Artificial Intelligence & Robotics Development Journal
Volume 1, Issue 2, pp 103-115, April 2021, https://doi.org/10.52098/airdj.202127
ISSN: 2788-9696 Received: 29/4/2021 Revised: 2/6/2021 Accepted: 3/6/2021

Image Processing Technique for the Detection of Al-Berseem Leaves Diseases Based on Soft Computing

Eimad Eldin Abusham[1,*], Amna Said Zaher Al-Shibli[2]
[1] Faculty of Computing and Information Technology, Sohar University, Oman
* Corresponding author: Eimad Eldin Abusham[1], EAbusham@su.edu.om

Abstract

Detecting plant diseases using the traditional method such as the naked eye can sometimes lead to incorrect identification and classification of the diseases. Consequently, this traditional method can strongly contribute to the losses of the crop. Image processing techniques have been used as an approach to detect and classify plant diseases. This study aims to focus on the diseases affecting the leaves of al-berseem and how to use image processing techniques to detect al-berseem diseases. Early detection of diseases important for finding appropriate treatment quickly and avoid economic losses. Detect the plant disease is based on the symptoms and signs that appear on the leaves. The detection steps include image preprocessing, segmentation, and identification. The image noise is removed in the preprocessing stage by using the MATLAB features energy, mean, homogeneity, and others. The k-mean-clustering is used to detect the affected area in leaves. Finally, KNN will be used to recognize unhealthy leaves and determines disease types (fungal diseases, pest diseases (shall), leaf minor (red spider), and deficiency of nutrient (yellow leaf)); these four types of diseases will detect in this thesis. Identification is the last step in which the disease will identify and classified.

Keywords*:* Image process; K-mean cluster; k-nearest neighbors; algorithm and al-berseem plants.

1. Introduction

Student Agriculture is a source of income for many countries in the world, especially countries that have a fertile climate and soil to produce various agricultural crops. These countries seek to achieve quality in agricultural production, which leads to paying more attention to agricultural diseases and pests affecting plants. Technology can help to find quick and effective solutions in detecting diseases before causing huge losses in crops and productivity. Image processing can play an important role in diagnosing the diseases through analyzing the image, classifying the symptoms of diseases and then identifying the specific disease.

Early discovery of diseases will reduce the spreads of diseases and find treatment without affecting productivity. Image processing can help farmers to save time and effort by early diseases discovery. Farmers determine the type of disease through symptoms that appear on the plant surface. However, similarities in the symptoms can cause a confusion in determining the accurate disease. Image processing techniques analyzes the symptom color and shape to determine the type of disease accurately and clearly. Image processing is an algorithm that studies image input produces an output of specific features (Nikkhouy, & Abusham, 2011). There are many algorithms that are used to improve images quality. Redistributing colors, the brightness and the contrast in the image all of these help in providing a high quality of pictures (Al-Hatmi & Yousif, 2017; Introduction & Processing, 2003).

In 2011 Patil & Bodhe studied the image processing technique to detect diseases affect sugarcane. Fungi the most important diseases affect sugarcane where produce large losses occur on crops. They merged two methods, first one a simple threshold, and other one triangle thresholding to divide the plant leaves to parts and identify the injured part. That gives a more accurate result and reduce the bad diagnosis (S. B. Patil & Bodhe, 2011).

In 2011 Mythili study the image noise which affects the image process. There are many filter techniques uses to remove noise from the picture, the noise quantization, and non-symmetric noise. In his paper, compare the filtering techniques use in removing noise and gave a result, using a fuzzy filter technique. This technique work with color image reduces the noise that affects the color component in the image. Remove the noise from the picture help to reduce time to detect diseases (if picture clear, detecting operation will be easy and fast) (Mythili, 2011; Hasoon et al., 2011).

In 2012 Chaudhary & Godara studied the first step of image classification, where spot color of diseases in plant leaves. The disease type is determined by the color and the area of the affected part. Color segmentation improves detect diseases. They implemented the Otsu method in “Monocot” and “Dicot” to study the background of color space

and how to make it an affected in classify the image. They Improved the algorithm to remove background noise and make the image smooth from impurities. Then they study the color model (CIELAB, YCbCr and HSI) compare between them and used each one in image process part to remove noise from the image. These methods contributed in to reduce noise from pictures (Chaudhary, Chaudhari, & Godara, 2012).

In 2016 Chatterjee & Rao study the need to find a solution to losses in crops, they used the artificial intelligence technique in segmentation part by applying the K-means method. Collected image and classifying it until extract information from it using the MATLAB program. Their study implements in maize crop to detect the syndrome of crop spot. The result got it from the program was very a good result (Chatterjee & Rao, 2016).

