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Detection of disease from Chilly Plant Using Vegetation Indices

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Abstract — Yield of chilly is very important aspect for farmer, it is depend on the supplied water to plant and use of pesticide. The chilly plant is mostly infected by white fly, bacterial leaf spot, pepper mosaic virus. In this paper we use peeper mosaic virus infected leaves of chilly plant. We also use four different vegetation Indices and Support Vector Machine classification to classify between diseased and non-diseased leaf. Among four vegetation indices, we found NPCI is better indices in this study work.

Keywords— NPCI, MCARI, NDVI, TCARI, SVM.

I. INTRODUCTION

To increase the maximum capacity of yield and reduce the use of pesticides is very important aspect for farmers. Detection of diseases of plant, prevention of plant from diseases is also important task. Plant diseases are reason for loss in yields. Using spectroscopy to detect diseases of plant is very convenient option. With the help of vegetation indices we can detect the diseases of plant. Simple solution to detect diseases is vegetation index, "A Vegetation Index is an indicator that shows the health of vegetation"[1]. Production of more chilly in some region of Marathwada i.e. Jalna, Bhokardhan, Sillod. The farmers are also facing problem of diseases and that diseases are white fly, ahid, leaf spot, pepper mosaic virus. Pepper mosaic virus is spread by aphids and whitefly, this virus is injected straight into the leaves and stems of chili plants. Symptoms of this diseases is alternate patches of green and yellow in a mosaic pattern on leaves, distorted and curled leaves, plant growth greatly slowed. Stunted pod growth and very poor yield. Ramin shamshiri used spectroscopy and monochromatic camera to collect data and used NDVI to identify yellow colored spore on leaves of wheat[2].

In agriculture point of view, study of chlorophyll content is very important. Chlorophyll is Leaf pigments, there are three pigment present in the Leaf of tree i.e. chlorophyll, carotenoids, anthocyanin's[3].There are more vegetation indices are available to study the pigments of leaf. Kerstin Groll et.al. Used ASD Field Spec Spectroradiometer to collect data and MCARI, TCARI, NPCI, OSAVI were use and the value of OSAVI decreases and NPCI increases[4]. Rainer laudien et al used ASD field spec to collect data and CAI indices was used to detect sugar beat diseases, and they found low value of diseased sugar beat leaf using CAI[5]. Dr. Agrarwissens chaften also used FieldSpecPro FR and FieldSpecProJR with NDVI, NPCI Vegetation indices to detect diseases6. F. Ghobadifar used spectral radiance measurement to identify functional changes inside vegetation using NDVI,RVI,SDI and found unhealthy plants have spectrum that is different form healthy7. W.C.Chew et.al. also use spectroscopy with DVI,CAI,PRI,TVI,MCARI ,They found PRI has decreased the photosynthic rate in infected plant8. Davoud Ashourloo et al used RGB Digital camera to determine rust of leaf and NDVI,TCARI,NPCI vegetation indices used detect infected leaf. The investigation carried out between spectra of Red and Red-edge region9.

II. DESCRIPTION OF DATABASE

A. Database Collection

Leaf spectral reflectances were measured in the laboratory with an ASD (Analytical Spectral Devices) Fieldspec-Pro spectroradiometer in the (0.4–2.5 µm) spectral domain with a spectral resolution of 3 nm in the (0.4–1.0 µm) domain and of 10–12 nm in the (1.0–2.5 µm) domain. The sample of database was collected from 10 KM away from Aurangabad CITY. It is carry in lab within 30Minutes; It is composed of 40 leaf samples.

B. Measurement Method

Before started to take sample, we taken white reference and then Spectral signature of every leaf. Each leaf sample is clean with cloth due to dust on it then reflectance spectra i.e. spectral signature is collected form every sample. Every sample is collected at 8 degree of FOV. In following figure 1 shows reflectance spectra of normal leaf and figure 2 shows reflectance spectra of diseased leaf.

