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Maize Leaf Disease Severity Analysis using Integrated Color Filtering and Threshold Masking

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Abstract*: *As the color is a dominant factor for isolation of the diseased part of corn maize, the detachment of disease affected parts in maize plant leaf is achieved using integrated Color Filtering followed by a threshold masking. The Particular HSV from a color image of maize plant is extracted .Major steps involved here is to initially convert an RGB image of disease affected maize plant to HSV and second is to apply a threshold mask to filter out the green color of healthy maize plant and detach the brown and yellow diseased area thereof. This method is applied and tested with around 30 maize leaves, and the results found that the proposed methodology performs well with overlapped healthy maize leaf compared to K-means Clustering algorithm. False Positive is produced in K-means method and this Proposed system as integrates with Color Filtering and thresholding works well with overlapped images so that it increases True negative as the Accuracy of the proposed method increases. This proposed methodology identifies well with perfect maize leaf images and misclassifications occur only with images with dark shadows, light illuminations and sanded background.

Keywords: **HSV, RGB, Color-Filter , Threshold, Cerpospora , NLB(Northern Leaf Blight), Common Rust**

I. INTRODUCTION

The maize is developed during the time in all conditions of the nation for different purposes including grain, feed, sweet corn, child corn and pop corn .Maize is generally developed all through the world, and a more noteworthy load of maize is created every year than some other grain.

Three kinds of common diseases that affect corn maize leafs are Northen Leaf Blight (NLB), Cerpospora Leaf Spot disease and Common Rust. These diseases will disturb the productivity and yield of corn maize leafs. Various researches regarding agricultural plant leaf diseases are though underway using color, texture and shape features. This paper focuses on the detection of corn maize disease using the intergraded color filtering and threshold masking. Color isolation can be achieved by extracting a particular HSV (hue, saturation, value) from an image.

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- Conversion from RGB color Model to HSV Color Model
- Applying Color Filtering
- Perform a Threshold Masking
- Morphological Smoothing
- Extract ROI in maize leaves
- Analyze Severity of Disease

The flow of proposed method is shown in Figure 1.After Extracting ROI in maize leaf the disease severity is analyzed