In 2016 Sabrol & Satish researcher study five types of disease affect tomato plant. Implement an application to classify disease affect plant is very important. In their research use classification technique to classify the disease by extract leaves features (color and texture) after checking segmented plant leaves. Tomato late blight and bacterial spot are a disease affect tomato plant studied in research. The result of their study the accuracy of the result found 97.3% through classifying tomato images and detect diseases (Sabrol & Satish, 2016).

In 2017 Raut and Fulsunge the writer focuses on improving the productivity of crops from monitoring the disease that affects plants. The traditional way to determine the disease not an effective, to get a perfect solution for it, the writer implements a modern technique to discover the disease in leaves and fruit. The MATLAB program has the algorithm to classify and identify diseases such as the k-means clustering and SVM. The technique of MATLAB program collects a picture of health leaf and not healthy and save it in a database. Then will preprocess the image and enhance a picture then apply K-mean to cluster image and use the SVM algorithm to classify and training image. Finally, the disease will be detected (Raut & Fulsunge, 2017).

In 2017 Narmadha & Arulvadivu, the writers studied cotton plant and how the image processing can help farmers to detect fungal disease. Using HPCCDD algorithm techniques that find a spot of fungal in leaf and classify it. RGB image classification work in the pixel of the leaf to select the affected parts. Then the techniques of homogenizing used in classify the edges of leaves, then identify the characteristic of it. Finally, detect disease type (Narmadha & Arulvadivu, 2017).

In 2018 Tlhobogang & Wannous studied the ICT how it is important if used in the agricultural field. This technology makes a big change if implemented in agricultural. The writers focused on the causes make detection disease late, and some of the reason for spread diseases, are the lost communication between the farmers, and there is

no data source contain all disease information. They focus on the input of the ICT technology in agricultural will solve many problems. Writers work in image analysis and neural networks to build data source contain disease information to improve the machine learning and training it to get fast result. They study also the problem make ICT not public, the differentiation between farmer level and agricultural area make cusses to stop spread ICT in the agricultural field (Tlhobogang & Wannous, 2018).

In 2018 Chouhan introduced a method to classify and identifies plant diseases, from what they see the importance of the plant in the world and diseases affecting it make huge losses for that, they implemented this method to reduce losses in agricultural fields. This method increases the efficiency of neural network and select a specific spot in the plant and study the features of it, then save it and use on the classification level. It worked on improving the identification and classification detection diseases. Implemented this method in a fungal disease, it gave an amazing result in computational efficiency and accuracy in detecting plant diseases (Chouhan et al., 2018).

This work aims to accurately classify and cluster diseases that affect al-berseem leaves. Also, to modify images through using local graph structure and histogram to improve their quality. The importance in this study derives from the importance of early detection of disease in reducing huge losses of crops and economy. Al-berseem farmers in Oman from different regions have been facing problems with diagnosing disease of their crop. This research utilizes image processing technique based on soft computing using in MATLAB program to classify pictures and discover the disease to help farmers select the correct medicine. One of the challenges is that image processing technique needs time to build a good database in order to be able to classify and detect untested images (Shaaban, 2021). Also, the study may take more time since it is my first time to use MATLAB program. There is a lack of studies and information concerning diseases that affect al-berseem leaf in Oman. This fact along with collecting data from the field can also be seen as a challenge that will take time in completing of the work.

2. Problem Statement & Objectives

The first symptoms affect the plant are similar and common in many diseases like changing in the color of leaves. Farmers may diagnose the disease wrongly with the old way of diagnosing by using the naked eye. The need to find a way to detect diseases fast and choose a correct medicine is a very important step because it will save the crops and money. Image processing technique provides features through classifying pictures and modifying them to get a quick result. Al-berseem is one of the popular crops that has been cultivated in Oman since a long time. The problem of study focuses on diseases that affecting al-berseem leaves. The following questions make the study problem clear.

- What are the diseases affecting al-berseem leaves?
- What are the causes of the disease?
- How can image processing help farmers in detecting diseases?

The main aim of the work is to accurately classify and cluster diseases that affect al-berseem leaves. A sub-objective of this study is to modify images through using local graph structure and histogram to improve their quality. Other objectives of the study are:

- To review related literature and studies.
- To detect unhealthy leaves of al-berseem.
- To classify al-berseem leaf diseases using texture features.
- To analyze the infected leaf and know the specific type of disease on time.

3. Study Area

The study is conducted in Mahdha city. Mahdha is in Al-Buraimi Governorate in Sultanate of Oman. It is characterized as a border area with United Arab Emirates. Farmers export al-berseem to it. Mahdha city has good soil and climate that contribute to have high quality of al-berseem. Figure 1. shows the study area.

