A Comparative Paper On Agriculture System For The Crop Leaf Fault Detection

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Abstract

As we know we are living in the era of high-tech science and technology, we have great innovations but still our agricultural area in not that much improvement if we compare that with other area, As we can see food quality is the most important parameter. If we are talking about farming so still there is no any low cost solution is available which is able to detect the fault on crop leaves. In our planet currently Crop diseases are major problem. In fact, it is estimated that plant pathogens may account for annual crop yield losses of up to 16% globally [Oe06].
In near future it's a calculation that world pollution will be nearly 10 billion by 2050, at present approximate 37.7% of total land surface is used for crop production. By 2050 food production will be increase by 70%, so we can see there is hedge demand of agricultural. As we discuss above in agricultural crop leaf fault detection is big challenge, there is no any low-cost solution which is easily used by any type of farmers. In this paper we did the comparative analysis on the existing leaf fault detection approaches. Here we also did the implementation of those previous existing approaches. Here we use the python as a language for the implementation of existing approaches. In terms of result analysis, we use two parameters which are time complexity and accuracy.

Key Words: Agricultural, Feature Extraction, Digital image processing, Computer vision, Image Classification

I. INTRODUCTION

The agricultural land mass is something other than being a taking care of sourcing in this day and age. Indian economy is exceptionally reliant of agrarian profitability. Hence in field of agribusiness, identification of sickness in plants assumes a significant job. To identify a plant sickness in starting stage, utilization of programmed ailment location strategy is advantageous. For EXAMPLE, a sickness named little leaf illness is an unsafe ailment found in pine trees in United States. The influenced tree has a hindered development and kicks the bucket inside 6 years. Its effect is found in Alabama, Georgia parts of Southern US. In such situations early discovery could have been productive. The current strategy for plant ailment recognition is basically unaided eye perception by specialists through which ID and location of plant illnesses is finished. For doing as such, an enormous group of specialists just as ceaseless observing of plant is required, which costs high when we do with huge homesteads. Simultaneously, in certain nations, ranchers don't have legitimate offices or even thought that they can contact to specialists. Because of which counseling specialists even cost high just as tedious as well. In such conditions, the recommended method ends up being valuable in observing huge fields of harvests. This additionally underpins machine vision to give picture based programmed process control, examination, and robot direction [2,4,5]. Plant illness recognizable proof by visual way is increasingly arduous undertaking and

simultaneously, less exact and should be possible just in constrained territories. While if programmed location system is utilized it will take less endeavors, less time and become progressively precise The division procedure depends on different highlights found in the picture. This may be shading data, limits or section of a picture [11,13]. We utilize Genetic calculation for shading picture division. Transformative figuring was first presented during the 1960s by I. Rechenberg. His thought was then taken forward by different specialists. Some of the time transformative changes are little and seem inconsequential from the outset, yet they have an impact in normal determination and the endurance of the species. Instances of normal determinations are 1. The warrior ants in Africa are presumably one of the most great instances of adjustment. Inside any single province, ants transmit a substance signal that tells the others they all have a place with a similar compound. Or on the other hand, set all the more forth plainly, a sign that says, "Don't assault me, we're all family." However, warrior ants have figured out how to impersonate the sign from an alternate settlement. So if a gathering of warrior ants assaults a province, they will have the option to copy that settlement's sign. Subsequently, the laborers in the province will progress forward, presently under the heading of new experts, while never understanding an attack has occurred. 2. All rodent snakes have comparative weight control plans, are fantastic climbers and murder by tightening. They all have a similar response when alarmed (they stay unmoving), and will keep away from showdown at whatever point conceivable. Some will nibble whenever undermined, ALTHOUGH they are non-venomous. Be that as it may, rodent snakes arrive in a wide assortment of hues, from yellow striped to dark to orange to greenish. This is on the grounds that rodent snakes are discovered everywhere throughout the Eastern and Midwestern states, and are exposed to a wide range of climate and territory. Rodent snakes are basic in urban zones, yet they can likewise be found in lush regions, mountains or waterfront areas. Therefore, rodent snakes have needed to adjust to their neighborhood surroundings with an end goal to maintain a strategic distance from discovery and chase all the more viably. Hereditary calculations have a place with the developmental calculations which produce answers for improvement issues. Calculation starts with a lot of arrangements called populace. Arrangements from one populace are picked and afterward used to shape another populace. This is finished with the expectation, that the new populace will be upgraded than the former one. Arrangements which are chosen to frame new arrangements (posterity) are picked by their wellness – the more fitting they are, the greater likelihood they need to repeat [12,14]. The rest of the paper is organized as follows. Necessary literature survey related previous research on leaf fault detection are given in II detection based previous work are given in section ii whereas section III describes research issue & future scope methodology & IMPLEMENTATION FOR THE PREVIOUS EXISTING APPROACHES. IV describes methodology & IMPLEMENTATION FOR THE PREVIOUS EXISTING APPROACHES. Experimental results and its analysis are given in section V. Finally, section VI concludes the paper.