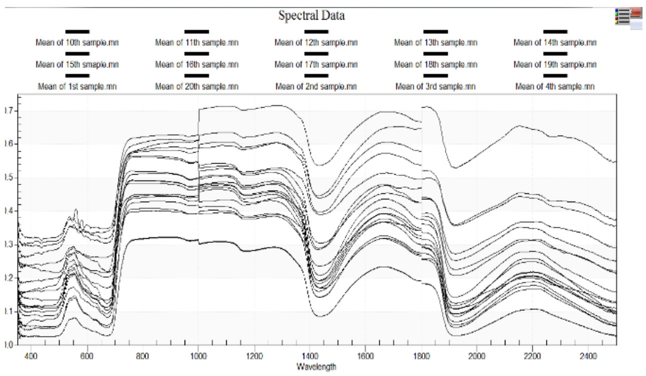

Figure1. Spectral Signature of Normal Leafs samples

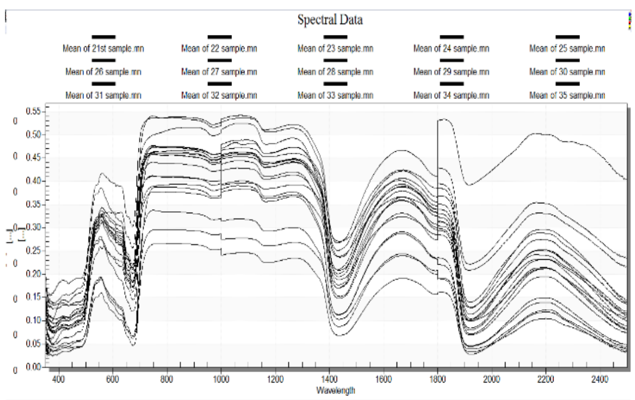

Figure2. Spectral Signature of Diseased Leaf samples

III. DESCRIPTION OF METHODS

Support vector machine (SVM) is a discriminative classifier formally defined by a separating hyperplane. In other words, given labeled training data (supervised learning), the algorithm outputs an optimal hyperplane which categorizes new examples. In two dimentional space this hyperplane is a line dividing a plane in two parts where in each class lay in either side10 .we can use support vector machine when data has exactly two class. An SVM classifies data by finding the best hyperplane that separates all data points of one class from those of the other class. The best hyperplane for an SVM means the one with the largest margin between the two classes. Margin means the maximal width of the slab parallel to the hyperplane that has no interior data points.The support vector are the data points that are closest to the separating hyperplane; these points are on the boundary of the slab. The following figure illustrates these definitions, with + indicating data points of type 1, and – indicating data points of type –1.

We used Support Vector Machine to classify diseased and normal samples, we have exactly two classes i.e. diseased and normal, and we use SVM. After classification we found that the NPCI index is use to identify leaf is healthy or diseases.

A. Normalized Pigment Chlorophyll Index (NPCI):

Because of chlorophyll pigment leaf reflectance in visible is influenced. Information contained in reflectance spectra has been used to estimate plant nitrogen status. NPCI is defined as following equation [11]

$$NPCI= (R680-R430)/ (R680+R430)$$

B. Modified chlorophyll absorption in reflectance index (MCARI):

MCARI is intrinsic indices. It is developed by Kim12 in 1994. MCARI is used for reduce the effect of non-photosynthetic materials on spectral estimates of absorbed photo synthetically active radiation. To calculate MCARI vegetation index is as follows

$$MCARI= [(R700–R670)-0.2(R700-R550)*(R700/R670)]$$

C. Normalized Difference Vegetation Index (NDVI):

NDVI is good parameter for leaf detection. NDVI is used to distinguish between infected and non-infected leaf. The NDVI is also used to analyse green vegetation or not .To calculate NDVI Vegetation index is as follows

$$NDVI = \frac{NIR-Red}{NIR+Red}$$

Where NIR represents reflectance at near infrared band (801 nm) and Red reflectance in the Red Band (670 nm).The values range from +1.0 to -1.0. High NDVI values are approximately 0.6 to 0.9[13]. NDVI is useful for vegetation monitoring. It is also useful for global vegetation monitoring.