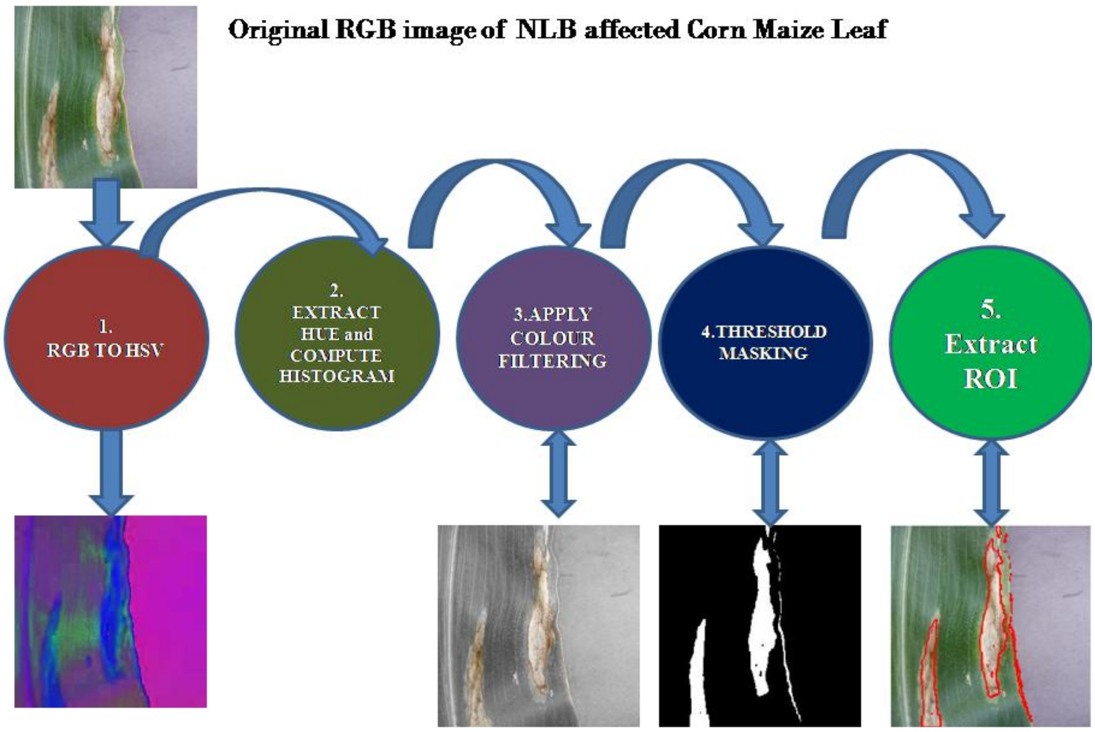


Figure 1: Proposed Method to isolate diseased chunk of maize Leaf

A.Literature Review

A hybrid approach is proposed for automatic detection and classification of six types of citrus diseases based on an optimized weighted segmentation and Feature selection methods. [1]Automated plant leaf type detection is proposed using the features of texture with Gabor, shape, and color. The kernel-based PSO is presented to overwhelm the issue of selecting the optimum features. The Fuzzy Relevance Vector Machine (FRVM) is employed to characterize the type of leaves. The main objective of the proposed FRVM classification is to accurately predict the type of leaf from the given input leaf images [2]

Content Based Image Retrieval (CBIR) sys-tem developed for retrieving diseased leaves of soy-bean. It uses color, shape and texture features of leaf. Color features are extracted using HSV color histogram. Scale Invariant Feature Trans-form (SIFT) provides shape features in the form of matching key points. Local Binary Pattern (LBP) and Gabor filter are widely used texture features. Novel texture feature named Local Gray Gabor Pattern (LGGP) is proposed by combining LBP and Gabor [3].

A HSV decision tree based method for greenness identification from maize seedling images captured outdoors is proposed [4]. A novel algorithm based on color features using HSV color space and morphological erosion and dilation is proposed.

This process segments cauliflower crop regions in the image from weeds and soil under natural illumination (cloudy, partially cloudy, and sunny). The proposed algorithm uses the HSV color space for discriminating crop, weeds and soil. [5] Foliar disease in soybean plants and their severity is discussed in [6]. Primary pitfalls in plant disease detection such as Lacking Lightning/resolution, Complex /Busy Background, Images with Shadow which still remains challenging for plant pathologists are discussed in [7].

The proposed system performs well for overlapping leaf images than K-Means Clustering, but still for complex backgrounds and shadows the occurrence of false positive values still occurs. The section I-B discusses the dataset used in the proposed work. Section II is regarding the color conversion from RGB to HSV Section III discusses of extracting Hue information and plotting Histograms. Section IV analyze the disease detection of maize leaf using color Filtering and threshold Masking. Section V reviews on the severity analysis with Severity Percentage and Mean, Entropy and IDM values of maize leaf extracted. It varies for NLB, cerpospora and healthy leaf. The values are analyzed and plotted. With the study its clear the proposed system diagnose well for healthy and diseased maize leaf except few images with shadows or high illuminated images.

Figure 2: A Snapshot of partial Dataset of NLB affected Maize Leaf

Four types of data set of Maize leaf are collected from Github. Around 4000 images are available and around 30 images are tested and their features are extracted for analysis. Figure 2 shows A Snapshot of partial Dataset of NLB affected Maize Leaf.

- Cerpospora Leaf Spot-1000 images
- Common Rust- 1000 images
- Northern Leaf Blight- 985 images
- Healthy Maize Leaf- 1000 images

Cerpospora images are available at [10]
https://github.com/spMohanty/PlantVillage-Dataset/tree/master/raw/color/Corn_(maize)___Cercospora_leaf_spot%20Gray_leaf_spot
Common Rust images are available at [11]
https://github.com/spMohanty/PlantVillage-Dataset/tree/master/raw/color/Corn_(maize)___Common_rust_
Northern Leaf Blight images are available at[12]
https://github.com/spMohanty/PlantVillage-Dataset/tree/master/raw/color/Corn_(maize)___Northern_Leaf_Blight
Healthy maize images are available at[13]
https://github.com/spMohanty/PlantVillage-Dataset/tree/master/raw/color/Corn_(maize)___healthy