II. LITRETURE REVIEW

As we know agricultural is the main source to grow any country. For agricultural the main problem is leaf sickness this issue will create a lots of problem to farmers. So in this area there is lots of research is going on, so as per the previous study the Ghaiwat et al. presents study on various grouping systems that can be utilized for plant leaf malady arrangement. For given test model, k-closest neighbor strategy is by all accounts appropriate just as least difficult of all calculations for class forecast. In the event that preparation information isn't straightly distinct, at that point it is hard to decide ideal parameters in SVM, which shows up as one of its downsides [1]. Creators in paper [2] portray that there are essentially four stages in created handling plan, out of which, initial one is, for the information RGB picture, a shading change structure is made, on the grounds that this RGB is utilized for shading age and changed or changed

over picture of RGB, that is, HSI is utilized for shading descriptor. In second step, by utilizing limit esteem, green pixels are covered and expelled. In third, by utilizing pre-registered limit level, expelling of green pixels and veiling is accomplished for the helpful fragments that are extricated first in this progression, while picture is divided. Furthermore, in last or fourth fundamental advance the division is finished. Mrunalini et al. [3] presents the strategy to characterize and recognize the distinctive illness through which plants are influenced. In Indian Economy a Machine learning based acknowledgment framework will end up being exceptionally helpful as it spares endeavors, cash and time as well. The methodology given in this for include set extraction is the shading co-event strategy. For programmed recognition of infections in leaves, neural systems are utilized. The methodology proposed can fundamentally bolster an exact location of leaf, and is by all accounts significant methodology, if there should be an occurrence of steam, and root maladies, investing less amounts of energy in calculation. As per paper [4] sickness ID process incorporate a few stages out of which four principle steps are as per the following: first, for the information RGB picture, a shading change structure is taken, and afterward utilizing a particular edge esteem, the green pixels are conceal and evacuated, which is additionally trailed by division process, and for getting helpful sections the surface insights are figured. Finally, classifier is utilized for the highlights that are extricated to arrange the malady. The strength of the proposed calculation is demonstrated by utilizing trial consequences of around 500 plant leaves in a database. Kulkarni et al. presents a system for ahead of schedule and precisely plant ailments discovery, utilizing counterfeit neural system (ANN) and differing picture preparing strategies. As the proposed approach depends on ANN classifier for characterization and Gabor channel for highlight extraction, it gives better outcomes with an acknowledgment pace of up to 91%. An ANN based classifier arranges diverse plant sicknesses and utilizations the blend of surfaces, shading and highlights to perceive those infections [5]. Creators present malady discovery in Malus domestica through a viable technique like K-mean bunching, surface and shading examination [6]. To group and perceive distinctive agribusiness, it utilizes the surface and shading highlights those for the most part show up in ordinary and influenced territories. In coming days, with the end goal of characterization K-implies grouping, Bayes classifier and head segment classifier can likewise be utilized. As per [7] histogram coordinating is utilized to distinguish plant illness. In plants, illness shows up on leaf along these lines the histogram coordinating is done based anxious recognition system and shading highlight. Paper [8] presents the triangle edge and straightforward limit techniques. These techniques are utilized to sore locale zone and section the leaf zone individually. In definite advance, order of sickness is finished by computing the remainder of leaf zone and injury region. As per the exploration done, the given technique is quick and precise for computing leaf infection seriousness and leaf region computation is finished by utilizing limit division. Creators depict a calculation for sickness spot division in plant leaf utilizing picture handling strategies [9]. In this paper, procedure of sickness spot location is finished by looking at the impact of HSI, CIELAB, and YCbCr shading space. For Image mitigating Median channel is utilized. In definite advance, by applying Otsu technique on shading part, estimation of edge should be possible to discover the infection spot. There is some clamor on account of foundation which is appeared in the exploratory outcome, camera blaze and vein. CIELAB shading model is utilized to expel that commotion. The condition of workmanship survey of various strategies for leaf sickness discovery utilizing picture preparing systems is introduced in paper [10]. The current strategies reads are for expanding throughput and decrease emotion which comes because of unaided eye perception through which ID and location of plant maladies is finished. As indicated by [14] delicate processing techniques, for example, counterfeit neural systems (ANN), hereditary programming, and fluffy rationale can be utilized as an elective strategy for demonstrating complex conduct of materials, for example, graphene. These calculations require input preparing information for tackling issues. These registering strategies