D.Transformed Chlorophyll Absorption Index (TCARI):

The MCARI is affected by various parameter like Chlorophyll and background reflectance. The variations of reflectance characteristics of background materials (soil and no photosynthetic components) and to increase the sensitivity at low chlorophyll values, the transformed chlorophyll absorption ratio index (TCARI) can be defined [14]

$$TCARI=3[(R700–R670)-0.2(R700- R550) (R700/R670)]$$

IV. Results and Discussion

It should include important

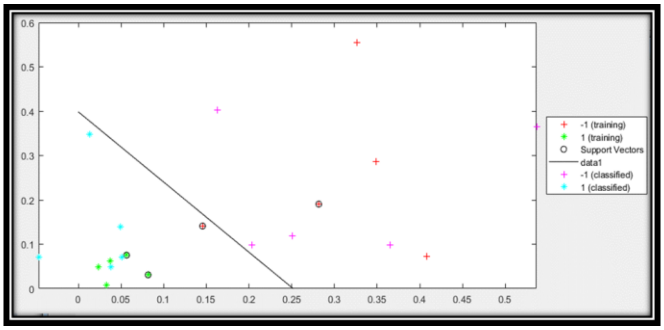

Figure 3. Classification Using SVM by using NPCI

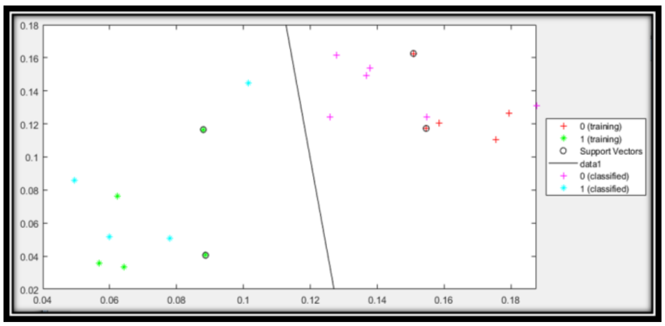

Figure 4. Classification Using SVM by using MCARI

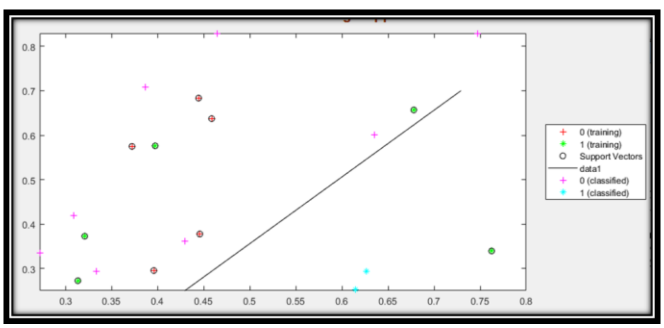

Figure 5. Classification Using SVM by NDVI

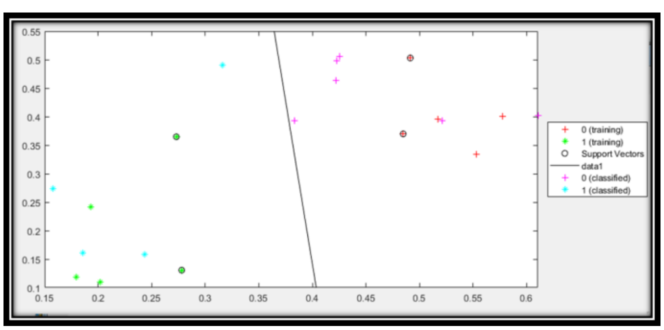

Fig 6:- Classification Using SVM by TCARI

In fig 3 SVM classify data using NPCI index, first we calculated NPCI index and then provided index value to SVM classifier for training and then testing. In first case we found 0.1 Miss Classification rate and 0.888547 mean squared errors. In fig 4 shown SVM classified data using MCARI index and then provided index value to SVM classifier for training and then testing, in this case we got 0.2 Miss Classification rate and 0.458796 is mean squared error. In fig 5 SVM classified data using NDVI index, first we calculated NDVI index and then provided index value to SVM classifier for training and then testing, in third case we get 0.4 Miss Classification rate and 0.339065 mean squared error. In fig 6 SVM classified data using TCARI index, first we calculated TCARI index and then provided index value to SVM classifier for training and then testing, in fourth case we got 0.2 Miss Classification rate and 0.428319 mean squared error.