Figure 1. Study Area

4. Research Methodology

This study is multistage approach that classify the images farmers using different types of smart devices. The Figure 2 shows the steps of the methodology that is followed in this study, which explain how image processing techniques will enhance the images quality (Hassin & Abbood, 2021) and detect diseases.

Step1: Capture leaves of al-berseem (healthy and unhealthy) using a smartphone (iPhone 7).

Step 2: Pre-processing image to improve the quality and remove noise from it.

Step 3: Cluster the image based on the affected area.

Step 4: Obtain the segmented parts.

Step 5: Compare the features from one cluster to the other clusters.

Step 6: Extract and detect of disease based on neural network classifier.

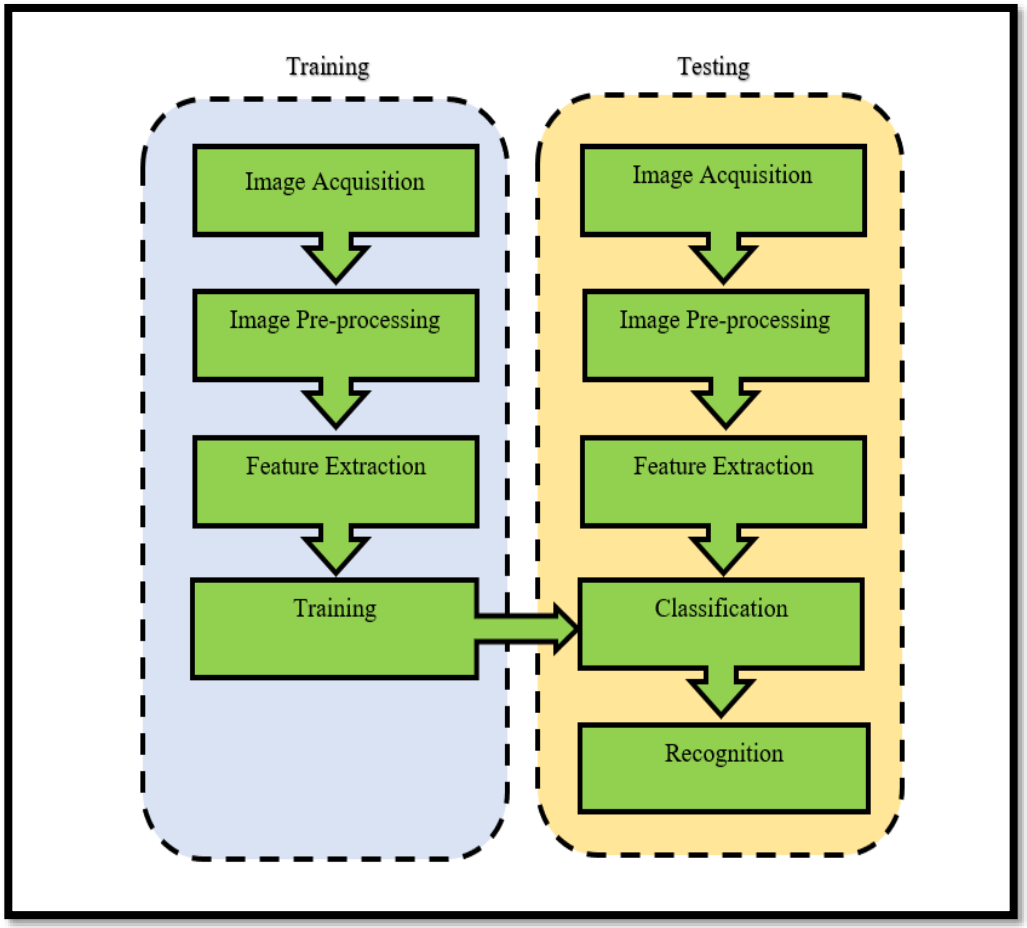

Figure 2. Research methodology

5. Image Processing Types Using Local Binary Pattern (LBP)

Local binary pattern (LBP) is a texture descriptor and a common technique that is used to extract texture and describe detail of the texture. In 1996, first algorithm of LBP was reported where image operation was used to detect features and classify texture. LBP is classified as a strong tool that can extract texture features through images analysis based on their properties. Compared to LBP, histogram uses a specific pixel and studies the intensity of the image, and then it compares the pixel with another near pixel. Generally, histogram takes a sample point and compares it to its neighborhood features (Muqeet & Holambe, 2018).

