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A Technical Seminar Presentation on

“INTELLIGENT PLANT DISEASE DETECTION SYSTEM USING WIRELESS MULTIMEDIA SENSOR NETWORKS”

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CONTENTS

INTRODUCTION

- Agriculture is a primary occupation in the developing country.
- The crop production losses its quality due to much type of diseases and sometimes they occur but are even not visible with naked eye.
- Plant disease detection is important for agricultural applications to increase the cultivation yield.
- It is the process of detecting the disease caused in the plant by extracting some features from the affected part.
- In plants, some general diseases seen are brown and yellow spots, early and late scorch, and others are fungal, viral and bacterial diseases.
- To detect a plant disease in very initial stage, use of automatic disease detection technique is beneficial.
- Automatic detection of the diseases by just seeing the symptoms on the plant leaves makes it easier as well as cheaper.

Figure 1: Images of a diseased leaves.

- With the help of WMSN and image processing techniques it is possible to increase the cultivation yield by building a decision support system which can detect and classify the disease.
- Wireless Multimedia sensor networks (WMSNs) consists of camera capable sensor nodes and regular sensor nodes deployed in the field of interest to gather information and communicate through wireless links.
- Image processing is used for measuring affected area of disease and to determine the difference in the color of the affected area.
- Precise knowledge of areas where disease has spread would help the farmer to apply appropriate amounts of pesticides to the affected areas, thereby yielding both economic and environmental benefits.

LITRATURE REVIEW

1. In 2011, Badnakhe Mrunalini, Prashant R. Deshmukh have proposed “An application of K-means clustering and artificial intelligence in pattern recognition for crop diseases” system.

- In this study the author presented the technique to classify and identify the different disease through which plants are affected.
- The approach proposed can significantly support an accurate detection of leaf.
- The approach given in this study for feature set extraction is the color co-occurrence method.[1]

2. In 2012, Anand H. Kulkarni, R.K. Ashwin Patil have proposed a system named “Applying image processing technique to detect plant diseases” was proposed.

- In this study the author presented a methodology for early and accurately plant diseases detection.
- It gave better results with a recognition rate of up to 91% in extracting in features to detect diseases in plant.[2]

3. In 2013, R. Newlin Shebiah, S. Ananthi, S. Vishnu Varthini have proposed a system called "Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features".

- Diseases were detected in plants and produced an accuracy 0f 95%.
- The robustness of the proposed algorithm is proved by using experimental results of about 500 plant leaves in a database [3].

4. In 2015, Mrunmayee Dhakate and A. B. Ingole have proposed "Diagnosis of pomegranate plant diseases using neural network," system.

- In this work the author has proposed a method to detect and classify the diseases in pomegranate plant.
- The proposed approach gave satisfactory results with 90% accuracy [4].

WIRELESS MULTIMEDIA SENSOR NETWORK BASED PLANT DISEASE DETECTION

- In agriculture practice, being able to detect plant diseases at their early stage can usually prevent major losses on the farmland yields.
- In recent years, the rapid development of Wireless Multimedia Sensor Network (WMSN) provides a new support to this task that has the potential of reducing the workload substantially.
- The wireless multimedia sensor network node is equipped with a low cost CCD camera and is able to take and send back images of its deployment location.
- After WMSN has been deployed on the farmland, the inspector only needs to distinguish crop images on the computer to obtain the information on crop growth.

- Considering the resource constraints on WMSN like computation power, network bandwidth, energy consumption and the workload of each WMSN node, it is not a good idea to let every node to send back the image frequently.
- Therefore, if the inspection interval (sample frequency) is too long, plant disease may spread in large scale during the interval.
- To solve this dilemma, a solution is obtained based on a plant disease detection program running on each node of the WMSN, which automatically inspects the newly taken plant images and determines whether the plant has the risk of infection.
- Under this mechanism, the WMSN can take plant photos at a higher frequency, but the amount of data to be transferred is reduced.