produce important answers for entangled improvement issues dependent on the information. In numerous models feed-forward system of three layers can be utilized. Root-mean-square blunder technique can be utilized to decide the quantity of neurons in covered up layer.[15] Vijai[16], Agricultural profitability is something on which economy profoundly depends. This is the one reason that sickness location in plants assumes a significant job in agribusiness field, as having infection in plants are very regular. In the event that legitimate consideration isn't taken here, at that point it causes genuine consequences for plants and because of which individual item quality, amount or profitability is influenced. For example a sickness named little leaf illness is a dangerous ailment found in pine trees in United States. Location of plant infection through some programmed strategy is helpful as it diminishes a huge work of observing in huge homesteads of yields, and at beginning period itself it distinguishes the side effects of illnesses for example at the point when they show up on plant leaves. This paper presents a calculation for picture division procedure which is utilized for programmed location and characterization of plant leaf ailments. Konstantinos[17], In this paper creator presents, convolutional neural system models were created to perform plant ailment location and conclusion utilizing straightforward leaves pictures of sound and ailing plants, through profound learning strategies. Preparing of the models was performed with the utilization of an open database of 87,848 pictures, containing 25 unique plants in a lot of 58 particular classes of [plant, disease] blends, including sound plants. A few model structures were prepared, with the best execution arriving at a 99.53% achievement rate in distinguishing the relating [plant, disease] mix (or solid plant). The altogether high achievement rate makes the model an extremely helpful warning or early admonition instrument, and a methodology that could be additionally extended to help a coordinated plant infection distinguishing proof framework to work in genuine development conditions. Komal[18], This paper presents, Image handling methods are broadly utilized for the discovery and arrangement of sicknesses for different plants. The structure of the plant and presence of the sickness on the plant represent a test for picture preparing. This examination actualizes SVM (Support Vector Machine) based picture preparing way to deal with investigate and order three of the rice crop illnesses. The procedure comprises of two stages, for example preparing stage and ailment forecast stage. The methodology recognizes infection on the leaf utilizing prepared classifier. The proposed explore work improves SVM parameters (gamma, nu) for greatest productivity. The outcomes show that the proposed approach accomplished 94.16% exactness with 5.83% misclassification rate, 91.6% review rate and 90.9% accuracy. These discoveries were contrasted and picture handling procedures talked about to reiterate writing. Florian[19], The investigation introduced in this paper is based on the in-field recognition of foliar esca indications during summer, showing a run of the mill "striped" design. To be sure, in-field illness recognition has indicated extraordinary potential for business applications and has been effectively utilized for other agrarian needs, for example, yield estimation. Separation with foliar side effects brought about by different illnesses or abiotic stresses was additionally thought of. Two vineyards from the Bordeaux district (France, Aquitaine) were picked as the reason for the analysis. Pictures of unhealthy and solid vine plants were gained during summer 2017 and marked at the leaf scale, bringing about a fix database of around 6000 pictures (224 pixels) separated into red cultivar and white cultivar tests. At that point, we handled the arrangement part of the difficult contrasting best in class SIFT encoding and pre-prepared profound learning highlight extractors for the grouping of database patches. Tanzeel[20], This paper thoroughly studied current utilization of measurable AI methods in machine vision frameworks, investigations every system potential for explicit application and speaks to a review of informative models in various farming regions. Proposals of explicit factual AI strategy for explicit reason and constraints of every system are additionally given. Future patterns of factual AI innovation applications are talked about. Gittaly[21], This paper, address a far reaching concentrate on sickness acknowledgment and grouping of plant leafs utilizing