II. CONVERSION FROM RGB COLOR MODEL TO HSV COLOR MODEL

Maize Leaf images are converted to HSV because working with HSV values is much easier to isolate colors. Light falls on the object and gets reflected. The three attributes of light are, Hue, intensity and Saturation (HUE). Hue is the dominant wave-length of the reflected light. It's the dominant color as perceived by the observer. Saturation is the amount of white light mixed with the hue. The value is the chromatic notion of intensity in the HSV representation of color, hue ascertains the color, saturation determines how intense the color is and value influence the lightness of the image

RGB (255,255,255) represents white color as #FFFFFF
RGB (255, 0, 0) represents red color as #FF0000
RGB (0, 255, 0) represents Green color as #00FF00
RGB (0, 255, 0) represents Blue color as #0000FF

B DataSet

Color models use three colors to obtain a reason-ably wide range of colors, called color gamut.

$$C=rR+gG+bB$$

RGB is a color model represented by a shape, whereas HSV is represented by a hexagonal cone.

Hue is nothing but the color, signifies a point in a 360 degree color circle. As can be seen in the in Figure 3 the original RGB maize leaf image and its corresponding HSV image is shown in Figure 3. Saturation directly connects to the intensity of the color. It is normally represented in terms of percentage normally

(0- 100 %) Value is nothing but brightness and represented in percentage.

H –Hue(0 – 360 ^{0})
S – Saturation (0 – 1)
V – Value(0-1)

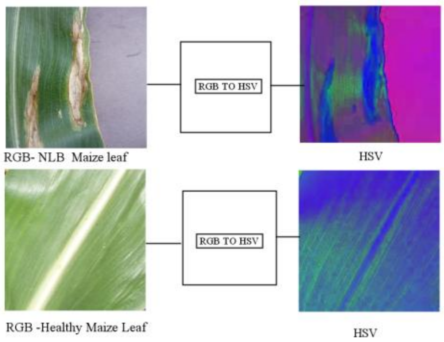


Figure 3: RGB to HSV Conversion

0 percentages represents black and 100% represents brightness. RGB values of the maize leaf image are divided by 255 to change the range from 0..255 to 0..1

$$R' = R / 255$$

$$G' = G / 255$$

$$B' = B / 255$$

The C_{max} and C_{min} which are maximum and minimum values of RGB are calculated and their difference is computed as shown,

$C_{max}=\max(R',G',B')$ // Maximum of RGB

$C_{min} = \min((R',G',B')$ // Minimum of RGB

$\Delta=C_{max} - C_{min}$

Hue Calculation,

$$\text{Hue } H=\begin{cases} 60^{0} \times ((G'-B') / \Delta \bmod 6), & C_{max} = R' \\ 60^{0} \times ((B'-R') / \Delta+2), & C_{max} = G' \\ 60^{0} \times ((R'-G') / \Delta+4), & C_{max} = B' \end{cases}$$

Saturation S,

$$S = \begin{cases} 0, & C_{max} = 0 \\ \Delta / C_{max}, & C_{max} \neq 0 \end{cases}$$

Value V is,

$V= C_{max}$

III. EXTRACT HUE INFORMATION AND PLOT HISTOGRAM

After initially changing over the picture from RGB to HSV , its significant color histograms Hue , Saturation and Value are plotted which is the histogram of the hue channel, saturation channel and value channel after maize leaf image has been converted from red, green, blue to hue, saturation, value with rgb2hsv().

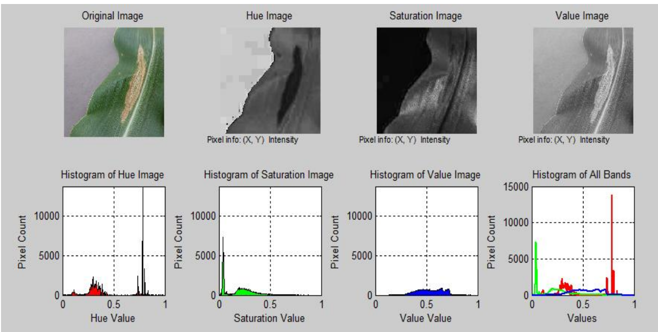


Figure 4 Histogram of HSV

Extracting Hue information and plotting hitogram is shown in Figure 4.