LBP works with a small pixel in the image and studies the feature of a neighborhood around each pixel in the picture. Also, it studies the intensity around each pixel and focuses on the central pixel because it is stronger than neighborhood pixels. LBP implements a binary code from '0' or '1' to implement a binary chain with the clockwise direction from the collection of a single binary code. LBP functions through taking the value of the central pixel and neighborhoods to get the result. The result takes several textures of LBPs. This method combines each neighborhood pixel and the difference between them by the gray level 0 or 1. The first image is divided into red, green, and blue components. Then, it is converted to blocks. LBP labels the blocks into numbers, calculates the distance between each pair based on the low distance. Finally, LBP calculates the neighborhood pixel (Hu & Zhan, 2020). Figure 3 shows central and neighborhood pixel used in LBP method.

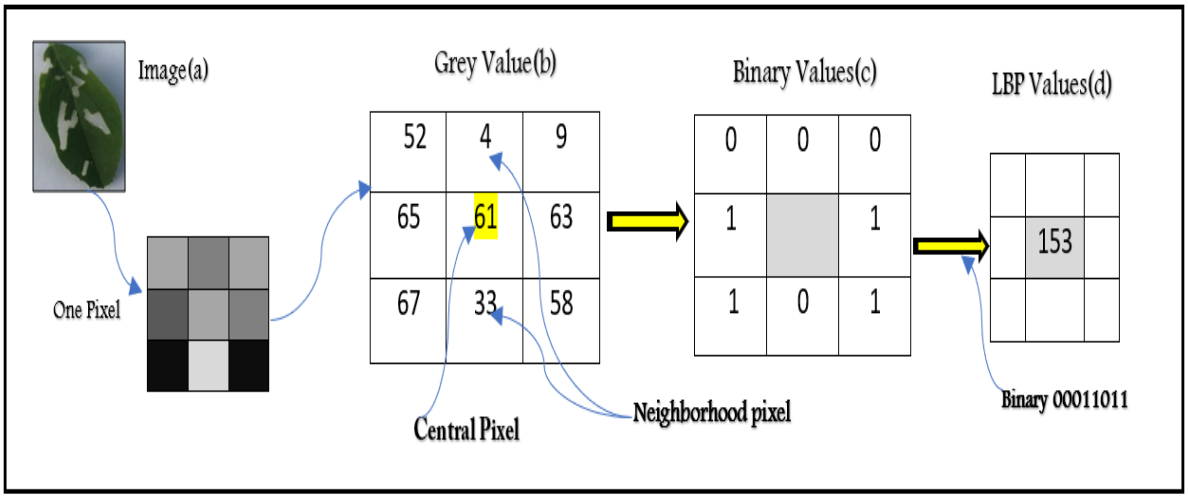

Figure 3. central and neighborhood pixel used in LBP method

6. Research Experimental Setup

The Pictures are the main data used in this research, called primary data, which was collected to study a specific problem (al-berseem leaves diseases). Use iPhone7 to capture al-berseem leaves, use digital cam and saved in computer to help reduce and control image size. First, select the disease wants to study. Then took photos of healthy leaves and unhealthy leaves (Radha, 2017). They found four types of disease affect al-berseem leaves in the period of collecting data (fungal infections, pest diseases (red spider), leaf minor (shall), and deficiency of nutrient (yellow leaf)). Take more than 100 pictures of each illness, spent three months collecting all data. Contact with the agricultural engineers in Mahdha and Al-buraimi to classify the type of diseases. They classify and give correcting diseases names. Figure 4 shows a sample of collected data from Mahdha farms.

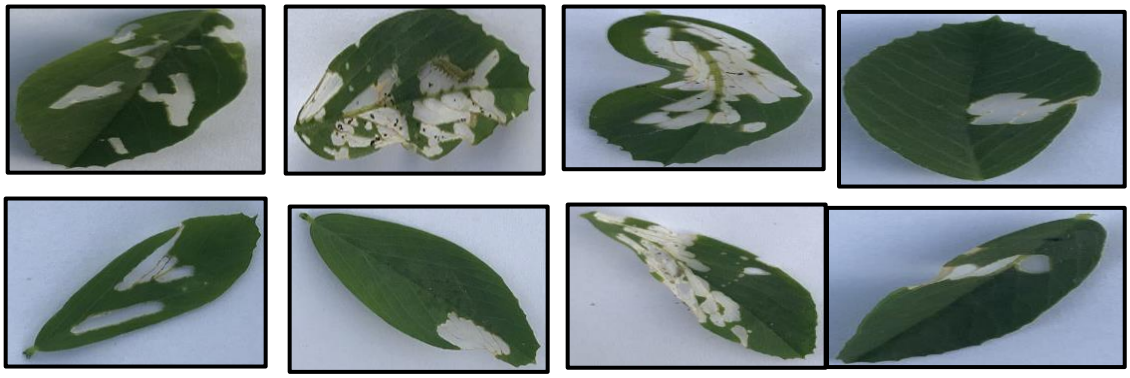

Figure 4. a sample of collected data from Mahdha farms.