picture preparing strategies.. A far reaching conversation on the infections discovery and arrangement execution is introduced dependent on examination of recently proposed condition of workmanship systems especially from 1997 to 2016. At long last, examined and group the difficulties and a few possibilities for future enhancements in this space. Abu Bakar[22], This paper depicts a coordinated strategy for discovery of illnesses on leaves called Rice Leaf Blast (RLB) utilizing picture preparing method. It incorporates the picture pre-preparing, picture division and picture investigation where Hue Saturation Value (HSV) shading space is utilized. To separate the locale of intrigue, picture division (the most basic errand in picture preparing) is applied, and design acknowledgment dependent on Multi-Level Thresholding approach is proposed. Accordingly, the seriousness of RLB malady is grouped into three classes, for example, disease stage, spreading stage and most noticeably awful stage. Haya[23], The paper point of this investigation was to build up a schematic convention so as to look at the sickness episode. P. infestans were segregated and distinguished dependent on morphological qualities, serological and species-explicit PCR measures. Ten examples were prepared and inspected morphologically and serologically (dipstick). Delima[24], In this paper creator present the red Onion is a tuber plant that is generally utilized by the individuals of Indonesia, both as herbs and home grown meds. Onion ranchers have restrictions in recognizing maladies that assault their harvests. This infection can cause crop disappointment against the onion. This structure starts with the formation of an information base up to include yield plan with forward tying strategy. The consequences of this structure can help ranchers in recognizing their plant ailments. In view of demonstrative aftereffects of a few techniques that have been finished trying can analyze ailments contained in onion plants. With side effects information that has been controlled by the master with the estimation of every side effect is unique. Jihen[25], Plant sicknesses are significant factors as they bring about genuine decrease in quality and amount of agribusiness items. In this way, early discovery and determination of these ailments are significant. To this end, we propose a profound learning-based methodology that robotizes the way toward grouping banana leaves maladies. Specifically, we utilize the LeNet engineering as a convolutional neural system to order picture informational indexes. The primer outcomes show the adequacy of the proposed approach considerably under testing conditions, for example, light, complex foundation, diverse goals, size, posture, and direction of genuine scene pictures. As we know currently we are in the era of smart technology which is mainly focus to improve our current existing system. Now a days farming is also a very critical market where we need some of the smart technology which help the farmers to improve there farming style and generate a good quality product. So based on that there is requirement where farmer can check what type of disease are there on there crops. These are previous researches which are related to the leaf fault detection.

III. Research Issue & Future Scope

In this section basically we talk about research gap which need to be solved, here are lots of research are there who work on that area but there is lots of challenges are there which really need to be solved so here are those research gap which need to be solved:

1. Lack of Real time system: Currently there is no any solution which is able to find the leaf disease on live camera.
2. Time complexity: In existing solution time complexity is main challenge
3. Not Applicable for most of the leaf: Current solutions are mostly for any specific like crop, graps etc, there is no any solution which are able to cover most of the leaves.
4. Quality: In current exsisting approach there is issue with quality ,as per there extra time complexity there is no any approach who are able to provide good quality
5. Time & Quality management issue: There is no any approach which is able to make justice with both parameters.

6. Accuracy: There is lack of accuracy in most of the previous existing approach

As per the previous research there is lots of research gap which need to be solved in near future.

Future Scope on Leaf Fault Detection Algorithm

As per the previous research there is lots of research gap which need to be solved so in this work these are our objects which we will solve:

- Real time system: In this work we will develop a system which is able to find the leaf disease on live camera.
- Reduction In Time complexity
- Applicable for most of the leaves
- Improvement in Quality
- Proper management in Time & Quality and try to make justice with both parameters.
- Improvement in accuracy

So this is the future scope of this leaf fault detction algorithm which will give a new direction to the researchers.

IV. METHADOLOGY & IMPLEMENTAION

In this section we talk about the basic leaf fault detection process, what kind of basic algorithm was used and what are the advance research is there. Here we did the complete comparative study and implementation of those approaches.