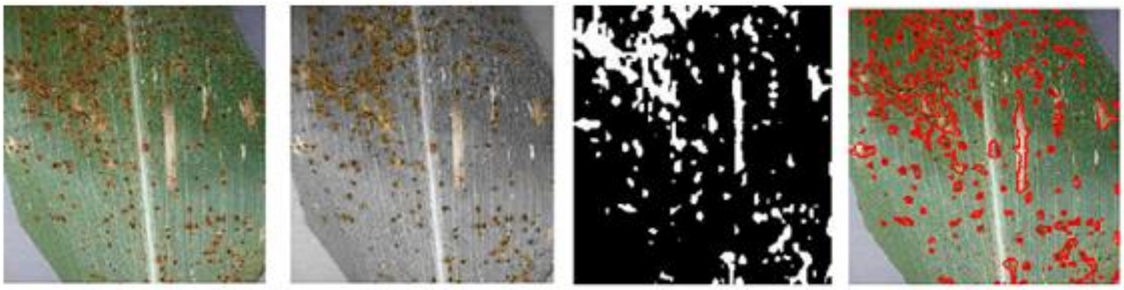
IV. DISEASE DETECTION

To isolate the colors, masking has been applied to leaf images. A low threshold and high threshold mask for hue, saturation and value. Any pixel within these thresholds will be set to 1 and the remaining pixels will be zero. Here a mask is applied to get rid of all of the red green hues, so that the disease affected maize leaf is retrieved. Color Filtering changes a given diseased/healthy maize leaf so as to keep a particular shade and to desaturate the remainder of the maize leaf image.

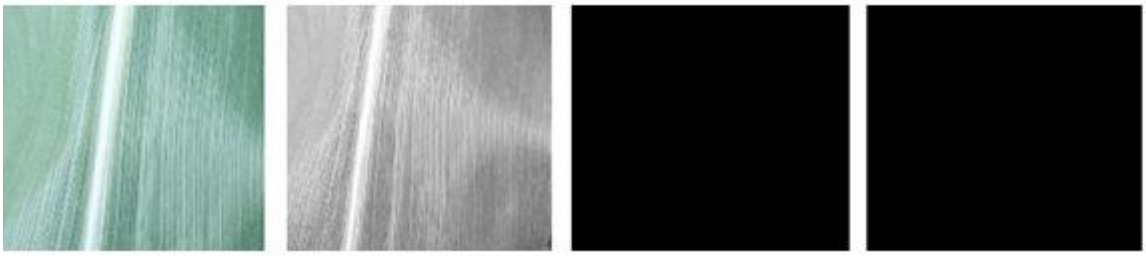
This methodology begins a leaf image with highly contrasting color map, barring the parts hued with that shade. Figure 5 shows Color Filtering, Threshold Masking and Extraction of ROI. From the Figure 5(c) shown it's clear that a healthy maize leaf doesn't filter out any color from the leaf whereas the NLB affected leaf Figure 5(a) filters out the color which deviates from green. Similarly Figure 5(b) Spots out the cerpospora affected leaf. After Filtration Masking based on threshold value is applied.

The masked region is the disease affected region. A morphological smoothing is applied to avoid misclassifications. Next the ROI, diseased chunk from our input image is extracted and highlighted. [6] Calculates disease severity in soybean. Also [7] and [8] discusses image processing techniques and calculates severity of disease for cotton plants.

(a) NLB affected Corn Maize Leaf



(b) Cerpospora affected maize Leaf



(c) Healthy Maize Leaf

Figure 5: Color Filtering, Threshold Masking and Extraction of ROI

V. SEVERITY ANALYSIS

Totally 30 leafs are tested and the results obtained are tabulated. Table 1 shows results obtained after analyzing 10 NLB leaves. Table 2 shows the results of 10 cerpospora leaves and Table 3 shows results obtained from 10 healthy leaves. NLB leaves (n1-n10), Cerpospora (c1-c10) and Healthy leaves (h1-h10) are undergone with the all the steps of the proposed method. TPC (Total pixel Count) of the image, DPC (Diseased Pixel Count), UPC (Unaffected pixel Count) are derived for all the 30 images. From these values SP (Severity Percentage) and HP (Healthy Percentage) values are calculated.

