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27th October 2021

Jointly Organized by

Department of Biological Science, Physical Science and Computational Science

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ABOUT THE INSTITUTION

A nations's growth is in proportion to education and intelligence spread among the masses. Having this idealistic vision, two great philanthropists late. S.P. Nallamuthu Gounder and Late. Arutchelver Padmabhushan Dr.N.Mahalingam formed an organization called Pollachi Kalvi Kazhagam, which started NGM College in 1957, to impart holistic education with an objective to cater to the higher educational needs of those who wish to aspire for excellence in knowledge and values. The College has achieved greater academic distinctions with the introduction of autonomous system from the academic year 1987-88. The college has been Re-Accredited by NAAC and it is ISO 9001 : 2015 Certified Institution. The total student strength is around 6000. Having celebrated its Diamond Jubilee in 2017, the college has blossomed into a premier Post-Graduate and Research Institution, offering 26 UG, 12 PG, 13 M.Phil and 10 Ph.D Programmes, apart from Diploma and Certificate Courses. The college has been ranked within Top 100 (72nd Rank) in India by NIRF 2021.

ABOUT CONFERENCE

The International conference on “Emerging Trends in Science and Technology (ETIST-2021)” is being jointly organized by Departments of Biological Science, Physical Science and Computational Science - Nallamuthu Gounder Mahalingam College, Pollachi along with ISTE, CSI, IETE, IEE & RIYASA LABS on 27th OCT 2021. The Conference will provide common platform for faculties, research scholars, industrialists to exchange and discus the innovative ideas and will promote to work in interdisciplinary mode.

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Linear and Non-Linear Filtering Mechanisms for Detecting the Strawberry Plant Leaf Diseases

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ABSTRACT: The deficiency diseases are the diseases that are affected within the very early stages in plant leaves. In strawberry plant leaves, various deficiency diseases occur during the yield. one among the foremost and customary deficiency are Nitrogen(N), Phosphorous(P), and Potassium(K) are considered to be the building block of plants. This paper is to spot these three nutrient deficiencies in strawberry leaves by using digital image processing methods. Here, the diseased leaves are pre-processing and segmented the diseased spot and therefore the disease feature vector is extracted. Filtering of images is a crucial process in image processing. it's mostly used for noise removal, blur removal, edge detection etc. Linear and Non-Linear is that the algorithms that are mostly commonly used algorithm in image filtering. The experimental results show the efficiency of the three deficiency diseases for strawberry plants by using box and gaussian filtering algorithm in linear filter and median and bilateral filtering algorithm in non-linear filter.

Keywords: Deficiency diseases, Digital Image Pre-processing, Segmentation, Feature Extraction, Linear Filter, Non-Linear Filter.

I Introduction

Strawberry is one of the easiest fruits to grow and great for beginners. The best thing about strawberry plants is that they are relatively easy to grow and maintain as long as you keep them in a location that gets full sun. The total production is about 6 million tonnes, with the USA the most important producing countries. It can be grown successfully in a wide variety of soils from sandy to silty clay but will grow best in deep, well-draining loam rich in organic matter. The optimum pH for their growth is between 5.5 and 6,5. If drainage is poor then it is recommended to plant strawberries on beds raised by a minimum of 15-20cm (6-8 in).

Strawberries generally fall into 3 categories: June-bearing, Evergreen, and Day-neutral. June-bearing plants commonly produce large fruits, and, as their name suggests, will produce a crop of fruit over a 2–3week period around June. Evergreen strawberry varieties produce two (and sometimes 3) crops of fruit per year in spring and late summer or early fall. Day-neutral strawberry varieties will give you fruit in the first year generally produce smaller fruits but will produce whenever the temperature is between 1.6–29°C (35–85°F). The deficiency diseases in strawberries are very tricky to identify. They are various deficiency diseases that are occurred during crop growth and production, there are Nitrogen, Phosphorous, Potassium, sulphur, Manganese

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and Zinc, Iron, copper, Calcium and Boron deficiency symptoms. So, the deficiency diseases are identified at early stages themselves to produce a better yield in the future and help in agricultural sectors. Since nitrogen (N), phosphorous (P), and potassium (K) are considered to be the building blocks of plants, this article will focus on identifying these three nutrient deficiencies in strawberries.