CAUSES OF PLANT DISEASES:

- Abiotic factors:- These are the resultants of deficiencies or excess of nutrients, light, moisture, aeration adverse soil condition or atmospheric condition.
- Miso-biotic factors:- The causal agent is neither living thing nor non-living thing. The diseases caused by viroid and viruses or of this category.
- Biotic factors:- This category includes diseases caused by living/cellular organizations. Eukaryotes – fungi, protozoa, algae, nematode, parasites. Prokaryotes – mycoplasma, rickettsia, bacteria.

CLASSIFICATION PLANT DISEASES:

Plant diseases can be classified based on the following criteria: -

❑ Infectious/biotic plant diseases which are caused by:

- Prokaryotes
- Fungi
- Viruses and viroid
- Nematodes, protozoa and by parasitic higher plants and parasitic algae

- Non-infectious or abiotic plant diseases which may be caused by:
- Too low temperature or too high temperature.
- Lack or excess soil moisture.
- Lack or excess of light.
- Lack of oxygen.

MAJOR DISEASES THAT AFFECT THE PLANTS:

- Black spot.
- Botrytis blight.
- Leaf spot.
- Powdery mildew.
- Rust.

PLANT DISEASE DETECTION SYSTEM:

- Efficient and novel Disease Detection System is used to detect the diseases in leaves and extract the features for classification.
- The classification process is carried out at the monitoring site where an expert analyzes the disease and provide solution to farmers.
- The suggested system consists of five phases: image acquisition, image preprocessing, image segmentation, feature extraction, analysis, and classification.