// Healthy unaffected percentage

If SP ranges from (1-3) - L

(3- 7) – M

(7-10)- H

(> 10) – VH

(0-1)- VL

0 - N

Table 1. NLB disease Severity Analysis

Image	TPC	DPC	UPC	SP	HP	SL
n1	196608	8408	188200	4.28	95.72	M
n2	196608	13874	182734	7.06	92.94	H
n3	196608	8324	188284	4.23	95.77	M
n4	196608	4576	192032	2.33	97.67	L
n5	196608	9104	187504	4.63	95.37	M
n6	196608	5789	190819	2.94	97.06	L
n7	196608	4917	191691	2.50	97.50	L
n8	196608	10493	186115	5.34	94.66	H
n9	196608	28601	168007	14.55	85.45	VH
n10	196608	3680	192928	1.87	98.13	L

Table 2. Cerpospora disease Severity Analysis

Image	TPC	DPC	UPC	SP	HP	SL
c1	196608	13253	183355	6.74	93.26	M
c2	196608	6661	189947	3.39	96.61	L
c3	196608	11832	184776	6.02	93.98	M
c4	196608	10317	186291	5.25	94.75	M
c5	196608	7395	189213	3.76	96.24	L
c6	196608	8950	187658	4.55	95.45	M
c7	196608	16523	180085	8.40	91.60	H
c8	196608	13478	183130	6.86	93.14	M
c9	196608	12292	184316	6.25	93.75	M
c10	196608	15607	181001	7.94	92.06	H

Table 3. Healthy Leaf disease Severity Analysis

Image	TPC	DPC	UPC	SP	HP	SL
h1	196608	0	196608	0.00	100.00	N
h2	196608	119	196489	0.06	99.94	VL
h3	196608	0	196608	0.00	100.00	N
h4	196608	236	196372	0.12	99.88	VL
h5	196608	0	196608	0.00	100.00	N
h6	196608	849	195759	0.43	99.57	VL
h7	196608	0	196608	0.00	100.00	N
h8	196608	15	196593	0.01	99.99	VL
h9	196608	0	196608	0.00	100.00	N
h10	196608	0	196608	0.00	100.00	N

From the Table 3 it can be noted that the healthy leaf h6 with no disease shows the diseased pixel count of 849 and severity percentage as 0.43 and disease severity VL. Even though this count is negotiable it's because of the background pixels misclassified as diseased portion. This is the false positive portion to be dealt with.

This healthy h6 image (shown in Figure 7.a) misclassified have a jurk in the severity analysis chart shown in the Figure 6. Also from the chart it can be noticed that from the Table 2, NLB image n9 is marked as VH which seems to be a very high risk factor and a higher switch can be observerd parallely in the severity chart Figure.6 which is to be notified immediately as it is a high risk factor