Table.1 Miss Classification Rate and MSE of Classifier

Vegetation Index	Miss classification Rate	Mean Squared error
NPCI	0.1	0.888547
MCARI	0.2	0.458796
NDVI	0.4	0.339065
TCARI	0.2	0.428319

The tables and figures without repeating their contents. Interpret the findings in view of the results obtained in this and in past studies on this topic. State the conclusions in a few sentences at the end of the paper. However, valid colored photographs can also be published.

Table.2 (a) Normal Vegetation Indices of Forty Samples

NORMAL					
	MCARI	***TCARI***	***OSAVI***	***NPCI***	***NDVI***
1	0.2902	0.3640	0.8536	0.0588	0.6644
2	0.2550	0.2780	0.9228	0.0377	0.7624
3	0.0898	0.1930	0.5012	0.0328	0.3972
4	0.1908	0.2730	0.8462	0.0818	0.6779
5	0.0724	0.1795	0.4244	0.0566	0.3133
6	0.0822	0.2019	0.4403	0.0238	0.3207
7	0.0529	0.1307	0.4406	0.0631	0.3394
8	0.1293	0.2411	0.7504	0.0073	0.5760
9	0.2679	0.3647	0.8668	0.0308	0.6569
10	0.0463	0.1187	0.3665	0.0752	0.2725
11	0.0421	0.1099	0.5035	0.0493	0.3726
12	0.0784	0.1856	0.6210	-0.0465	0.4641
13	0.3400	0.4220	0.8128	0.0385	0.6351
14	0.3400	0.4220	0.8128	0.0385	0.6351
15	0.0632	0.1576	0.3695	0.0493	0.2718
16	0.2068	0.3163	0.7916	0.0130	0.6145
17	0.1619	0.1614	0.9183	0.0714	0.8295
18	0.1570	0.1585	0.9156	0.0714	0.8286
19	0.3531	0.4628	0.7870	0.0488	0.6012
20	0.1349	0.2732	0.4416	0.1399	0.3353

Table.2 (b) Diseased Vegetation Indices of Forty Samples

DISEASED					
	MCARI	*TCARI*	*OSAVI*	*NPCI*	*NDVI*
1	0.2865	0.4906	0.3756	0.3473	0.2520
2	0.4066	0.5174	0.5467	0.3266	0.3957
3	0.4467	0.5533	0.5943	0.2817	0.4443
4	0.5142	0.5773	0.6243	0.3487	0.4585
5	0.3508	0.4914	0.5130	0.4085	0.3721
6	0.3356	0.4848	0.5928	0.1456	0.4456
7	0.2421	0.3950	0.4051	0.5540	0.2954
8	0.4153	0.3346	0.7309	0.1905	0.6835
9	0.5300	0.4004	0.7630	0.2870	0.6373
10	0.4228	0.5029	0.7386	0.0730	0.5748
11	0.2455	0.3698	0.4877	0.1410	0.3776
12	0.4513	0.6106	0.5496	0.2507	0.3868
13	0.2744	0.4252	0.4345	0.5367	0.3088
14	0.2960	0.4226	0.5380	0.1628	0.4297
15	0.3768	0.5212	0.4794	0.3650	0.3333
16	0.3768	0.5212	0.4794	0.3650	0.3333
17	0.4494	0.4016	0.8498	0.1186	0.7080
18	0.3629	0.5062	0.5557	0.3643	0.4186
19	0.3446	0.4978	0.4968	0.4033	0.3612
20	0.2244	0.3932	0.3934	0.0985	0.2943