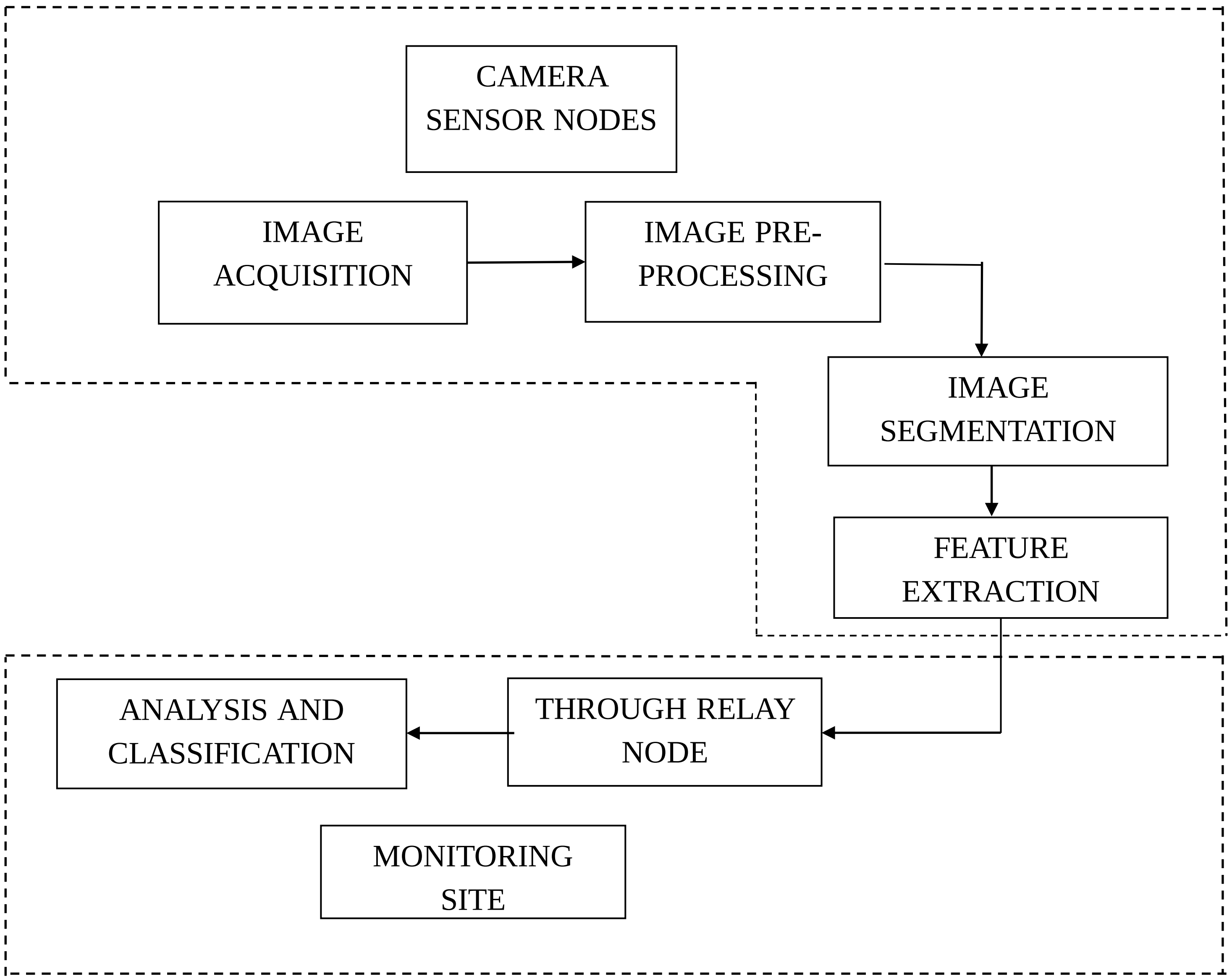

Figure 3:Plant disease detection system for farmers using WMSNs.

1. IMAGE ACQUISITION:

- Image acquisition is the very first step that requires capturing an image with the help of a digital camera.
- After the image is obtained various methods of processing can be applied to the image to perform the many different vision tasks.

2. IMAGE PRE-PROCESSING:

- Image pre-processing involves removing low frequency background noise, normalizing the intensity of individual particles images, removing reflection and masking portion of images.
- It is the technique for enhancing data images prior to computational processing.
- Initially, captured pictures are resized to a fixed resolution therefore on utilize the storage capacity or to reduce the process burden within the later process.

3. IMAGE SEGMENTATION:

- Image segmentation is considered as an important basic operation for meaningful analysis and interpretation of image acquired.
- It is a critical and essential component of an image analysis and/or pattern recognition system, and is one of the most difficult tasks in image processing, which determines the quality of the final segmentation.
- Methods for image segmentation are broadly classified into 7 groups:
- Histogram thresholding, clustering (Fuzzy and Hard), Region growing, region splitting and merging, Edge-based, Physical model- based, Fuzzy approaches, and Neural network and GA (Genetic algorithm) based approaches.

4. FEATURE EXTRACTION:

- It is the process of generating the features to be used in selection and classification.
- Colour, Morphology and Texture feature vectors are used for feature extraction. Some of the texture features.

- Contrast: - It is the difference in visual properties that makes an object distinguishable from other objects in the background.
- Energy: - Energy is defined based on a normalized histogram of the image. Energy shows how the grey levels are distributed. When the number of grey levels is low then energy is high.
- Entropy: - Image entropy is a quantity which is used to describe the ‘business ’of an image i.e. the amount of information which must be coded for, by a compression algorithm.
- Homogeneity: - Homogeneity is computed from image grey levels to facilitate the classification.
- Correlation: - Correlation is a basic operation that is performed to extract information from images.

5. ANALYSIS AND CLASSIFICATION:

- Support Vector Machine (SVM) algorithm is used for training and classification.
- It finds out the linear separating hyper plane that maximize margin and can be used for classification.
- After applying SVM, clusters will classify into 2 classes with labels disease infected images and non-infected images. Infected image class consist leaf images affected by bacterial blight and non-infected image class includes healthy leave images

METHODOLOGY:

The system consists of five phases: image acquisition, image pre-processing, image segmentation, feature extraction, analysis, and classification.

➢ IMAGE ACQUISITION:

- In this phase, images of the diseased leaves are captured using a camera sensor node.
- In order to reduce the memory and energy complexity, the camera is triggered only when the color change in leaves is detected.
- Once the image is captured it undergoes pre-processing.

➢ IMAGE PRE-PROCESSING:

- The acquired image is pre-processed to enhance the quality of the image for efficient segmentation.
- In the pre-processing phase the image is resized and the contrast of the image is enhanced.

- The RGB to HSI (Hue Saturation Intensity) transformation is carried out on the enhanced image as it can be easily segmented from the HSI transformed image rather than the RGB image.