4.1 Vijay[16]:

As per this algorithm author use the technique of image acquisition, using this process leaf image is convert into the digital encoded form after that step they try to remove the distorted part. In next step they use the threshold approach to mark the green pixels. If green pixel are less so they mark that as a image cluster and based on that they detect the leaf fault.

4.2 Konstantinos[17]:

As per this algorithm author use the convolutional neural network models, according to this system they use deep learning approach to detect the health of the leaves. Here they use the training model based approach and based on that approach they did the analysis on healthy and faulty leaf.

4.3 Komal[18]:

As per this algorithm author use the image acquisition process after that process they use preprocessing approach which is based on sift algorithm. In this process they target the green pixel and based on that only they decide which is faulty part.

4.4 Jihen[25]:

As per this algorithm author use the followings steps:

1. Image Resize
2. Colour Transformation
3. Feature Extraction Model
4. Classification Model

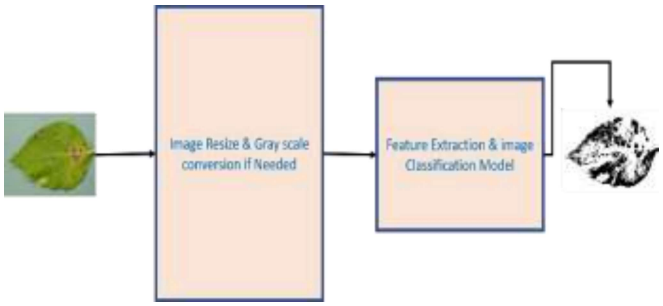

Fig. 4.1 Jihen Approach

Based on these steps author detect the fault on the leaf. Here author use the feature extraction and image classification ,model technique.

As we know present era there is need of fast processing system so for the implementation of those previous algorithm we use python as a language, here we use some common library for implementations of existing approaches are those are:

1. Numpy
2. Matplot
3. OpenCv
4. Pillow
5. Scikit-image

These are some library which we use for the implementation of existing algorithms.

V. RESULT & ANALYSIS

In this section we introduce the relative investigation of all with past existing methodology. As we can see fig. 5.1 is test image and there is total 26 faults on the leaf, we apply this test image as an input in all approaches and based on that we will do the comparative analysis Here we did the analysis of followings approaches based on followings parameters:

1. Time Complexity

2. Error Level (% Accuracy)

Fig. 5.1 Test Images

Table 5.1 Error Analysis

Process	No. of Real Fault	No. of fault detected by approach	% Accuracy
Vijay	26	18	69.2
Konstantinos	26	23	88.4
Komal	26	20	76.9
Jihen	26	21	80.7

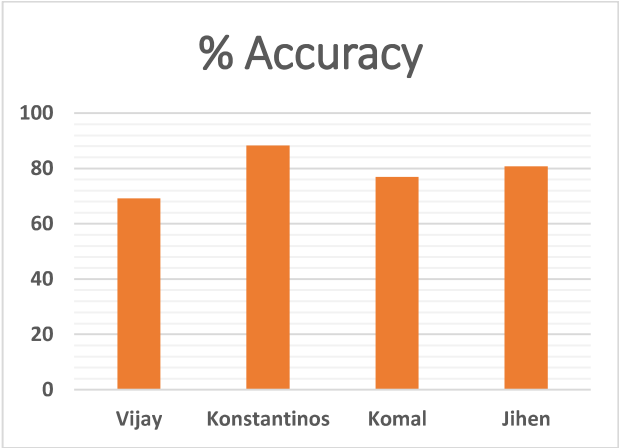

Fig. 5.2 Error Analysis

Here fig. 5.2 shows the comparative analysis of accuracy, as per the analysis we can see konstantions is best in terms of accuracy level as compare to other approaches.