Then, the pictures divided into parts and each part contains a matrix with a fixed size, a binary value takes features from the neighbor pixel and calculated decimal value for each matric (Ayoob & Kumar, 2015). The local graph structure is a relation between X and Y pixel in each image with another neighbor (Bashier, et al, 2013) (Abusham, & Khalifa, 2010)," LGS is found to be a very powerful texture operator with compare to the local binary pattern LBP where reduce the size of the image and remove noise from the picture (Abusham & Bashir, 2011). In this section will remove noise from the picture and keep all pictures in the same size after normalization (Sayeed, Hossen, & Kalaiarasi, 2012) (Abusham, & Kiong, 2009). After that, extract the feature of the image color, shape, texture, and size all of these features will use to detect the disease affects al-berseem plant leaves (Abusham et al. , 2008). The separation of color in leaves give a type of information different from feature that take from texture, then save each feature separately. Each feature in leaves gives a different meaning of diseases affect plants. Finally, collecting list of features and what are the changes made in leaves, help to classify diseases (Khirade, 2015). The classification method is an

important step, it identifies differentiation between symptoms of the disease with different conditions and several features (Arnal Barbedo, 2013). By using the histogram to reduce the size and minimize the size of pictures and focus only in the affected area. A histogram is a tool used to discover an important statically shape for continuous data. Here will fetch the disease in the matrix with specific features, then the program will start to compare the affected leaves with healthy leaves. The program will be training all newly entered data, with the data already saved in the program. It keeps the data features in the program and when the new data enter, will read and save the features. Finally, for the new data entered to the program will go through all previous sections, then will get the accurate result in a short time. Lastly, collect all information come from the upper section to get the result. Here will show which disease affect al-berseem leaves, from the features of the picture, after clustering it by affected area. It will compare disease features saved previously in the program with new features collected from the new picture entered. Finally, will detect disease types and show the result.

7. Results and Discussion

The program collects the features for each leaf entered to program and sprite it as order saved in the program (leaf minor (shall), deficiency of nutrient (yellow leaf), pest diseases (red spider) and fungal disease). All image has specific features the program extracts it and list in table and sprite it as 13 features (contrast, smoothness, variance, correlation energy, kurtosis, homogeneity, skewness, mean, standard deviation, entropy, and RMS) these features getting from the segmented areas of images. Saving features in the table with a specific number, each number has exact meaning and can control a specific area in the image. Then contrast the image by reducing the distance between image pixels to make picture clear and change the image value distribution to cover a wide range during control the dark or mostly bright image, figure 5.5 a code of enhancing image contrast in MATLAB. Fixe image size in photoshop program and cut extra area in the images. After removing noise and save image features move to cluster the image depend on the affected area using the k-mean cluster.

In this search using three clusters depend on changes in the color of the affected area. Use of K Means clustering for segmentation and convert image from RGB Color space to L*a*b* color space the L*a*b* space consists of a luminosity layer 'L*', chromaticity-layer 'a*' and 'b*'. Color information is in the 'a*' and 'b*' layers. The colors classify in a*b* color space by K means clustering. The image has 3 colors create 3 clusters. Using results from K means and saved to use in classify disease types using K-nearest neighbor. Each cluster shows a different area of diseases affecting leaves, and the program distinguishes the affected area, or which have different characteristics in the (color,

texture, and shape) by the nearest characteristic in entered image with new image entered to the program as shown in Figures 5 & 6.