II Proposed Methodology

There are quite a few diseases that affect strawberry plants. The strawberry plant's leaves, roots, and fruit are all liable to a variety of diseases, depending on the confrontation of the strawberry plant cultivar being considered. The various diseases in plants are Red Stele

Root Rot, Leaf Spot, Leaf Blight, Leaf Scorch, Gray Mold, Leaf Variegation, Leather Rot (Crown Rot).

Image filtering is done through the quality of the images. For ex. Smoothening the images, enhancing the quality of the image and reduces the cost of the blurred images. Filtering algorithms are broadly classified into two types (i.e) Linear and Non-linear algorithms: The linear image filter is one the most important filtering algorithms that are commonly used for powerful image enhancements. The non-linear filter is used to remove the unwanted noises from the digital images. The output is not a linear function of its input thus, its results various in non-initiative manner. Here the image shows how the median filter enhances the images by reducing the noise and smoothening. For further processing the images like image segmentation, edge detection etc. noises should be eliminated. The median filter is a non-linear algorithm to detect and remove the noises from the image and it retains the edges while removing the noise so, it is most widely used. The noises are evaluated and categorized as noisy pixels and switching based on median filter and it is applied to other pixels which are not noisy.

Bilateral filter is one of the non-linear filters and it reduces the noise by smoothening and preserves edges of the images. It exchanges the intensity of each pixel with a weighted average of intensity values from nearby pixels.

Filtering of images is an important process in image processing. It is mostly used for noise removal, blur removal, edge detection etc. Linear and Non-Linear is the algorithms that are mostly commonly used algorithm in image filtering.

Nitrogen, phosphorous and potassium are the nutrients that plants need in the largest quantities [1]. They are so important to plant health that plants would fail to thrive without them and death would be a certainty.

A. NITROGEN DEFICIENCY

The nitrogen deficiency in strawberry plants can cause rather significant problems for the longevity and vitality of strawberry patch. If your soil is low nitrogen then you can expect consequences. The deficiency is in middle-aged leaves and the yellow strawberry plant leaves occur in these middle-aged leaves, primarily, and not the new, still-green leaves emerging from the crown. This is due to two factors. First, nitrogen is a component in many amino acids. Second, the young leaves emerging from the crown exacerbate the deficient state of the middle-aged leaves by appropriating for themselves the nitrogen that otherwise would have been used in the older leaves.

B. PHOSPHOROUS DEFICENCY

Phosphorous is an essential nutrient for fruit production, so fruits with P deficiencies tend to be small and soft. In general, strawberries do not have a very high demand for P and shortages of this macronutrient are rare. Visual symptoms of a P deficiency are difficult to discern, and by the time they appear the deficiency has already taken its toll on crop quality and yields. In severe cases, upper leaf surfaces take on a shiny appearance and turn dark green; the undersides take on a reddish-purple cast.

C. POTASSIUM DEFICENCY

Potassium is necessary for many plant functions such as enzyme activity, photosynthesis, and water movement. Deficiency symptoms first show up on mature leaves, particularly on the leaf margins. The damage works its way inward between the veins and eventually necrosis occurs. Short, brittle petioles and leaf scorch also indicate a K problem. Other noticeable differences include decreased runner production and deteriorating fruit.

III Linear Filtering Algorithm

Filtering is a *neighborhood operation*, in which the value of any given output image is determined by applying some algorithm to the values of the pixels in the corresponding input pixel. Linear filtering is the filtering algorithm in which the output of the images is linear combination to the neighborhoods input images. The box filtering and Gaussian filtering are the two linear filtering methods.

A. BOX FILTER

Box filtering is an average-of-surrounding-pixel and it's a sort of image filtering method. it's actually a convolution filter which is employed commonly a mathematical process for image filtering and it provides a way of multiplying two arrays to supply a third array. In box filtering, the strawberry leave image samples and therefore the filtered kernel are multiplied to urge the filtering image result. The filter kernel is sort of a description of how the filtering goes to happen, it actually defines the sort of filtering. the facility of box filtering general image filter which will do sharpen, emboss, edge-detect, smooth, motion-blur, etcetera. Provided appropriate filter kernel is employed.