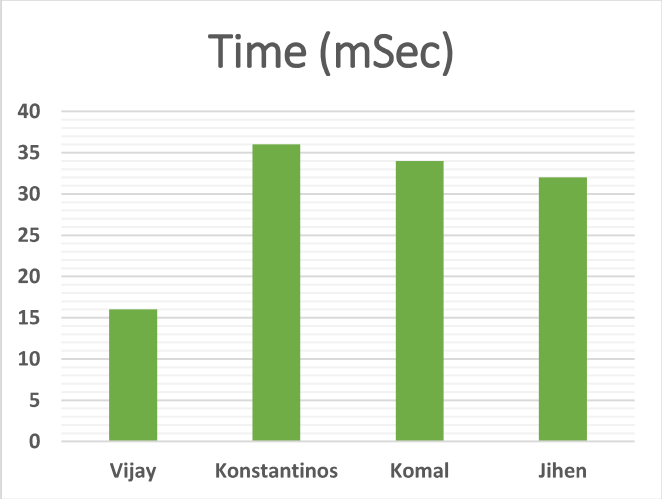

Fig. 5.3 Time Analysis

Process	Time (mSec)
Vijay	16
Konstantinos	36
Komal	34
Jihen	32

Table 5.2 Time Analysis

Here fig. 5.3 shows the comparative analysis of time, as per the analysis we can see vijay is best in terms of time parameters. as compare to other approaches. If we see the overall result than jihen is best approach in terms of time and accuracy level. If we are talking about only the accuracy than konstantions is best approach. As per the result analysis there is lots of future work is needed, as all these applications are not suitable for all type of leaves, specially if there color is not green.

VI. CONCLUSION

Agribusiness experiences a serious issue, plant illnesses, which lessens the creation and nature of yield. Plus, the lack of diagnostics instruments in immature nations devastatingly affects their turn of events and personal satisfaction. Thus, there is a pressing need to recognize the plant infections at the beginning period with reasonable and simple to utilize arrangements. In this paper we did the comparative analysis on previous existing approaches which are based on leaf fault detection, as per the analysis we can see there is lots of improvement is needed there is no any approach which are able to check the fault on any color of leaves all approaches are only focus on green color. Apart form that there is no any approach which is able to manage accuracy and time complexity paraments. In future there is lots of improvement can be done on this area. As per the result analysis Jihen is best approach which is able to maintain accuracy and time complexity