Figure *5*. Affected Area in Al-berseem Leaves by Bacteria

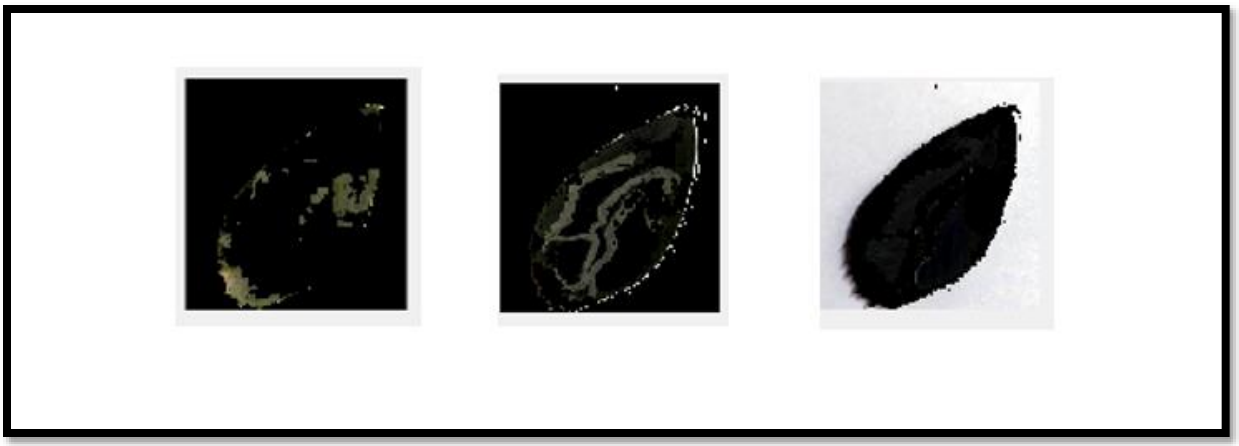

Figure *6*. Affected Area in Al-berseem Leaves by Spider.

The results show that the proposed system recognized Alfalfa diseases effectively and quickly by up to 90%. The result shows a powerful detecting rate of diseases which equal 90%., 8 of 10 pictures got the correct result with some diseases and with other diseases got 9 of 10, that means the program has 90% of correct result from of detecting diseases. The program works on enhance images and reduces the time to detect diseases. In the figures below will show some tested sample in the program to detecting diseases with a correct and incorrect result as shown in Figures 7 & 8.

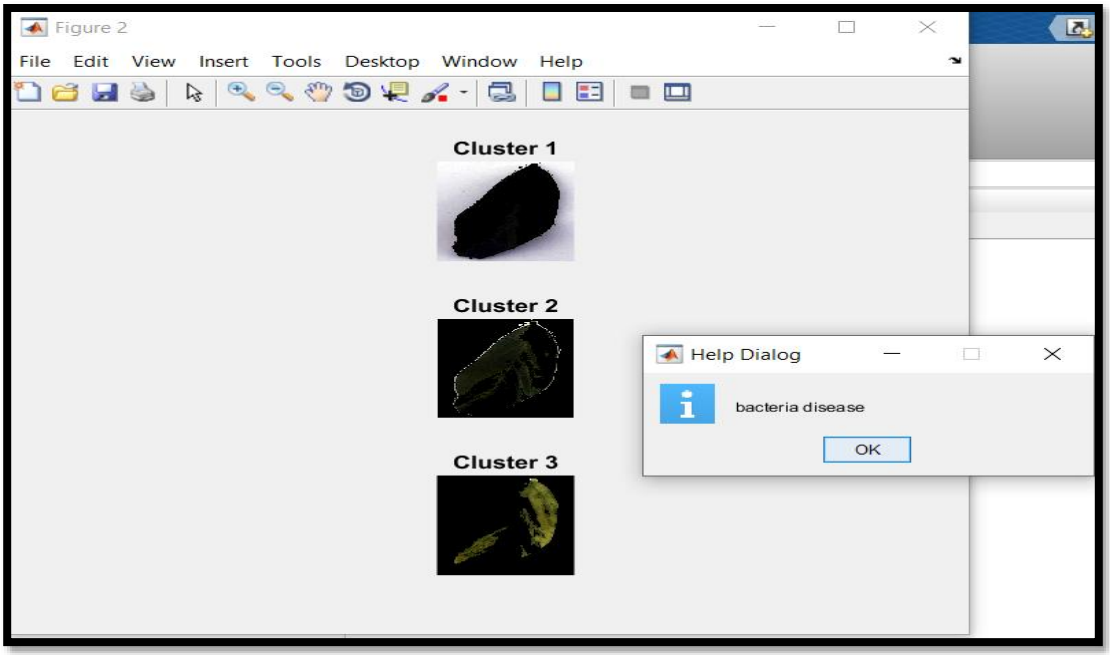

Figure 7. Correct Detect of Diseases Affect Al-berseem Leaves.