A box blur allows with a complexity independent of a filter radius. The sum S of elements within the rectangular window are often decomposed into sums C of columns of this window.

$$S(i,j) = \sum_{k=-r}^{+r} C[i,j+K]$$

This allows a simple update rule when window S is moving from left to right.

$$S[i,j+1 = S[i,j] + C[i,j+r+1] - C[i,j-r]$$

Column sums C can be, in turn, effectively updated when window S is moving to the next row:

$$C[i+1,j] = C + x[i+r+1,j] - x[i-r,j]$$

Here,

x[i,j] are image pixel values,

C[I,j] are sum of (2r+1) – pixel columns centered at [i,j], and

S[i,j] are sum of (2r+1)(2r+1)- pixel square window centered at [i,j]

The result of the box filter is

$$B[i,j] = \frac{1}{(2r+1)^2} S[i,j]$$

and it requires one multiplication per pixel after S[i,j] is calculated. So, the overall per-pixel complexity of the box filter is 4 additions and one multiplication per pixel. Some additional over head is required to calculate initial values of C and S at the image boundaries.

Figure 1 represents the Nitrogen Deficiency image as an input image and noise has been removed by Box filtering methods.

Figure 2 represents the Phosphorous Deficiency image as an input image and noise has been removed by Box filtering methods.

Figure 3 represents the Potassium Deficiency image as an input image and noise has been removed by Box filtering methods.

B. GAUSSIAN FILTER

The gaussian filtering is used to blur the images and remove the noises from the input images. Using Gaussian filter for noise suppression, the noise is smoothed out, at the same time the signal also distorted. The use of gaussian filter is used to detect the edges. The two-dimensional gaussian filter is expressed as

$$G(x,y) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{x^2 + y^2}{2\sigma^2}\right)$$

Where, σ^2 is the variance of Gaussian filter, and the size of the kernel filter. The Gaussian filter is used for noise suppression and a large variance filter is effective in smoothening the noises.

Figure 4 represents the Nitrogen Deficiency image as an input image and noise has been removed by Gaussian filtering methods.

Figure 5 represents the Phosphorous Deficiency image as an input image and noise has been removed by Gaussian filtering methods.

Figure 6 represents the Potassium Deficiency image as an input image and noise has been removed by gaussian filter

III Non-Linear Filter

The non-linear filter has several types and the one main thing is to remove the unwanted noises from the images. Sometimes the non-linear filtering algorithms is used to perform the other tasks and for the large set of images data. Median and Bilateral are the two effective algorithms that are used for image filtering.

A. MEDIAN FILTER

The median filter is one of the well-known algorithms in statistical type due to its good performance of the algorithm some specific noise types such as gaussian, random and salt and pepper noises [9]. And it is particularly effective in removing 'salt and pepper noises' from the images. The median filter works by moving each pixel by pixel and replaced by the median valve of the corresponding images. Here the noise pixels are considered different from the noise removal. The following are the error detection method i) noise-free edges are separated and the smoothly varying areas, ii) pixel in the image noise has an uneven intensity i.e either it is low or high in comparison of neighbourhood image. The two image sequences are generated one is series of Gray-scale images, $x_{(i,j)}^{(0)}, x_{(i,j)}^{(1)} \dots\dots\dots, x_{(i,j)}^{(n)}$. Here the first image $x_{(i,j)}^{(0)}$ is a noisy image of i, j where the position in the image is $1 \leq i \leq M$, $1 \leq j \leq N$, the M and N represents the directions of the image pixels in vertical and horizontal direction respectively.

Figure 7 represents the Nitrogen Deficiency image as an input image and noise has been removed by Median filtering methods.

Figure 8 represents the Phosphorous Deficiency image as an input image and noise has been removed by Median filtering methods.

Figure 9 represents the Potassium Deficiency image as an input image and noise has been removed by Median filtering methods.

B. BILATERAL FILTER

It is simple non-linear filtering algorithm method; it conserves the edges through smoothening the noisy image by quality combination of nearby images. It also combines the gray scale level image or colors and prefers nearby values than the distant values in both the domain and range. It is similar to Gaussian convolution as it is average of the pixels but the bilateral filter considers the variations in intensities and it preserves the edges of the images.

The bilateral filter is defined by:

$$BF[I]_p = \frac{1}{W_p} \sum_{q \in S} G_{\sigma s}(||p - q||) G_{\sigma r}(Ip - Iq) Iq$$

Where W_p is a normalization factor:

$$W_p = \sum_{q \in S} G_{\sigma s}(||p - q||) G_{\sigma r}(Ip - Iq)$$

Where r and s are the amount of filtration, first one represents the normalized weighted average where the spatial Gaussian $G_{\sigma s}$ decreases the impact of distant pixels, the range Gaussian $G_{\sigma r}$ reduces the impact of q pixels having their intensity values other than I_p. Range signifies the quantities such as pixel values, that refers to the location of pixels in contrast to the space.