REFRENCES

- GHAIWAT SAVITA N, ARORA PARUL. DETECTION AND CLASSIFICATION OF PLANT LEAF DISEASES USING IMAGE PROCESSING TECHNIQUES: A REVIEW. INT J RECENT ADV ENG TECHNOL 2014;2(3):2347–812. ISSN (ONLINE).
- DHAYGUDE SANJAY B, KUMBHAR NITIN P. AGRICULTURAL PLANT LEAF DISEASE DETECTION USING IMAGE PROCESSING. INT J ADV RES ELECTR ELECTRON INSTRUM ENG 2013;2(1).
- MRUNALINI R BADNAKHE, DESHMUKH PRASHANT R. AN APPLICATION OF K-MEANS CLUSTERING AND ARTIFICIAL INTELLIGENCE IN PATTERN RECOGNITION FOR CROP DISEASES. INT CONF ADV INF TECHNOL 2011;20. 2011 IPCSIT.
- ARIVAZHAGAN S, NEWLIN SHEBIAH R, ANANTHI S, VISHNU VARTHINI S. DETECTION OF UNHEALTHY REGION OF PLANT LEAVES AND CLASSIFICATION OF PLANT LEAF DISEASES USING TEXTURE FEATURES. AGRIC ENG INT CIGR 2013;15(1):211–7.
- KULKARNI ANAND H, ASHWIN PATIL RK. APPLYING IMAGE PROCESSING TECHNIQUE TO DETECT PLANT DISEASES. INT J MOD ENG RES 2012;2(5):3661–4.
- BASHIR SABAH, SHARMA NAVDEEP. REMOTE AREA PLANT DISEASE DETECTION USING IMAGE PROCESSING. IOSR J ELECTRON COMMUN ENG 2012;2(6):31–4. ISSN: 2278-2834.
- NAIKWADI SMITA, AMODA NIKET. ADVANCES IN IMAGE PROCESSING FOR DETECTION OF PLANT DISEASES. INT J APPL INNOV ENG MANAGE 2013;2(11).
- PATIL SANJAY B ET AL. LEAF DISEASE SEVERITY MEASUREMENT USING IMAGE PROCESSING. INT J ENG TECHNOL 2011;3(5):297–301.
- CHAUDHARY PIYUSH ET AL. COLOR TRANSFORM BASED APPROACH FOR DISEASE SPOT DETECTION ON PLANT LEAF. INT COMPUT SCI TELECOMMUN 2012;3(6).
- RATHOD ARTI N, TANAWAL BHAVESH, SHAH VATSAL. IMAGE PROCESSING TECHNIQUES FOR DETECTION OF LEAF DISEASE. INT J ADV RES COMPUT SCI SOFTW ENG 2013;3(11).
- BEUCHER S, MEYER F. THE MORPHOLOGICAL APPROACH TO SEGMENTATION: THE WATERSHED TRANSFORMS. IN: DOUGHERTY ER, EDITOR. MATHEMATICAL MORPHOLOGY IMAGE PROCESSING, VOL. 12. NEW YORK: MARCEL DEKKER; 1993. P. 433–81.
- BHANU B, LEE S, MING J. ADAPTIVE IMAGE SEGMENTATION USING A GENETIC ALGORITHM. IEEE TRANS SYST MAN CYBERN DEC 1995;25:1543–67.
- BHANU B, PENG J. ADAPTIVE INTEGRATED IMAGE SEGMENTATION AND OBJECT RECOGNITION. IEEE TRANS SYST MAN CYBERN PART C 2000;30:427–41.
- WOODS KERI. GENETIC ALGORITHMS: COLOUR IMAGE SEGMENTATION LITERATURE REVIEW, 2007.BOS L (1970) SYMPTOMS OF VIRUS DISEASES IN PLANTS, 2ND EDN. VADA, WAGENINGEN
- ATZORI, L.; IERA, A.; MORABITO, G. THE INTERNET OF THINGS: A SURVEY. COMPUT. NETW. 2010, 54, 2787–2805.
- SINGH, VIJAI, AND AK K. MISRA. "DETECTION OF PLANT LEAF DISEASES USING IMAGE SEGMENTATION AND SOFT COMPUTING TECHNIQUES." *INFORMATION PROCESSING IN AGRICULTURE* 4.1 (2017): 41-49.
- FERENTINOS, KONSTANTINOS P. "DEEP LEARNING MODELS FOR PLANT DISEASE DETECTION AND DIAGNOSIS." *COMPUTERS AND ELECTRONICS IN AGRICULTURE* 145 (2018): 311-318.
- BASHIR, KOMAL, MARAM REHMAN, AND MEHWISH BARI. "DETECTION AND CLASSIFICATION OF RICE DISEASES: AN AUTOMATED APPROACH USING TEXTURAL FEATURES." *MEHRAN UNIVERSITY RESEARCH JOURNAL OF ENGINEERING AND TECHNOLOGY* 38.1 (2019): 239-250.

- Rançon, Florian, et al. "Comparison of SIFT Encoded and Deep Learning Features for the Classification and Detection of Esca Disease in Bordeaux Vineyards." *Remote Sensing* 11.1 (2019): 1.
- Rehman, Tanzeel U., et al. "Current and future applications of statistical machine learning algorithms for agricultural machine vision systems." *Computers and Electronics in Agriculture* 156 (2019): 585-605.
- Dhingra, Gittaly, Vinay Kumar, and Hem Dutt Joshi. "Study of digital image processing techniques for leaf disease detection and classification." *Multimedia Tools and Applications* 77.15 (2018): 19951-20000.
- Bakar, MN Abu, et al. "Rice Leaf Blast Disease Detection Using Multi-Level Colour Image Thresholding." Journal of Telecommunication, Electronic and Computer Engineering (JTEC) 10.1-15 (2018): 1-6.
- Khalid, Haya, Atul Grover, and Sanjai K. Dwivedi. "PCR-based Methods for Identification and Detection of Phytophthora infestans in Infected Leaves of Tomato." (2018).
- Sitanggang, Delima, et al. "Application of forwardchaining method to diagnosis of onion plant diseases." *Journal of Physics: Conference Series*. Vol. 1007. No. 1. IOP Publishing, 2018.
- Amara, Jihen, Bassem Bouaziz, and Alsayed Algergawy. "A Deep Learning-based Approach for Banana Leaf Diseases Classification." *BTW (Workshops)*. 2017.