➢ IMAGE SEGMENTATION:

- In the segmentation phase, a simple and novel mean based thresholding strategy (MTS) is proposed to segment the diseased part of the leaves.
- MTS is designed using the HSI transformed image and the pixels of the transformed image are compared with the threshold to segment the affected part. The procedure for designing the threshold is as shown:

  Input: H image, Output: threshold (TMTS)

  Procedure:

  Step 1: Compute the maximum of the pixels in the H image (MH)

  $$MH = \max(H) \qquad \text{…………(1)}$$

  Step 2: Compute the mean of the H image (μH)

  $$\mu_H = \frac{\sum_{O=0}^{L}\sum_{P=0}^{N} H(o,p)}{L*N} \qquad \text{…………(2)}$$

Step 3: Compute the threshold using equation (1):

$$T_{MTS} = \frac{M_H}{\mu_{H*10}} \qquad \ldots\ldots\ldots\ldots(3)$$

The pixels of the H image are compared with the threshold shown in Eq. (3) to segment the diseased part of the leaves. Feature extraction is carried out after the segmentation phase.

➢ FEATURE EXTRACTION:

- In DDS feature extraction is carried out based on the texture analysis.
- The Grey Level Co-occurrence Matrix (GLCM) is used to obtain the statistical texture features.
- Contrast, energy, homogeneity, entropy and correlation are some of the texture based features extracted from the segmented image.
- The GLCM matrix is used for the H image and the features and its corresponding equations are shown in the above design of mean based threshold, where P (i, j) denotes the elements of the GLCM matrix and K denotes the number of grey levels in the image.

➢ CLASSIFICATION OF DISEASES:

- The features based on texture are transmitted through relay nodes to the monitoring site where the classification is carried out using the SVM classifier.
- SVM is commonly used for classification process and belongs to the group of supervised learning. Supervised learning makes use of the training dataset to predict the testing dataset.
- It high accuracy when used with texture features. SVM makes use of the linear kernel function to classify the healthy leaves and diseased leaves.

➢ The suggested work can be applicable for detecting various kinds of disease in different plants. Some of them are listed below:

- Fungal disease.
- Sun burn disease.
- Bacterial leaf spot disease.
- Scorch disease.

Figure 3: Input and output image of beans leaf and output diseases is fungal disease

Figure 4: Input and output image of lemon leaf and output diseases is sun burn disease