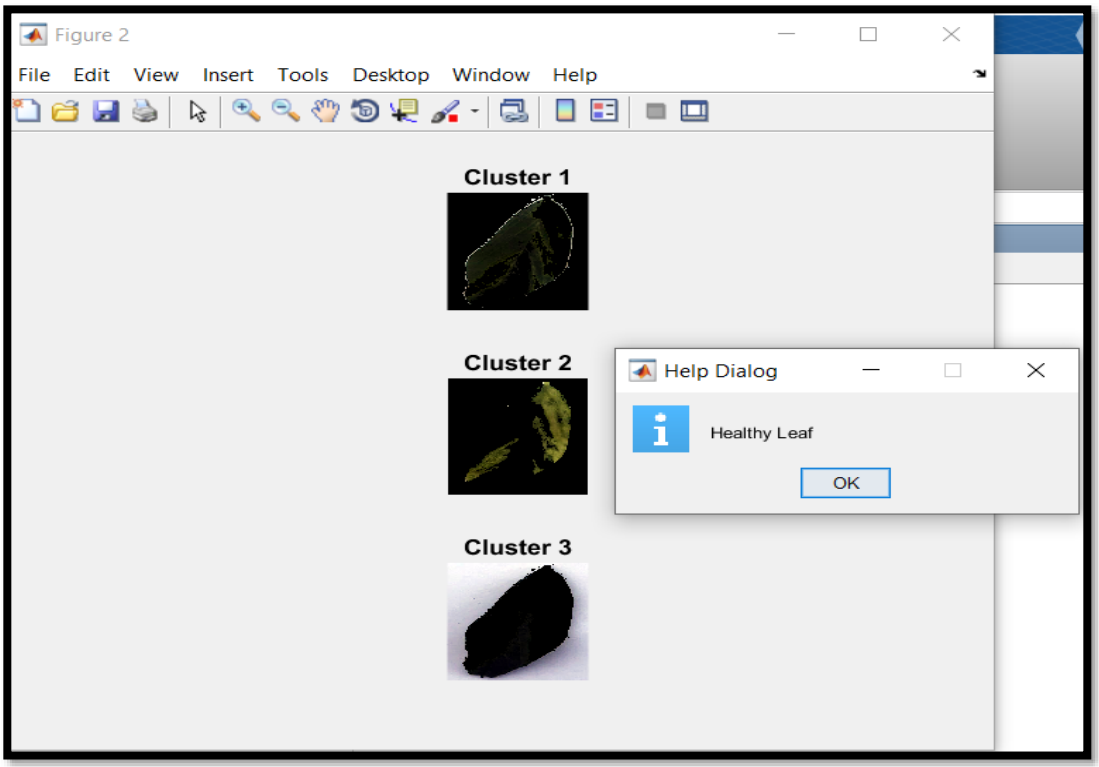

Figure 8. Incorrect Detect of Diseases Affect AL berseem Leaves.

8. Conclusion

This research focuses on diseases that affected al-berseem leaves and how detecting diseases will change the productivity of crops. This research used MATLAB 2016 to identify diseases and classify their types. Early detection of diseases makes a considerable difference in productivity and economic income because most losses in this field come from misdiagnosing the disease or late detection of the disease. This work showed that modern photo techniques contribute to saving a lot of time. It helps determine immediately appropriate solutions and, therefore, to control the spread of diseases among crops.

The future work of this research looks forward to creating an application of a plant disease detection system on mobile phones. So, farmers can use it easily. Also, the study seems to complete all pests that affect the al-berseem plant clover, not only the problems that affect the leaves. A different perspective is that studying other al-berseem planting regions in Oman would provide more information on the topic.

Acknowledgment

The research leading to these results has no Grant Funding.

References

[1]. Abusham, E. E. A., & Bashir, H. K. (2011). Face Recognition Using Local Graph Structure (LGS), 169–170.
[2]. Abusham, E. E., Jin, A. T., Kiong, W. E., & Debashis, G. (2008). Face recognition based on nonlinear feature approach.
[3]. Abusham, E., & Khalifa, H. Face recognition using local graph structure. In Hcii11 Proceedings of the 14 International Conference on Human-computer Interaction: Interaction Techniques and Environments2010 (No. PART II, pp. 169-175).
[4]. Abusham, E. E. A. A., & Kiong, W. E. (2009). Non-linear principal component embedding for face recognition. J. Journal of Applied Sciences, 9, 2625-2629.
[5]. Al-Hatmi, M. O., & Yousif, J. H. (2017). A review of Image Enhancement Systems and a case study of Salt &pepper noise removing. International Journal of Computation and Applied Sciences (IJOCAAS), 2(3).
[6]. Arnal Barbedo, J. G. (2013). Digital image processing techniques for detecting, quantifying and classifying plant diseases. SpringerPlus, 2(1), 1–12. https://doi.org/10.1186/2193-1801-2-660
[7]. Ayoob, M. R., & Kumar, R. M. S. (2015). Face Recognition using Symmetric Local Graph Structure, 8(September). https://doi.org/10.17485/ijst/2015/v8i
[8]. Bagde, S., Patil, S., Patil, S., & Patil, P. (2015). Artificial Neural Network Based Plant Leaf Disease Detection, 4(4), 900–905.
[9]. Bashier, H. K., Abusham, E. E., Abdullah, M. F. A., Liew, T. H., Yusof, I., & Lau, S. H. (2013). Real time face tracker based on local graph structure threshold (LGS-TH). Australian Journal of Basic and Applied Sciences, 7(2), 632-638
[10]. Chatterjee, P., & Rao, B. H. (2016). Leaf Disease Detection using Image Processing Technique, 4(9), 90–93. https://doi.org/10.17148/IJIREEICE.2016.4919
[11]. Chaudhary, P., Chaudhari, A. K., & Godara, S. (2012). Color Transform Based Approach for Disease Spot Detection on Plant Leaf, 3(6), 4–9.
[12]. Chouhan, S. S., Kaul, A., Singh, U. P., & Jain, S. (2018). Bacterial Foraging Optimization Based Radial Basis Function Neural Network (BRBFNN) for Identification and Classification of Plant Leaf Diseases : An Automatic Approach Towards Plant Pathology. IEEE Access, 6, 8852–8863. https://doi.org/10.1109/ACCESS.2018.2800685
[13]. Hasoon, F. N., Yousif, J. H., Hasson, N. N., & Ramli, A. R. (2011). Image Enhancement Using Nonlinear Filtering Based Neural Network. Journal of Computing, 3(5), 171-176.

