phone and send them to a web server. The central system in the server analyzes the images based on visual symptoms using image processing algorithms to measure the health condition of vegetable Leaf. Figure 8 shows the testing process of the mobile apps and their functionality.

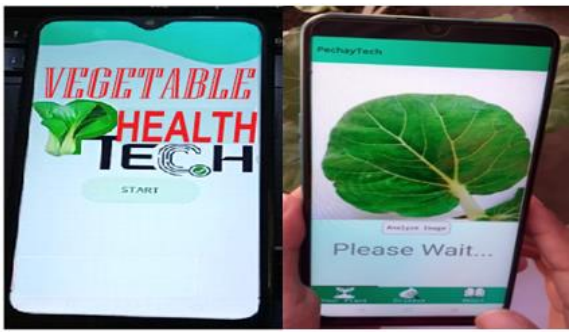

Fig. 8. Mobile Apps Implementation

Evaluation Phase

During the implementation process, the researcher executed a series of testing to develop a holistic yield to the solution of the health status of the vegetable. Figure 9 below shows the different types of the result displayed in the smartphone display screen during image capturing in the testing process.

Fig. 9. Result of the captured image

After visualizing, the researchers proceed to the process stage where planning, analysis, system design, development, implementation, and evaluation occur. This stage is crucial because it may involve complex calculations, trials, and errors.

III. Results and Discussions

Based on the methods applied in attaining the targeted objectives of this study, the researchers finally came up with the desired output. Figure 10 below shows the actual capturing of the image in the vegetable leaves using the smartphone equipped with the Android apps developed by the researcher. This smartphone, as mentioned earlier, is a Realme 6i model with a 48MP primary camera image resolution suitable for capturing the clear image status of the leaves.

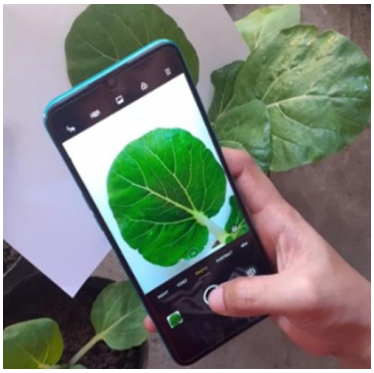
Fig. 10. The Realme 6i

Furthermore, after sending the image from the smartphone to the web server, the decision support of the server automatically responds in seconds if Internet connectivity is present the status of the image, as shown in Figure 11 below. It means that the leaf is healthy based on the dataset stored in the server's database.

Fig. 11. Healthy Status of the Vegetable Leaf

Figure 12 shows the part of the application which indicates the desired information, prevention, and detailed guidelines to the users on how to take care of the vegetable, particularly a Brassica Rapa.

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Fig. 12. Data Information of Diseases

IV. CONCLUSIONS

Based on the result of the study, the researcher drew the following conclusion:

The technical descriptions are feasible, and the desired output functions well. The mobile application that sends the image via Wi-Fi (Internet connectivity) is to be classified by the image processing algorithm, identify whether it's healthy, and send the classification result to be displayed in the mobile phone application.

The possibility to receive decision support through smartphones is signified. The identified results will send back to the mobile application and demonstrate the classification evidence.

The precise and complete information is displayed to avoid losing Brassica Rapa due to inaccurate or incomplete information about the disease. The app is accurate; however, it will need additional images in the web server for a different vegetable plant leaf disease.

Recommendations

For the future development and betterment of this study, the researchers recommend the following:

1. Variety of vegetable plant diseases images for accurate results.
2. Must add a language selection feature to the system for widely used.
3. Must run on popular mobile operating systems.

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REFERENCES

[1] Margaret Rouse, Ivy Wigmore (2013) "Mobile App". Tech Target [Online]. Viewed 8 September 21.Retrieved from: https://bit.ly/3uZgWwA
[2] Federal Trade Commission Consumer Information (2017). "Understanding Mobile Apps". Retrieved from: https://bit.ly/3LKe8JE
[3] Neu, Walton (2008). "Image Processing" Retrieved from: https://bit.ly/3sNZ8C6
[4] E. Suganya, S. Sountharrajan, Shishir Kumar Shandilya, M. Karthiga (2019). "IoT in Agriculture Investigation on Plant Diseases and Nutrient Level Using Image Analysis Techniques". Retrieved from: https://bit.ly/3sNZ8C6
[5] Staff Reporter Tech Times LLC "The Importance of Mobile Applications". Staff Reporter Tech Times LLC Retrieved from: https://bit.ly/3BDxBr6
[6] Aurélie Baronnet (2018). "The Importance of Image Processing". Cultural Heritage Digitization Retrieved from: https://bit.ly/3oU4OcI
[7] Monirul Islam Pavel, Syed Mohammad Kamruzzaman, Saifur Rahman Sabuj, Sadman Sakib Hasan (2019), "An IoT Based Plant Health Monitoring System Implementing Image Processing". IEEE 4th International Conference on Computer and Communication Systems.
[8] National Research Council (US) Committee on Biosciences. Washington (DC): 1985, "New Directions for Biosciences Research in Agriculture: High-Reward Opportunities". *NCBI.* [Online]. Viewed 23 Sept. 20. Retrieved from: https://bit.ly/3H0GFr5
[9] Vignesh Dhandapani, S. Remya, T. Shanthi, R. Vidhy "Plant Health Monitoring Using Image Processing". International Journal of Engineering Research in Computer Science and Engineering (IJERCSE) Vol 5, Issue 3, March 2018
[10] Jorge Mendes, Tatiana M. Pinho, Filipe Neves dos Santos, Joaquim J. Sousa, Emanuel Peres, José Boaventura-Cunha, Mário Cunha, Raul Morais, "Smartphone Applications Targeting Precision Agriculture Practices—A Systematic Review". *Agronomy* 2020 [Online]. Viewed 25 September 20. Retrieved from: https://bit.ly/36cWcqU
[11] Manikanta Munnangi (2019). "Crop: Plant Disease Identification Using Mobile App". [Online]. Viewed 9 September 21. Retrieved from: https://bit.ly/3LIBPlD
[12] Bruno Brandoli Machado, Jonatan P M Orue, Mauro S Arruda, Cleidimar V Santos, Diogo S Sarath, Wesley N Goncalves, Gercina G Silva, Hemerson Pistori, Antonia Railda Roel, Jose F Rodrigues-Jr. "BioLeaf: A professional mobile application to measure foliar damage caused by insect herbivory". Computers and Electronics in Agriculture, 2016. [Online]. Viewed 9 September 21. Retrieved from: https://bit.ly/353P8MM
[13] Wikipedia. "Plantix". [Online]. Viewed 9 September 21. Retrieved from: https://bit.ly/3H0GMmv
[14] Reddy, S.; Pawar, A.; Rasane, S.; Kadam, S. "A Survey on Crop Disease Detection and Prevention using Android Application". Int. J. Innov. Sci. Eng. Technol. 2015
[15] Jorge Mendes, Tatiana M. Pinho, Filipe Neves dos Santos, Joaquim J. Sousa, Emanuel Peres, José Boaventura-Cunha, Mário Cunha and Raul Morais. "Smartphone Applications Targeting Precision Agriculture Practices—A Systematic Review". Retrieved from: https://bit.ly/3sI2JBC
[16] Buinickaitė, A. (2017) "Crop Problem Identification—Quick and Easy". Retrieved from: https://bit.ly/3v4Aksp