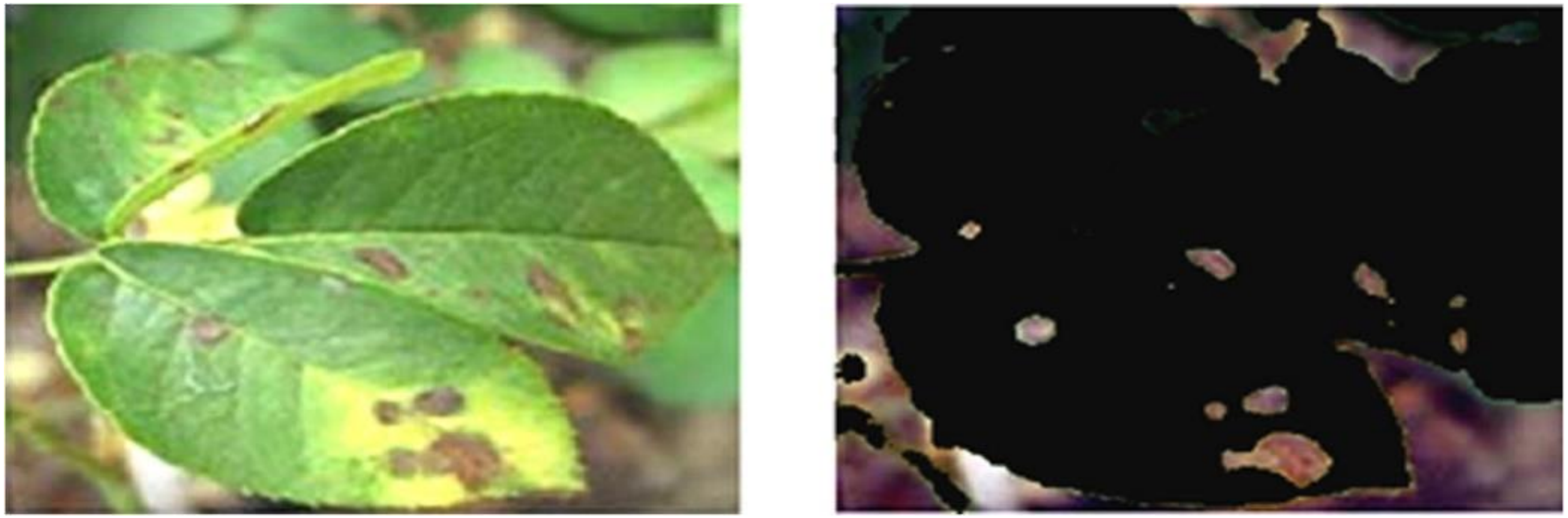

Figure 5: Input and output image of rose leaf and output diseases is bacterial leaf spot

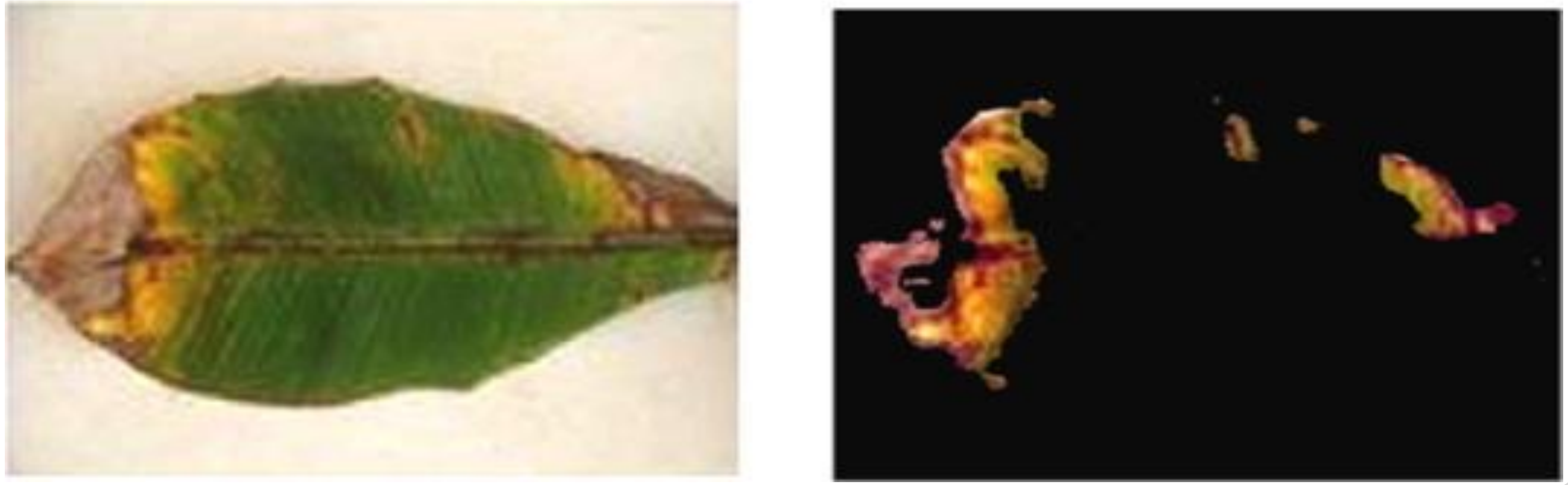

Figure 6: Input and output image of banana leaf and output diseases is early scorch disease.

RESULTS AND DISCUSSION:

- The suggested disease detection and classification system is simulated using MATLAB environment in Windows 10 PC.
- For simulation, diseased leaves of the pomegranate plant are considered. Database is created with 20 images for training and 10 images are used for testing.
- The diseases such as Anthracnose, Alternaria Alternata and Cercospora leaf spot in pomegranate leaves are considered for demonstration.
- In the image acquisition phase the test images are taken as input and pre-processed by resizing the image to 256×256.
- To enhance the quality of the image, contrast enhancement technique is adopted. After enhancing the quality, the image is transformed from RGB to HSI color space.
- The image is segmented using the proposed MTS threshold strategy.