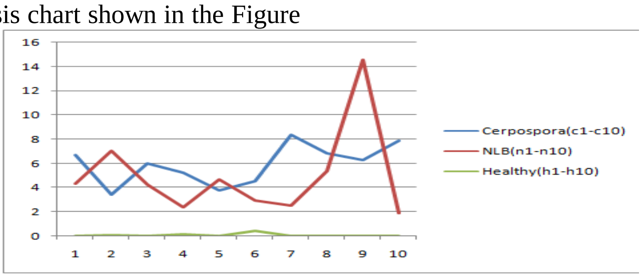


Figure 6.Severity Analysis Chart

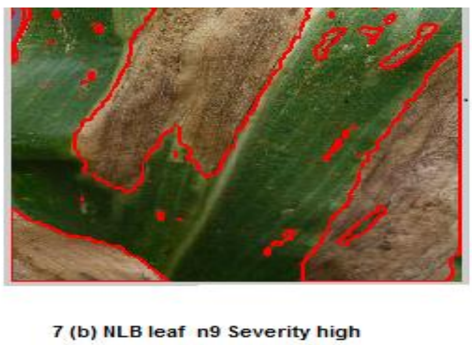
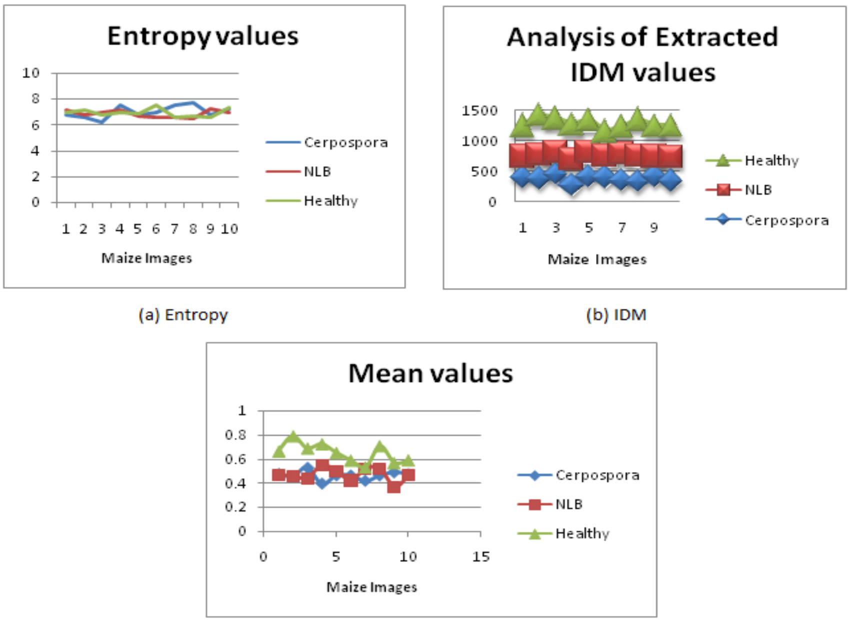


Figure 7 compares healthy and NLB affected maize leaf.

Also Figure 7(b) shows maize leaf with high severity percentage SP greater than 14. Picking out a cerpospora leaf with a dark shadow as a diseased area which is a similar case to 7(a) which dosent properly handle the background only in this particular leaf. This Study discusses in depth about the separation of diseased chunk of a maize leaf. The maize leaf is analyzed and the segmented parts indicate the diseased area. If no segmented area is extracted then it shows a healthy maize leaf.

The maize leaf is analyzed and the segmented parts indicate the diseased area. If no segmented area it shows a healthy maize leaf. Various features are extracted from the leaf and the comparison chart is produced. The Mean and IDM values of a Healthy Maize Leaf seem to have a higher range of value than the Northern Leaf Blight (NLB) and Cerpospora affected Leaf images.



(a) Entropy (b) IDM

(c) Mean

Figure 8 .Entropy, IDM and Mean values of Cerpospora, NLB and healthy Leaves

Figure 8 shows the comparison of the Entropy, IDM and Mean values of Cerpospora, NLB and healthy Leaves. It works well in well captured images. But in images with shadows or high illuminated images, the dark shadows are extracted as disease. This is the underlying problem to be sorted out.

K-means clusters are obtained for a healthy maize image h13 as shown in Figure.9. K-means produces a false Positive and identifies 52770 pixels (DPC) as diseased with a severity percentage as 26.84 and Severity Level (SL) as VH. Actually it is a healthy leaf with overlapping of other maize leaf. Proposed method produces no mask and extracts no ROI as shown in Figure 10. Table 5 also shows the DPC as zero with Sp as zero and produces a True negative.

(a) K-means Cluster 1 (b) K-means Cluster 2 (c) K-means Cluster 3

(a) original image (b) Mask (c) No ROI extracted

Figure 9.K-means clustering applied to a healthy maize leaf with False positive Figure 10 Proposed Method of healthy maize leaf with true Negative

Image	TPC	DPC	UPC	SP	HP	SL
H13	196608	52770	143838	26.84	73.15	VH

Table 4. K-Means -Healthy maize leaf h13 with False Positive [Sp =26.84]

Image	TPC	DPC	UPC	SP	HP	SL
H13	196608	0	196608	0.00	100.00	N

Table 5. Proposed Method -Healthy maize leaf h13 with True Negative [Sp=0]

VI CONCLUSION

The database of healthy and NLB, cerpospora and common rust affected maize leafs are collected. These RGB images are converted to HSV color space. Then using color filtering Technique non-green color pixels are filtered out and a threshold mask is applied. These affected regions ROI, is extracted from the original image and their Entropy, Mean and IDM values of around 50 leafs are extracted and compared. These values after analysis show that the Mean and IDM values of healthy leaf seem to be higher range than the affected leafs. The Entropy value of healthy also seems to deviate lighter than the affected part. Tests have demonstrated that there is still opportunity to get better. A few moves might be made during the catch so as to maintain a strategic distance from a considerable lot of the issues watched, for example, staying away from specular reflections and light/shadow blends.

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