As shown in Table 2. Left hand side shows the indices value of normal 20 samples and in Right hand side the indices values of diseased sample. We calculated the five indices i.e. MCARI, TCARI, OSAVI, NPCI, NDVI throughout the table index the value of NPCI normal sample is low as compare to diseased sample. Diseased sample shows high value .In other indices like MCARI they shows same value or increase or decrease value in normal and diseased, in TCARI also shows same value or decrease value, in also NDVI shows same or increase or decrease value in normal and diseased sample. Preesan Rakwatin et al observed that NPCI behaved as a rough estimate of the ratio total pigments chlorophyll, NPCI decrease in healthy plants and increase in stressed plants15. Swati B Magare was also concluding that Chlorophyll content is a good indicator of plant health16. Sushma D Guthe et al was proving that SVMR method estimates biochemical content of plants17. Anatoly A. Gitelson et al proved that range of 450nm to 750nm is used to estimate the chlorophyll content of leaf18.

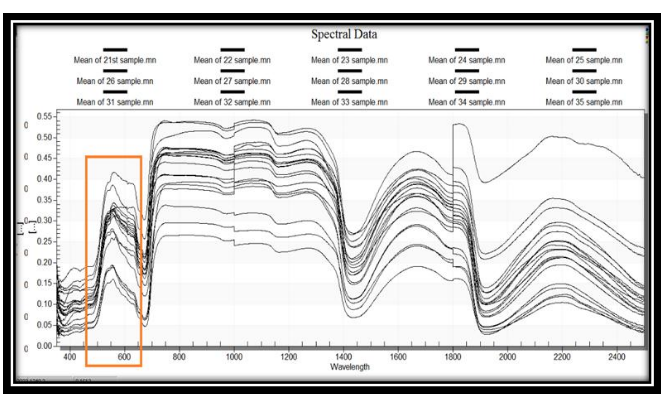

Figure 7. Diseased sample Reflectance Spectra at 450nm to 700nm

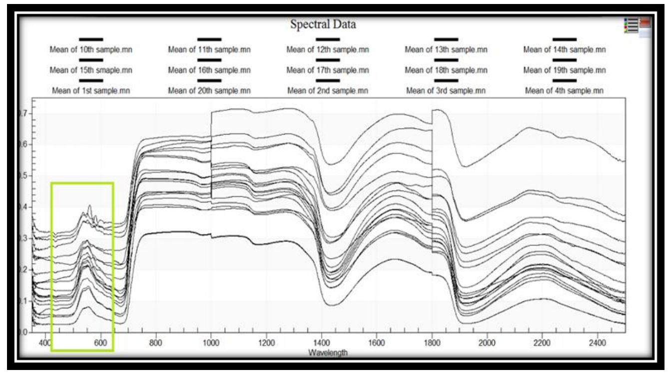

Figure 8. Normal sample Reflectance Spectra at 450nm to 700nm

In Figure 7 absorbance from 450nm to 700nm is week absorbance while in fig 8 more abosorbance shows high peck which show's it is diseased[19].

V. CONCLUSION

The NPCI was suitable to detect diseases from chilly plant, more vegetation indices have to test. According to result of SVM and observation from table 2 NPCI is used to detect the disease of chilly plant. according to Preesan Rakwatin et.al. also found that, it will decrease in healthy plants and increase in diseased plant15. According to Anatoly A. Gitelson et al and observation from fig E and fig F with the range of 450nm to 700nm, we can predict the diseased or normal leaf.

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REFERENCES

[1] J Brown. NDVI, the Foundation for Remote Sensing Phenology. Available:"https://phenology.cr.usgs.gov/ndvi_foundation.php2017"

[2] R Shamshiri "Plant disease detection based on spectral band selection." Department of Agricultural and Biological Engineering, University of Florida, Gainesville, USA, 2008.

[3] Leaf Pigment, Available: http://harvardforest.fas.harvard.edu/leaves/pigment , time 4.14 PM 31/8/2018.