- The threshold is computed using Eq. (3) and the pixels of the H image are compared with the threshold to segment the diseased part in the leaves.
- After segmentation, the texture based features such as contrast, energy, homogeneity, entropy and correlation are computed. GLCM matrix for H image is used to analyze the texture based features.
- These features are transmitted through the TelosB nodes to the monitoring site. SVM classifier is used at the receiver side in a PC which has the database with trained images for classification.

Figures 7, 8 and 9 shows the input test images, preprocessed images, and segmented images of the diseased pomegranate leaves.

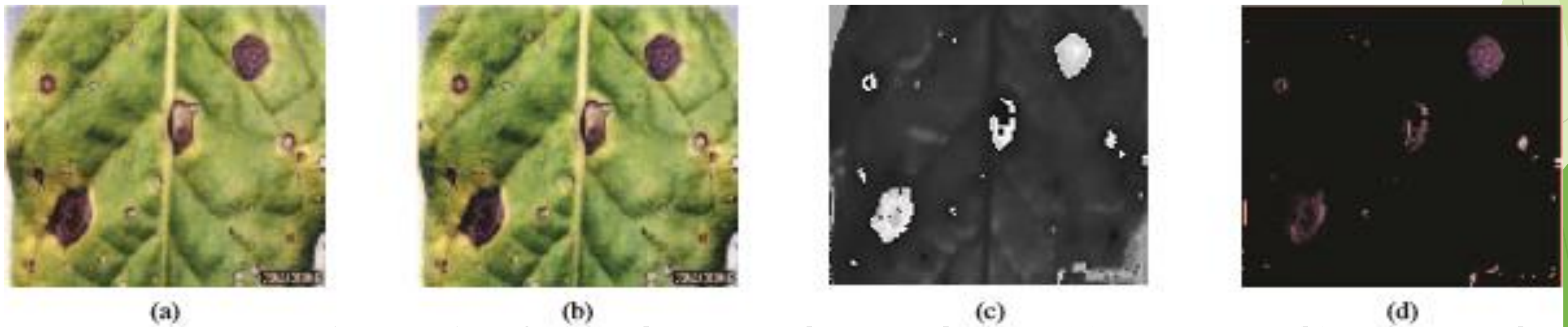

Figure 7: Pomegranate leaves identified as Alternaria Alternata disease. (a) Test image. (b) Contrast enhanced image. (c) HSV transformed image. (d) Segmented image using proposed MTS.[6]

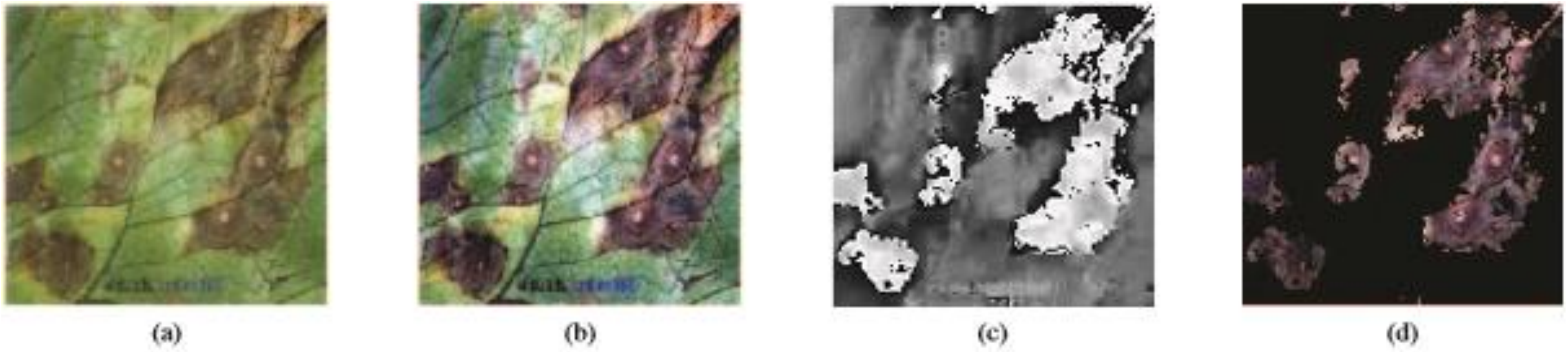

Figure 8: Pomegranate leaves identified as Anthracnose disease. (a) Test image. (b) Contrast enhanced image.(c) HSV transformed image. (d) Segmented image.[6]