Figure 10 represents the Nitrogen Deficiency image as an input image and noise has been removed by Bilateral filtering methods.

Figure 11 represents the Phosphorous Deficiency image as an input image and noise has been removed by Bilateral filtering methods.

Figure 12 represents the Potassium Deficiency image as an input image and noise has been removed by Bilateral filtering methods.

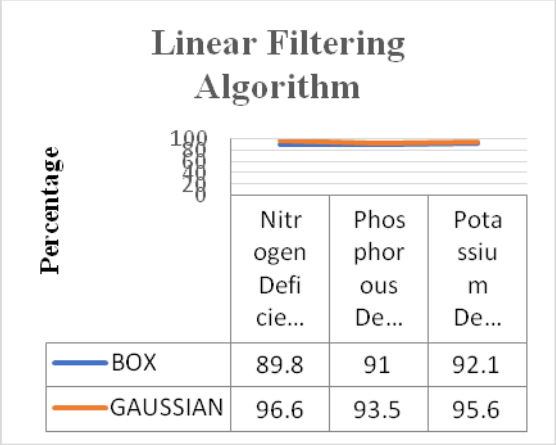
IV Experimental Result and Analysis

The input image of strawberry leaf with deficiencies like Nitrogen, Phosphorous and Potassium has been used as experimental image are collected from Kaggle. The simulation has been carried out using MATLAB, the noises have been removed using different filtering methods of Linear based (Box, Gaussian) and Non-Linear based filter (Median, Bilateral). The performance evaluation of linear and non-linear filtering methods is shown.

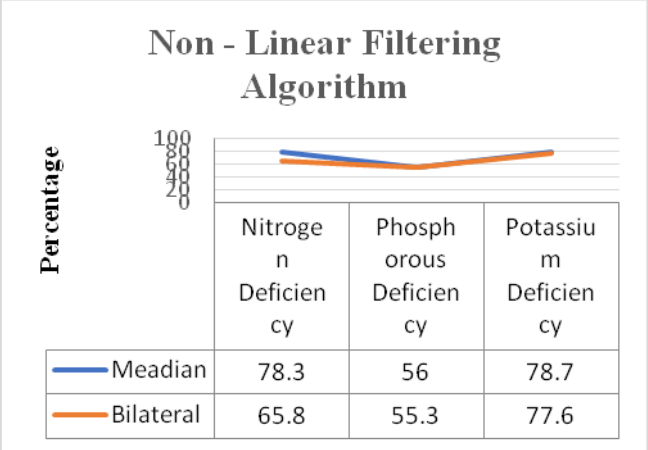
Deficiencies	Linear		Non-Linear	
	Box	Gaussian	Meadian	Bilateral
Nitrogen Deficiency	89.8	96.6	78.3	65.8
Phosphorous Deficiency	91	93.5	56	55.3
Potassium Deficiency	92.1	95.6	78.7	77.6

The table 1, represents the quality of the image has been compared using image filtering algorithms Linear and Non-Linear Algorithms. Figure 1 represents the Linear for 2 filters.

The Experimental results shows that the Linear values for Box is lower than Gaussian. Figure 2 represents the Non-Linear values. This shows that the Linear filter is efficient than Non-Linear filtering methods



Performance evaluation Linear Filtering Algorithms with Box and Gaussian



Performance Evaluation Non – LinearFiltering Algorithms with Median and Bilateral

V CONCLUSION

Nitrogen, phosphorous and potassium deficiencies are the most widely recognized leaf sicknesses and they all overwinter in contaminated dead or living leaves. They all produce spores that spread the illness by causing new diseases during wet, warm conditions. In this work the digitally captured image having noise background is initially filtered using various type image filters of Linear (Box, Gaussian Filter) and Non-Linear filters (Median and Bilateral filter) Filter. The background noise should be removed by filtering methods. The experimental result shows that the Non-Linear filter value is lower than the Linear filter. This shows that Linear filtering methods have more efficient than the non-linear filter. For future enhancement the linear filter is the base for filtering algorithms which will be used for further classification process and identify the leaf diseases easily by use mobile application.

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