[4] Kerstin Grill, Simone Graeff, Wilhelm laupein, "Use of Vegetation indices to detect plant diseases." The 27th GIL Annual Meeting, 5-7, Stuttgart, Germany, March 2007.

[5] Rainer Laudien, Georg Bareth, Reiner Doluschitz "Analysis of hyperspectral field data for detection of Sugar beet diseases." 5-9, EFITA Conference, Debrecen, Hungary, 2003

[6] Dr.Agrarwissenschaften "Detection, identification, and quantify cation of fungal diseases of sugar beet Leaves using imaging and non-imaging hyper spectral techniques." Ph.D. Inaugural-dissertation, Institute of Crop Science and Rescource Conservation – Phytomedicine, Ansbach, 2011

[7] F Ghobadifar, A Wayayok, M Shattri, H Shafri "Using SPOT-5 images in rice farming for detecting BPH." In Conf .Earth and Environmental Science, Kuala Lumpur, Malaysia, 2014.

[8] W C Chew, M Hashim2, A M S Lau1,4, A E Battay3 and C S Kang " Early detection of plant Disease using close range sensing system for input Into digital earth Environment.", In Conf. Earth and Environmental Science, Kuching, Sarawak, Malaysia, 2013.

[9] Davoud Ashourloo, Mohammad Reza Mobasheri, Alfredo Huete, "Developing Two Spectral Disease Indices for Detection of Wheat Leaf Rust." Remote Sensing, 6(6), 4723-4740, 2014.

[10] Support Vector Machine [online] https://medium.com/machine-learning-101/chapter-2- svm-support-vector-machine-theory-f0812effc7217. time 4.14 PM, 31/8/2018

[11] J. Penuelas, J.A.Gamon, A.L redeen, J.Marineo, C, B, Field "Reflectance indices Associated with Physiological changes in Nitrogen-and water limited sunflower leaves." Remote Sensing of Environment, 48, 2, 135-146, 1994.

[12] Yong-Hyun Kim et al, "Comparative Analysis of the Multispectral Vegetation Indices and the Radar Vegetation Index." Journal of the Korean Society of Surveying, Geodesy, Photogrammetry & Cartography. 32(6): 607-615. Dec 2014

[13] C. S. T. Daughtry C. L. Walthall, M. S. Kim, E. Brown de Colstoun‡ and J. E. McMurtrey III "Estimating Corn Leaf Chlorophyll Concentration from Leaf and Canopy Reflectance." Elsevier Science Inc. Remote sensing 74:229–239, 2000.

[14] Chaoyang Wu, Zheng Niu, Quan Tang, Wenjiang Huang "Estimating chlorophyll content from Hyper spectral vegetation indices: Modeling and validation." Agricultural and Forest Meteorology, Vol 148, 1230-1241, 2008.

[15] Preesan Rakwatin1, Grienggrai Pantuwan2, Sunamee Ngamsaard3, Kanin Ditkhamma4, Wannisa Nilapan5 "Brown plant hopper damage monitoring in rice using field imaging spectroscopy"

[16] Swati B. Magare, Dr.Ratnadeep R. Deshmukh "To Study the Impact of Glyphosate on Chlorophyll Content of Crops" International journal of innovative research in science, Engineering and technology. Vol. 5, Issue 3, March 2016

[17] Sushma D Guthe, Dr.Ratnadeep R. Deshmukh " Prediction of Phosphorus Content in Different Plants: Comparison of PLSR and SVMR Methods" International Journal of Computer Technology and Research, Volume 6–Issue 8, 410-416, 2017.

[18] Anatoly A. Gitelson et al "Relationships between leaf chlorophyll content and spectral reflectance and algorithms for non-destructive chlorophyll assessment in higher plant leaves" Journal of plant Physiology, 271-282,2003.

[19] Remote Sensing and GIS in Agriculture [Online] http://www.seos-project.eu/modules/agriculture/agriculture-c01-s01.html 27/11/2018.

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