Figure 9: Pomegranate leaves identified as Cercospora leaf spot disease. (a) Test image. (b) Contrast enhanced image. (c) HSV transformed image. (d) Segmented image using proposed MTS.[6]

- The performance suggested work is evaluated in terms of accuracy of the system which is compared with the existing work reported in [9].
- The transmission energy is also computed for transmitting the features through Telos B nodes which is compared with the raw frame transmission. The accuracy (A) of the system is calculated using Eq. (4) [9].

$$A = \frac{\text{Number of correct classification}}{\text{Total number of test images}} \quad \ldots\ldots\ldots.(4)$$

- The accuracy of the system is tabulated for different diseases in Table 1. MTS is compared with the well-known k-means clustering process based segmentation.

Leaf diseases	**Detection accuracy (%)**	
	SVM with k-means [7]	SVM with MTS
Alternaria Alternata	98.48	100
Anthracnose	96.7742	98.3871
Cercospora leaf spot	96.7742	96.7742

Table 1: Comparison of suggested work with existing work in terms of accuracy.

- From Table 1 it is observed that the suggested system achieves 98% accuracy on an average and it is better compared with the SVM with k-means clustering process reported in [8].
- Figure 11 shows the overall accuracy achieved using MTS with SVM classifier.
- The transmission energy is calculated by transmitting the features in real time through Telos B nodes. Telos B nodes [9] operate under Conic OS platform [10].

- The power trace tool [11] in Contiki OS platform is used to calculate the transmission energy in nodes. The practical energy for transmitting a bit (Et) is calculated to be 0.27 μ J [12]. The transmission energy for an image (EI) is calculated using the equation $EI = n * Et$ (9) where ‘n’ denotes the number of bits.

Input	Transmission energy (m J)	
	Raw image	Features
Test image	141	0.011

Table 2: Comparison of transmission energy for raw image and features extracted.

- Table 2 shows the comparison of transmission energy between raw image transmission and feature transmission.
- From the table, it is observed that the reduction in transmission energy is around 99%.
- Hence the suggested system yields better accuracy with less transmission energy which indicates that the feature transmission is preferred over raw image for resource constraint environment like WMSN.