[14]. Hassin, A., & Abbood, D. (2021). Human–Ear Recognition Using Scale Invariant Feature Transform. Artificial Intelligence & Robotics Development Journal, 1-12.
[15]. Hu, N., Ma, H., & Zhan, T. (2020). Finger vein biometric verification using block multi-scale uniform local binary pattern features and block two-directional two-dimension principal component analysis. Optik, 208, 163664.
[16]. Journal of Computer Science and Mobile Computing, 62(2), 101–106.
[17]. Khirade, S. D. (2015). Plant Disease Detection Using Image Processing. 2015 International Conference on Computing Communication Control and Automation, 768–771. https://doi.org/10.1109/ICCUBEA.2015.153
[18]. Mythili, C. (2011). Efficient Technique for Color Image Noise Reduction, II(Iii).
[19]. Muqeet, M. A., & Holambe, R. S. (2018). A collaborative representation face classification on separable adaptive directional wavelet transform based completed local binary pattern features. Engineering science and technology, an international journal, 21(4), 611-624.
[20]. Narmadha, R. P., & Arulvadivu, G. (2017). Detection and measurement of paddy leaf disease symptoms using image processing. 2017 International Conference on Computer Communication and Informatics, ICCCI 2017, 7(5), 11964–11967. https://doi.org/10.1109/ICCCI.2017.8117730
[21]. Nikkhouy, E., & Abusham, E. E. A. (2011). Facial features detection using Eyes-Nose template. IJCSNS International Journal of Computer Science and Network Security, 11(11).
[22]. Patil, J. K., Kumar, R., Vidyapeeth, B., Kolhapur, C. O. E., & Vidyapeeth, B. (2011). Advances in image processing for detection of plant diseases. Journal of Advanced Bioinformatics Applications and Research ISSN, 2(2), 135–141. https://doi.org/ISSN 0976-2604
[23]. Patil, S. B., & Bodhe, S. K. (2011). Leaf disease severity measurement using image processing. International Journal of Engineering and Technology, 3(5), 297–301. https://doi.org/10.1094/PDIS-09-16-1392-RE
[24]. Radha, S. (2017). Leaf Disease Detection using Image Processing, 10(November), pp 670–672.
[25]. Raut, S., & Fulsunge, A. (2017). Plant Disease Detection in Image Processing. International Journal of Innovative Research in Science, 6(6), 10373–10381. https://doi.org/10.15680/IJIRSET.2017.0606034
[26]. Shaaban, H. (2021). Enhanced Region of Interest Extraction method for Finger Vein Images. Artificial Intelligence & Robotics Development Journal, 13-25.
[27]. Sabrol, H., & Satish, K. (2016). Tomato Plant Disease Classification in Digital Images using Classification Tree. 2016 International Conference on Communication and Signal Processing (ICCSP), pp 1242–1246. https://doi.org/10.1109/ICCSP.2016.7754351
[28]. Sayeed, S., Hossen, J., & Kalaiarasi, S. M. A. (2012). Illumination normalization using eimad-housam technique. Trends in Applied Sciences Research, 7(8), pp 692-700.
[29]. Tlhobogang, B., & Wannous, M. (2018). Design of Plant Disease Detection System: A Transfer Learning Approach Work in Progress. 2018 IEEE International