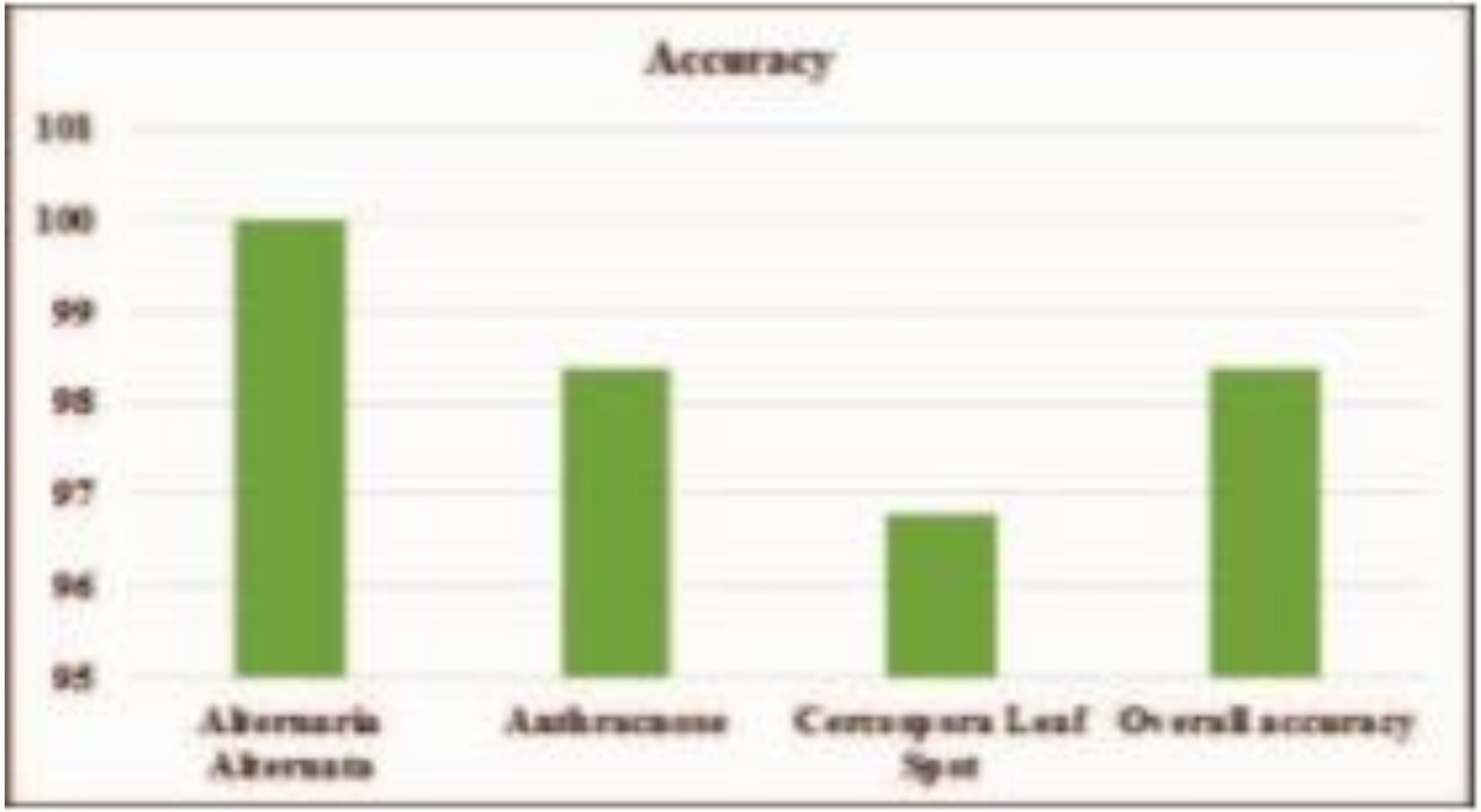

Figure 10: The overall accuracy of system.

ADVANTAGES:

- Use of estimators for automatic Initialization of cluster centers so there is no need of user input at the time of segmentation.
- The detection accuracy is enhanced with suggested algorithm.
- The suggested system is fully automatic while existing methods require user input to select the best segmentation of input image.
- It also provides environment friendly recovery measures of the identified disease.

LIMITATIONS:

- The implementation still lacks in accuracy of result in some cases. More optimization is needed.
- Priori information is needed for segmentation.
- Database extension is needed in order to reach the more accuracy.
- Very few diseases have been covered. So, work needs to be extended to cover more diseases.
- The possible reasons that can lead to misclassifications can be as follows: disease symptoms vary from one plant to another, features optimization is needed, more training samples are needed in order to cover more cases and to predict the disease more accurately.

CONCLUSION

- This system provides the overall information about different plant diseases.
- WMSN with camera capability is used to capture the diseased leaves in the farm and process it to extract the features.
- These features are transmitted to the monitoring site through relay nodes. At the monitoring site the diseases are classified based on the extracted features. Based on the classified disease the farmers are given suggestions.
- A novel and simple segmentation process based on threshold is proposed to segment the diseased part and the features are extracted using GLCM matrix. The SVM classifier is used to classify the disease using linear kernel function.
- The proposed threshold strategy performs better compared to k-means clustering technique with less complexity. The extracted features are transmitted through Telos B nodes and the transmission energy can be analyzed in real time.
- The transmission energy can be reduced to 99% on an average compared to raw frame transmission.

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Thank you!